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# OVERFIRE AIR TECHNOLOGY FOR TANGENTIALLY FIRED UTILITY BOILERS BURNING WESTERN U.S. COAL

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# FIELD TEST PROGRAM TO STUDY STAGED COMBUSTION TECHNOLOGY FOR TANGENTIALLY FIRED UTILITY BOILERS BURNING WESTERN U.S. COAL TYPES

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# ABSTRACT

This report presents the findings of a program designed to investigate and evaluate the effectiveness of employing overfire air as a method of reducing $NO_x$ emission levels from tangentially fired boilers burning Western U.S. coal types. This work was performed under the sponsorship of the Office of Research and Development of the Environmental Protection Agency (Contract 68-02-1486). The results of this program are compared with the results obtained under Phase II "Program for Reduction of $NO_x$ from Tangentially Coal Fired Boilers" (Contract 68-02-1367).

These test programs investigated the effect that variations in excess air, unit slagging, load and overfire air had on unit performance and emission levels. Additionally, the effect of biasing combustion air through various out-of-service fuel nozzle elevations was also investigated. The effect of overfire air operation on waterwall corrosion potential was evaluated during thirty (30) day baseline and overfire air corrosion coupon tests. The results of the corrosion coupon tests indicate that overfire air operation for low $NO_x$ optimization will not result in significant increases in corrosion coupon degradation.

Overfire air operation and reductions in excess air levels were found to be effective in reducing $NO_x$ emission levels. $NO_x$ reductions of 20 to 30 percent were obtained when operating with 15 to 20 percent overfire air. These reductions occurred with the boilers operating at a total unit excess air of approximately 15 to 25 percent as measured at the economizer outlet. Unit loading exhibited a minimal effect on $NO_x$ emission levels. Waterwall slag conditions were found to have wide and inconsistent effects on $NO_x$ emission levels.

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# CONVERSION FACTORS

## SI METRIC UNITS TO ENGLISH UNITS

| To Convert From | To | Multiply By |
|---|---|---|
| kg/s | $10^3$LB/HR | 7.936640 |
| ng/J | LB/$10^6$BTU | 2.326E-3 |
| MJ/s | $10^6$BTU/HR | 3.412141 |
| ug/J | LB/$10^6$BTU | 2.326 |
| kJ/kg | BTU/LB | 4.299226E-1 |
| MPa | PSIA | 1.450377E+2 |
| KW/$m^2$ | $10^6$BTU/HR-$FT^2$ | 3.16998E-1 |

## ENGLISH UNITS TO SI METRIC UNITS

| To Convert From | To | Multiply By |
|---|---|---|
| $10^3$LB/HR | kg/s | 1.259979E-01 |
| PSIA | MPa | 6.894757E-3 |
| LB/$10^6$BTU | ng/J | 4.29922E+2 |
| LB/$10^6$BTU | ug/J | 4.29922E-1 |
| $10^6$BTU/HR | MJ/s | 2.930711E-1 |
| BTU/LB | kJ/kg | 2.326 |
| $10^6$BTU/HR-$FT^2$ | KW/$m^2$ | 3.154594 |

$^oF = 1.8(^oC)+32^o$

## ABBREVIATIONS AND SYMBOLS

| Abbreviations | Definitions |
|---|---|
| $NO_x$ | Oxides of Nitrogen |
| THC | Total Hydrocarbons |
| NA | Not Available |
| X-S | Excess |
| WW | Waterwall |
| MCR | Maximum Continuous Rating |
| TA | Theoretical Air to Fuel Firing Zone |
| EA | Excess Air |
| FFZ | Fuel Firing Zone |
| NSPS | New Source Performance Standard |

| Symbols | |
|---|---|
| $NO_2$ | Nitrogen Dioxide |
| CO | Carbon Monoxide |
| $O_2$ | Oxygen |
| $SO_2$ | Sulfur Dioxide |
| $CO_2$ | Carbon Dioxide |

## ACKNOWLEDGMENTS

The authors wish to acknowledge the constructive participation of Mr. D. G. Lachapelle, EPA Project Officer, in providing the program direction necessary for its successful completion.

The cooperation and active participation of the following companies and, in particular, the personnel at the respective plants were essential to successfully conducting the various test program phases.

1. Alabama Power Company
   Barry Station, Unit #2

2. Utah Power and Light Company
   Huntington Station, Unit #2

3. Wisconsin Power and Light Company
   Columbia Station, Unit #1

The results presented in this report represent the effort of many Combustion Engineering, Inc. personnel whose participation was required for its successful completion. In particular the technical contributions made by R. F. Swope, R. W. Robinson, E. R. LePage, L. A. Ratte, M. S. Hargrove and K. M. Cerrato are gratefully acknowledged.

## SECTION I

## INTRODUCTION

The emphasis on improved quality of the environment has led to the design of coal fired steam generators with the capability of using overfire air to reduce and control $NO_x$ emission levels. For tangentially fired steam generators, the overfire air is admitted through registers in an extended windbox.

Previous work with coal fired steam generators has demonstrated that overfire air simulation with tangential firing is effective in reducing $NO_x$ emission levels by as much as 50 percent of uncontrolled values.

Some of this previous work was performed by Combustion Engineering, Inc. under an EPA-sponsored two-phase program to identify, develop and recommend the most promising combustion modification techniques for the reduction of $NO_x$ emissions from tangentially coal fired utility boilers with a minimum impact on unit performance.

This two-phase program is briefly described as follows:

Phase I (performed under EPA Contract 68-02-0264) consisted of selecting a suitable utility boiler to be modified for experimental studies to evaluate $NO_x$ emission control. Phase I also included the preparation of preliminary drawings, a detailed preliminary test program, a cost estimate and detailed schedule of the program phases and a preliminary application economic study indicating the cost range of a variety of combustion modification techniques applicable to existing and new boilers [1]*.

Phase II (performed under EPA Contract 68-02-1367) consisted of modifying and testing the utility boiler selected in Phase I to evaluate overfire air and biased firing as methods for $NO_x$ control. This phase also included:

1. The completion of detailed fabrication and erection drawings,
2. Installation of analytical test equipment,
3. Updating of the preliminary test program,
4. A baseline operation study,
5. Analysis and reporting of test results and,

* Numbers in brackets refer to references at end of report.

6. The development of control technology application guidelines for existing and new tangentially coal fired utility boilers.

This program was conducted at the Barry Steam Station, Unit #2 of the Alabama Power Company [2].

The majority of this previous work has been conducted on units firing Eastern or Midwestern bituminous coals.

In recent years, the utilization of Western U.S. coals as an energy source has increased significantly. The incentives for their use are the low sulfur content conducive to low $SO_x$ emission levels and the large available reserves that may be used in lieu of oil and natural gas which are in short supply.

Based on Phase II recommendations to investigate Western coal types which were becoming a predominate source of fuel for electric generating stations, this study, EPA Contract 68-02-1486, was contracted by Combustion Engineering, Inc.'s, Field Testing and Performance Results Department.

The objective of this program was to investigate the effectiveness of employing overfire air as a method of reducing $NO_x$ emission levels from tangentially fired boilers burning Western U.S. coals. The effect of reducing $NO_x$ emission levels was evaluated with respect to unit performance, unit efficiency, waterwall corrosion rates and related gaseous emission levels.

Specifically, the factors considered in realizing this objective were as follows:

1. The program was conducted on two units designed with overfire air registers, the first unit firing a Western U.S. subbituminous coal and the second unit firing a Western U.S. bituminous coal.

2. The test program evaluated baseline, biased firing and overfire air operation and consisted of approximately 60 steady state tests per unit and two months of waterwall corrosion rate studies per unit.

3. The effect of $NO_x$ control methods on all gaseous constituents was evaluated during all tests. The following constituents were measured: $NO_x$, $SO_x$, CO, THC, $O_2$ and particulate samples for unburned combustible analysis.

4. The effects of $NO_x$ control methods on steam generator performance were evaluated during all tests by obtaining necessary temperatures, pressures, flows, etc., with calibrated equipment.

5. Based on the results of this program, conclusions and recommendations were made pertaining to the acceptable application of staged firing with respect to $NO_x$ emission levels, corrosion rates and unit operation for each type of coal tested.

6. The results of this program were compared with the results obtained under Contract 68-02-1367 for a unit equipped with an overfire air system not included in the original design.

# CONCLUSIONS

## NORMAL OPERATION

1. Under normal unit operation without overfire air, excess air variation was found to have the greatest single effect on $NO_x$ emission levels, increasing $NO_x$ with increasing excess air. An average increase of 6.4 ng/J for each one percent change in excess air (EA) was observed over a normal operating range of 15 to 25 percent EA for the three units.

2. Unit loading was found to have a limited effect on $NO_x$ and CO emission levels and carbon heat loss.

3. Variations in furnace waterwall deposits had wide and inconsistent effects on $NO_x$ and CO emission levels and carbon heat loss.

4. Under normal unit operation, the percent carbon loss in the fly ash and CO emission levels increased with decreasing excess air with the increases becoming greater below a level of approximately 20 to 25 percent excess air. CO levels in excess of 24 ng/J were considered unacceptable for the purposes of this program.

## BIASED FIRING OPERATION

Biased firing was found to be most effective when the top fuel firing elevation was removed from service. This mode of operation simulates overfire air operation. However, while biased firing is a potentially effective method of $NO_x$ control, it may necessitate a reduction in unit loading. Therefore, biased firing is not considered to be the most desirable method of $NO_x$ control.

## OVERFIRE AIR OPERATION

1. $NO_x$ reductions of 20 to 30 percent were obtained with 15 to 20 percent overfire air when operating at a total unit excess air of approximately 15 to 25 percent as measured at the economizer outlet.

   This condition would provide an <u>average</u> fuel firing zone stoichiometry of 95 to 105 percent of theoretical air. Stoichiometries below this range did not result in large enough decreases in $NO_x$ levels to justify their use.

2. When using overfire air as a means of decreasing the theoretical air to the fuel firing zone, the combustible loss and CO emission levels were less affected than when operating with low excess air since during overfire air operation, acceptable overall excess air levels are maintained. Reduction in operating excess air levels for $NO_x$ control is often precluded because of the ash properties of the coal being fired. Further, as coal is an extremely complex fuel characterized by wide variations in properties, even

between different seams in the same mine area, excess air is the only means available to the operator to compensate for departures from the design coal. For the above reasons, the application of overfire air rather than low excess air firing is recommended on coal fired steam generators.

3. Furnace performance as indicated by waterwall slag accumulations, visual observations and absorption rates were not affected by overfire air operation.

4. At Alabama Power Company's Barry Station Unit #2 where the overfire air port could not be installed as a windbox extension, test results indicated that the centerline of the overfire air port should be kept within 3 meters of the centerline of the top fuel elevation. Distances greater than 3 meters did not result in significantly decreased $NO_x$ levels. On new designs, and whenever possible on field modified units, it is preferable to introduce the overfire air through a vertical extension of the windbox rather than through isolated ports displaced above the windbox. The effectiveness of introducing overfire air through an extended windbox is demonstrated via the tests conducted on Wisconsin Power & Light, Columbia #1 and Utah Power & Light, Huntington Canyon #2. The overfire air compartments on an extended windbox tilt independently of the remainder of the windbox to permit adjustments in the "point" of overfire air introduction.

5. Optimum overfire air operation was obtained when the overfire air registers were tilted away from the fuel nozzles. $NO_x$ control was nearly as effective when the overfire air registers were tilted with the fuel nozzles. $NO_x$ emission levels increased when the overfire air registers and fuel nozzles were directed toward each other. At Alabama Power Company's Barry Station Unit #2, flame stability decreased when the overfire air registers and fuel nozzles were directed away from each other by more than 20 to 25 degrees. This phenomena was not observed at either Wisconsin Power and Light Company's Columbia Energy Center Unit #1 or at Utah Power and Light Company's Huntington Station Unit #2. With the overfire air tilts fixed in a horizontal position, acceptable unit operation was obtained, however, $NO_x$ levels varied with fuel nozzle position.

6. The results of the thirty day baseline and overfire air corrosion coupon runs indicate that the overfire air operation for low $NO_x$ optimization did not result in significant increases in corrosion coupon degradation. Additional long-term operation studies will be required to verify these observations.

7. The average $NO_x$ levels experienced during the thirty day overfire air studies were as follows: Barry #2-172 ng/J, Huntington Canyon #2-231 ng/J and Columbia #1-294 ng/J. The emission levels for Columbia #1 reflect operating conditions beyond the control of the test program.

8. Variables normally used to control normal boiler operation should not be considered as $NO_x$ controls with coal firing. These variables include unit load, nozzle tilt, pulverizer fineness, windbox dampers and total excess air.

9. Overall unit efficiency was not affected by overfire air operation.

## RECOMMENDATIONS

This program was designed to investigate the effects of the following process variables and combustion modifications on $NO_x$ emission levels in existing steam generating units:

Process Variables

Excess Air Level
Unit Load
Furnace Waterwall Deposits

Combustion Modifications

Biased Firing
Overfire Air Firing

The effects of furnace waterwall deposits could not be adequately documented. Several investigations have indicated that furnace waterwall deposits can effect $NO_x$ emission levels. Therefore, this process variable should be investigated further.

The effect of fuel nitrogen on $NO_x$ formation was not investigated per se in this program. However, as the effect of fuel nitrogen is becoming of increasing concern, its contribution to $NO_x$ emission levels in coal fired boilers should be quantified.

Additionally, the results of the corrosion probe evaluations indicate that the coupon weight losses encountered during a thirty day evaluation are small and consideration should be given to studies of up to one year duration to verify short term test results. These studies should include evaluation of actual fireside waterwall tube wastage rates as well as corrosion probe wastage rates.

## SUMMARY

Percent excess air, bulk flame temperature and residence time of the combustion gases all directly affect the formation of oxides of nitrogen ($NO_x$). The two oxides of nitrogen which are of significance are nitric oxide (NO) and nitrogen dioxide ($NO_2$). NO is the more predominant form and accounts for 90 to 95 percent of the total $NO_x$ generated in a utility boiler. Once it enters the atmosphere NO is converted to $NO_2$, which is more hazardous to human health. Most references in this report to $NO_2$ are actually refering to total nitrogen oxides. This method of expressing $NO_x$ as $NO_2$ is in agreement with EPA practice.

While it is not the subject of this report, it should be noted that $NO_x$ generated by the combustion of coal can occur by two mechanisms. One mechanism is by the oxidation of atmospheric nitrogen (thermal $NO_x$) while the other mechanism involves the conversion of fuel bound nitrogen (fuel $NO_x$). The formation of thermal $NO_x$ is known to be dependent on flame temperature, oxygen concentration in the combustion zone and residence time at temperature.

Several investigators have observed that the formation of fuel $NO_x$ is responsible for a significant portion of the total $NO_x$ emitted from the combustion process [3,4,5,6]. The reaction can take place at a much lower flame temperature and has also been shown to be dependent on the oxygen concentration in the combustion zone. The coals being fired at Alabama Power Company's Barry #2 and Utah Power and Light Company's Huntington Canyon #2 had nitrogen analysis ranging from 1.1 to 1.3 percent nitrogen by weight. Wisconsin Power and Light Company's Columbia #1 had an analysis ranging from 0.6 to 0.8 percent nitrogen by weight. Preliminary plots of $NO_2$ versus the coal nitrogen content did not show any correlation between $NO_2$ and coal nitrogen content. Any correlation would probably have been masked by the limited range of the nitrogen content of the coals being fired and by the variation in excess air levels.

### BASELINE OPERATION STUDY

It has been well documented that the formation of $NO_x$ is dependent upon excess air and the oxygen concentration in the combustion zone. The oxygen concentration in the combustion zone is directly related to excess air and also to the theoretical air to the fuel firing zone (TA). TA is a computational tool used by Combustion Engineering, Inc. which accounts for variations in position and leakage in all windbox compartment dampers.* This method allows for the accounting of leakage in the compartments above the top active fuel compartment and, therefore, is a better approximation of the actual air (i.e., oxygen) available for combustion in the fuel firing zone than total excess air (EA). Therefore, all parameters are plotted versus theoretical air to the fuel firing

* See Appendix D.

zone rather than the total excess air. For the baseline operation study the TA is essentially the same as the total air since no air was diverted through the overfire air registers.

Figure 1 is a plot of $NO_2$* versus TA for the full load baseline tests at Alabama Power Company's Barry Station Unit #2, Utah Power and Light Company's Huntington Canyon Station Unit #2 and Wisconsin Power and Light Company's Columbia Energy Center Unit #1. As shown by this figure, $NO_2$ is proportional to TA and, therefore, to oxygen concentration in the fuel firing zone and excess air.

Figure 2 is a plot of $NO_2$ versus TA for the half (1/2) load tests for all three units. As with the full load tests, the half (1/2) load tests also show increasing $NO_2$ emission levels with increasing TA. Comparison of the full and half (1/2) load tests show that at similar theoretical air levels, the $NO_2$ emission levels for the half (1/2) load tests are lower than or equal to the $NO_2$ levels for the full load tests. The effect of load is better shown in Figure 3, where emission levels are plotted versus theoretical air level for full, three quarter and one half load baseline tests. This plot shows that in some, but not all cases, $NO_2$ levels tend to increase with unit loading. It can be shown that occasionally the opposite trend was observed.

While $NO_2$ levels correlated well with TA, attempts to find what effect fuel nozzle tilt and furnace condition had on $NO_x$ formation were not as successful. Changes in fuel nozzle tilt were found to produce wide and inconsistent variations in $NO_2$ emission levels.

Other investigators have found that increased slagging of the furnace walls tends to increase $NO_x$ by increasing the furnace outlet temperature and, therefore, the bulk flame temperature [3,5]. Bulk flame temperature increases due to the reduced heat transfer from the hot combustion gases to the water-cooled furnace walls. The amount of reduction in heat transfer may depend greatly upon the type of slag on the furnace walls. The furnace conditions for the full and half (1/2) load tests are indicated on Figures 1 and 2. Furnace condition was found to have wide and inconsistent effects on $NO_2$ emission levels for the tests run on the subject boilers. The results obtained showed that for some tests an increase in furnace slag resulted in an increase in $NO_2$ emission levels while no effect was observed for other tests. Furnace condition was measured by visual observation of the furnace waterwalls. Since waterwall absorption is closely related to furnace condition, an attempt was made to correlate $NO_2$ emission levels with furnace waterwall absorption and therefore with furnace condition. This attempt produced no meaningful results. The lack of correlation between $NO_2$ emission levels and furnace condition might be partially attributed to the fact that the visual observation of furnace waterwall deposits is very subjective. Also, the contribution of fuel nitrogen may be dominant in the formation of $NO_x$.

* In this report, oxides of nitrogen ($NO_x$) are expressed as nitrogen dioxide ($NO_2$) to be consistent with the requirements of the New Source Performance Standards, Federal Register Vol. 35, No. 247, Part II, Dated December 31, 1971.

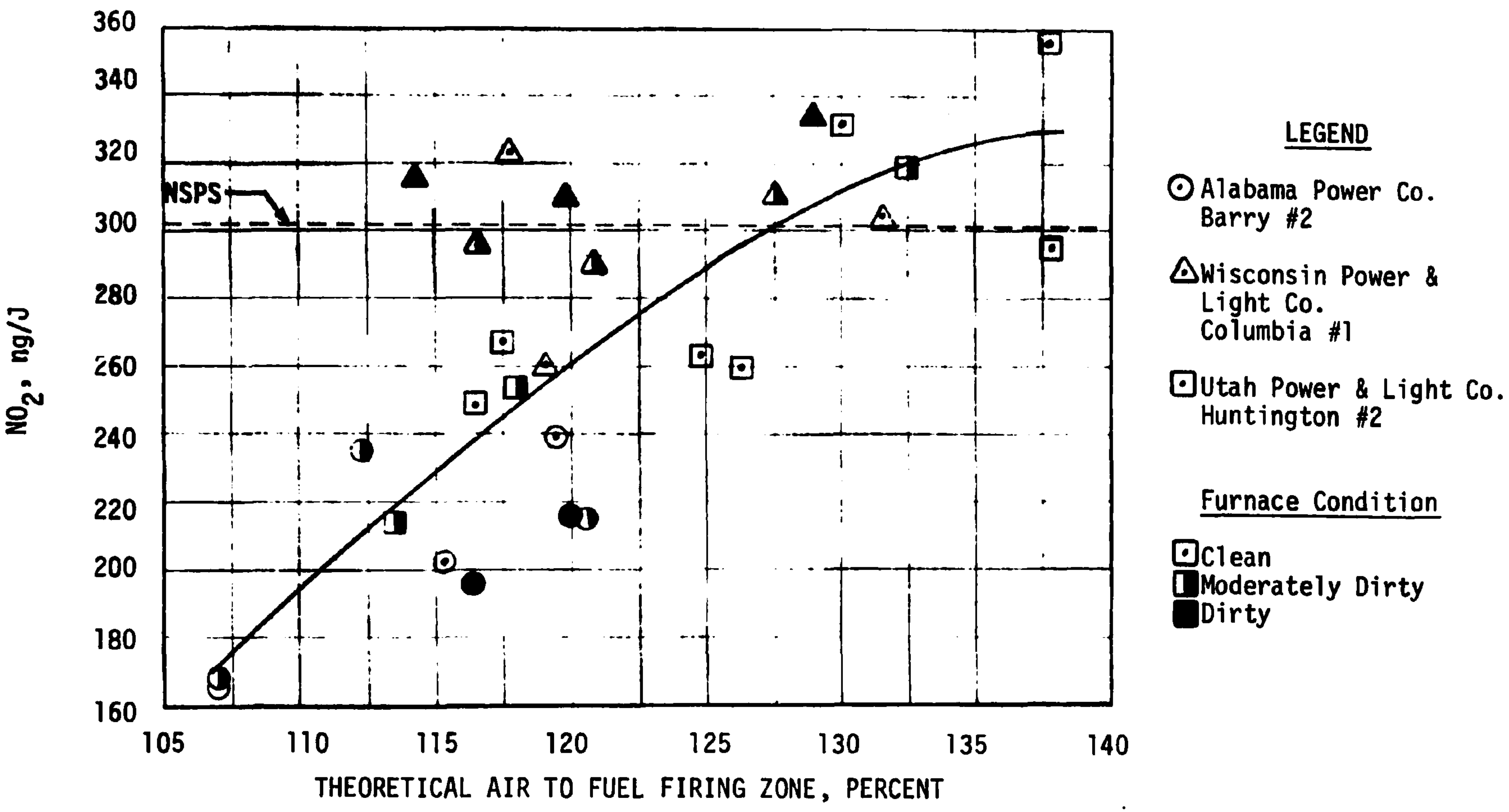



Figure 1: $NO_2$ vs. theoretical air, baseline study, maximum load

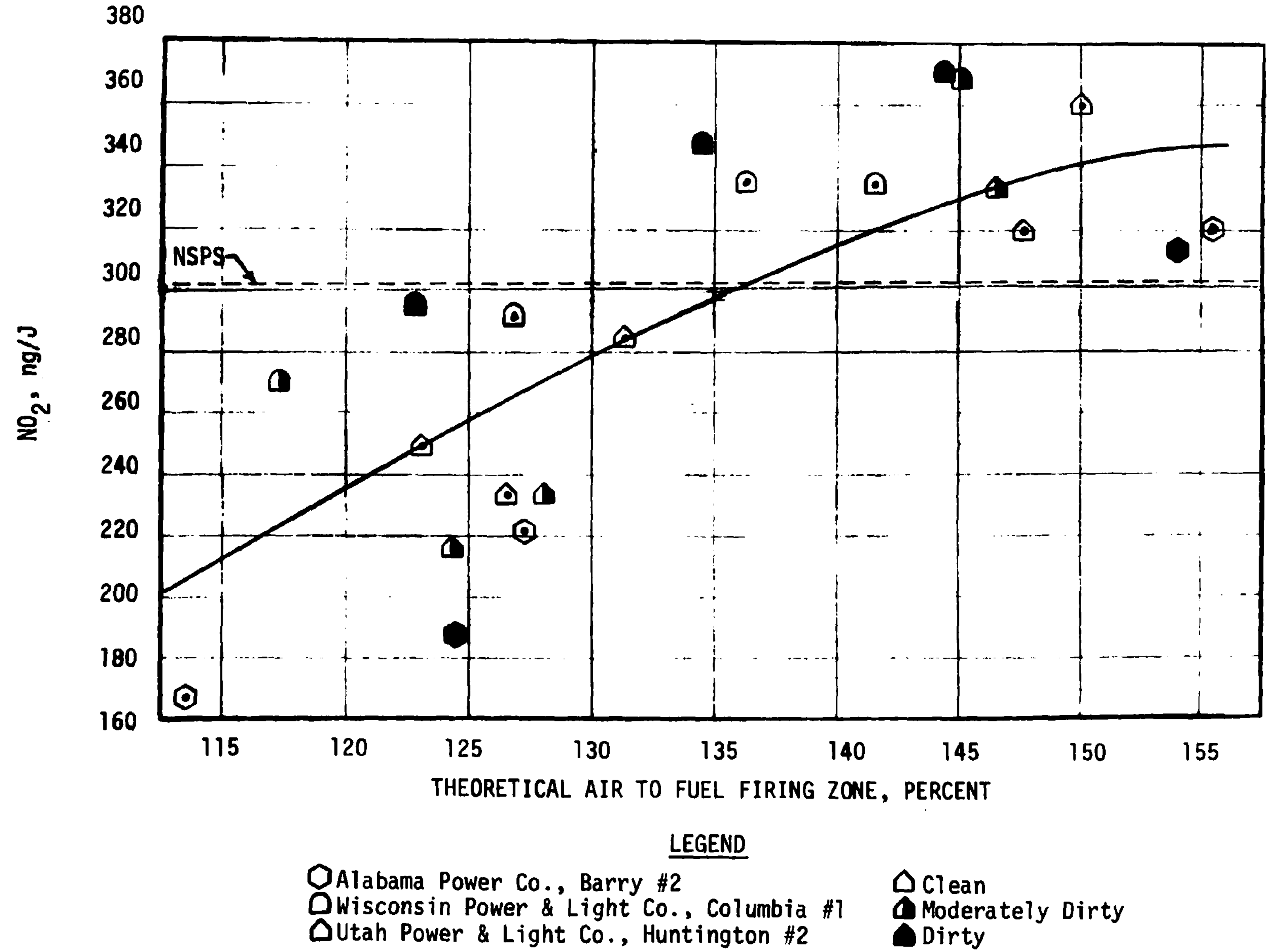



Figure 2: $NO_2$ vs. theoretical air, baseline study, 1/2 load

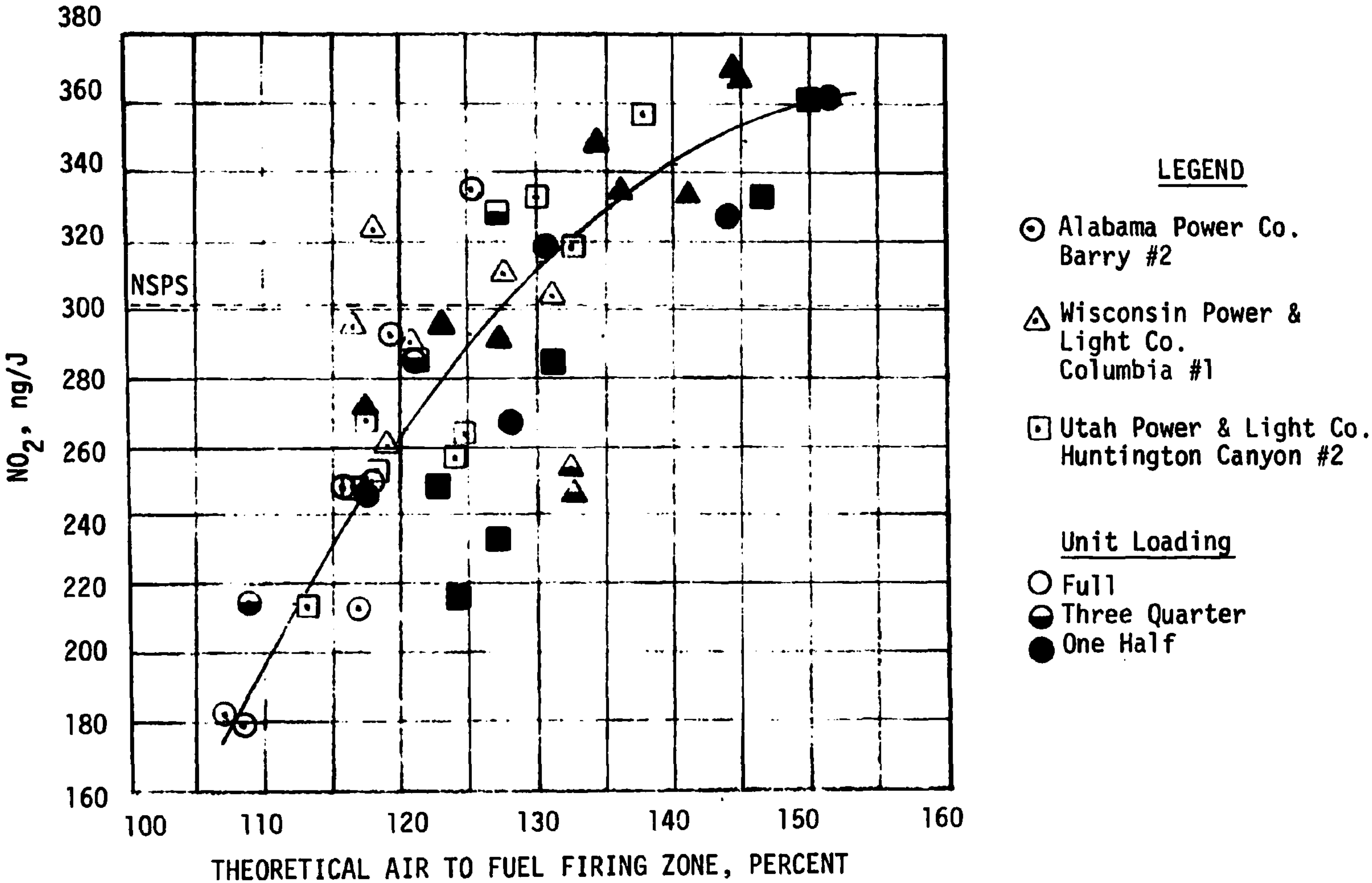



Figure 3: $NO_2$ vs. unit loading, baseline study

The effect of reducing TA on CO emission levels and carbon heat loss is shown on Figures 4 and 5 for the full load tests. Both CO emission levels and carbon heat loss increase with decreasing TA. This trend is a result of the reduced oxygen available for complete combustion. CO emission levels show no effect due to furnace condition. However, carbon heat loss appears to decrease with increasing furnace waterwall deposits. This may be related to the higher bulk flame temperatures encountered in a heavily slagged furnace.

## BIASED FIRING OPERATION STUDY

Biased firing involves the removal of a full firing elevation from service with the dampers being opened so as to admit air through the idle fuel nozzle elevations. The effect on $NO_2$ emission levels when taking various fuel elevations out of service is shown in Figure 6. The lowest $NO_2$ levels for each unit were obtained when the top fuel firing elevations were removed from service and the respective compartment air dampers were 100 percent open. Overfire air operation is simulated by this method of unit operation. The trend is for increasing $NO_2$ levels as the elevation being removed is lower in the windbox. The increase in $NO_2$ levels can be attributed to the increased oxygen available in the fuel firing zone.

Examination of the units on an individual basis showed a slight reduction in $NO_2$ levels when the bottom fuel firing elevation was removed from service. This reduction in $NO_2$ might be caused by a cooling of the hot combustion gases by the cooler combustion air, which is being admitted through the bottom fuel firing elevation.

$NO_2$ is plotted versus TA for the full load biased firing tests in Figure 7. The correlation found for the baseline tests is also evident for the biased firing tests, $NO_2$ being directly proportional to TA.

CO emission level and carbon heat loss plots for the biased firing tests have not been included. Preliminary plots of these variables against TA revealed wide and inconsistent variations. This inconsistency is most probably due to firing with different fuel elevations out of service.

## OVERFIRE AIR OPERATION STUDY

The overfire air operation studies were divided into three separate test series, each designed to determine an optimum operating condition. The three test series were:

1. Excess Air and Overfire Air Rate Variation,
2. Overfire Air Register Tilt Variation, and
3. Load and Furnace Waterwall Deposit Variation at Optimum Conditions

The first of these test series involved the variation of the overfire air rate at various excess air levels. Variation of the overfire air rate is accomplished by changing the overfire air register damper opening. The maximum overfire air rate corresponds to the overfire air register dampers being 100 percent open. With the exception of Alabama Power Co., Barry #2, the overfire air

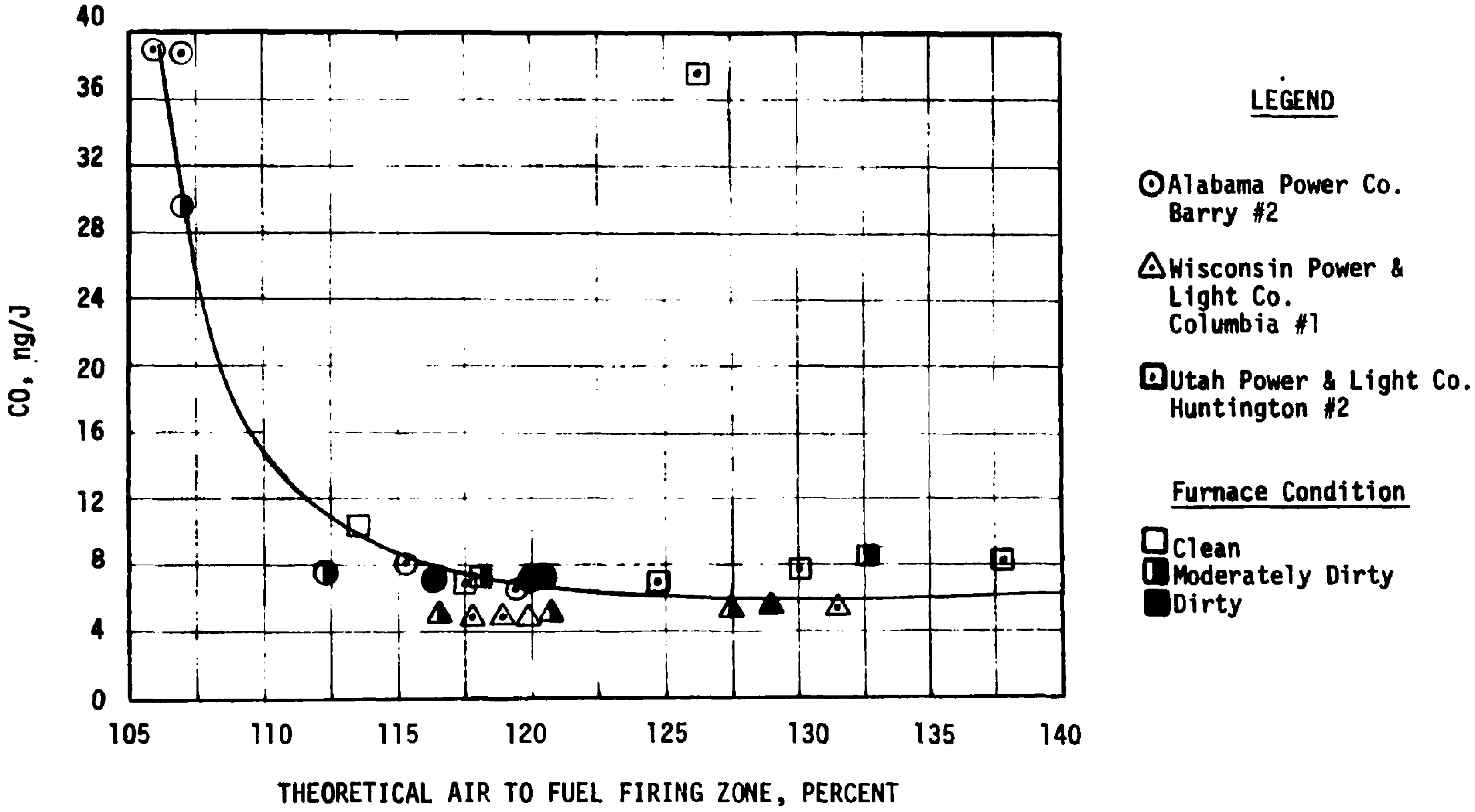



Figure 4: CO vs. theoretical air, baseline study, maximum load

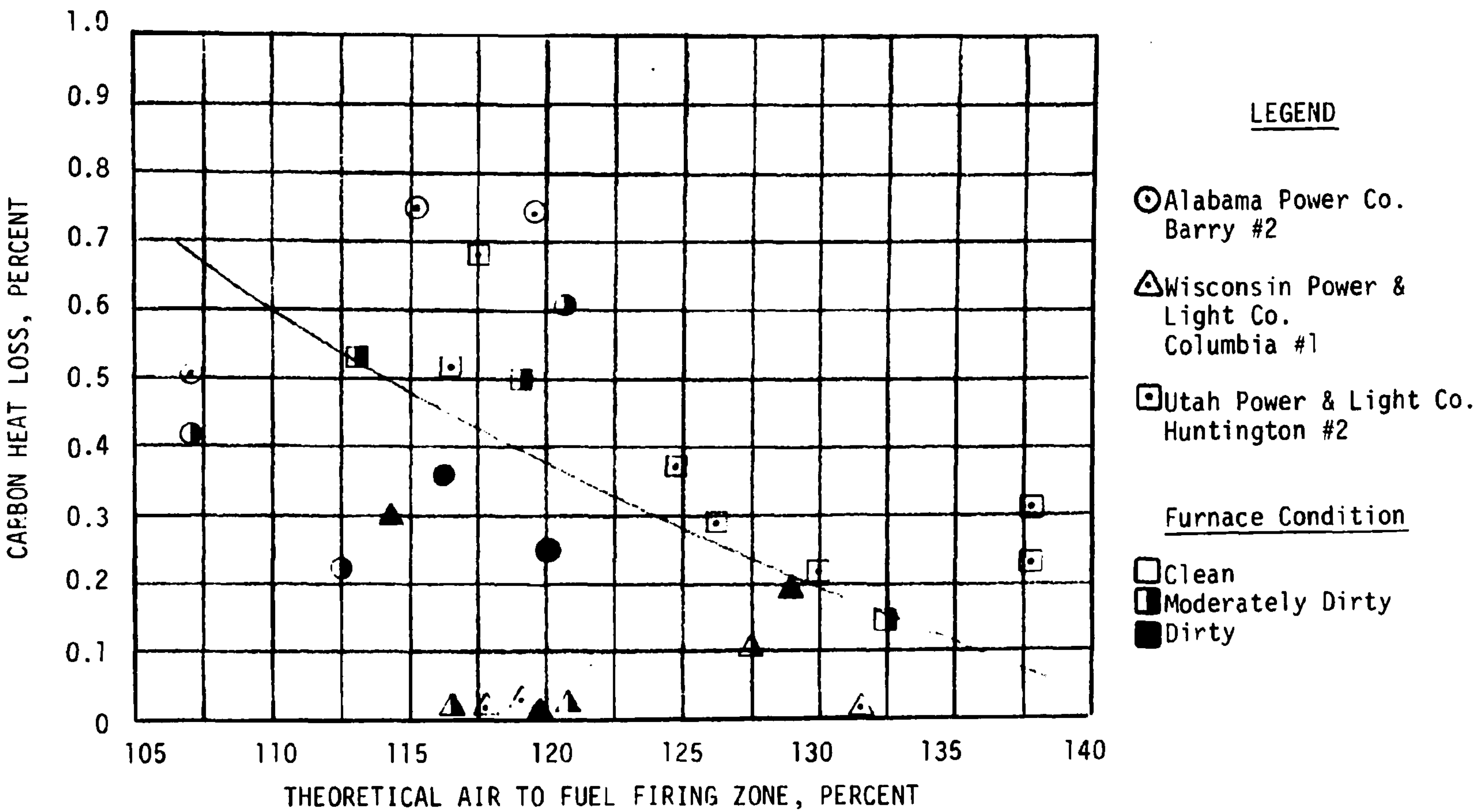



Figure 5: Carbon heat loss vs. theoretical air, baseline study, maximum load

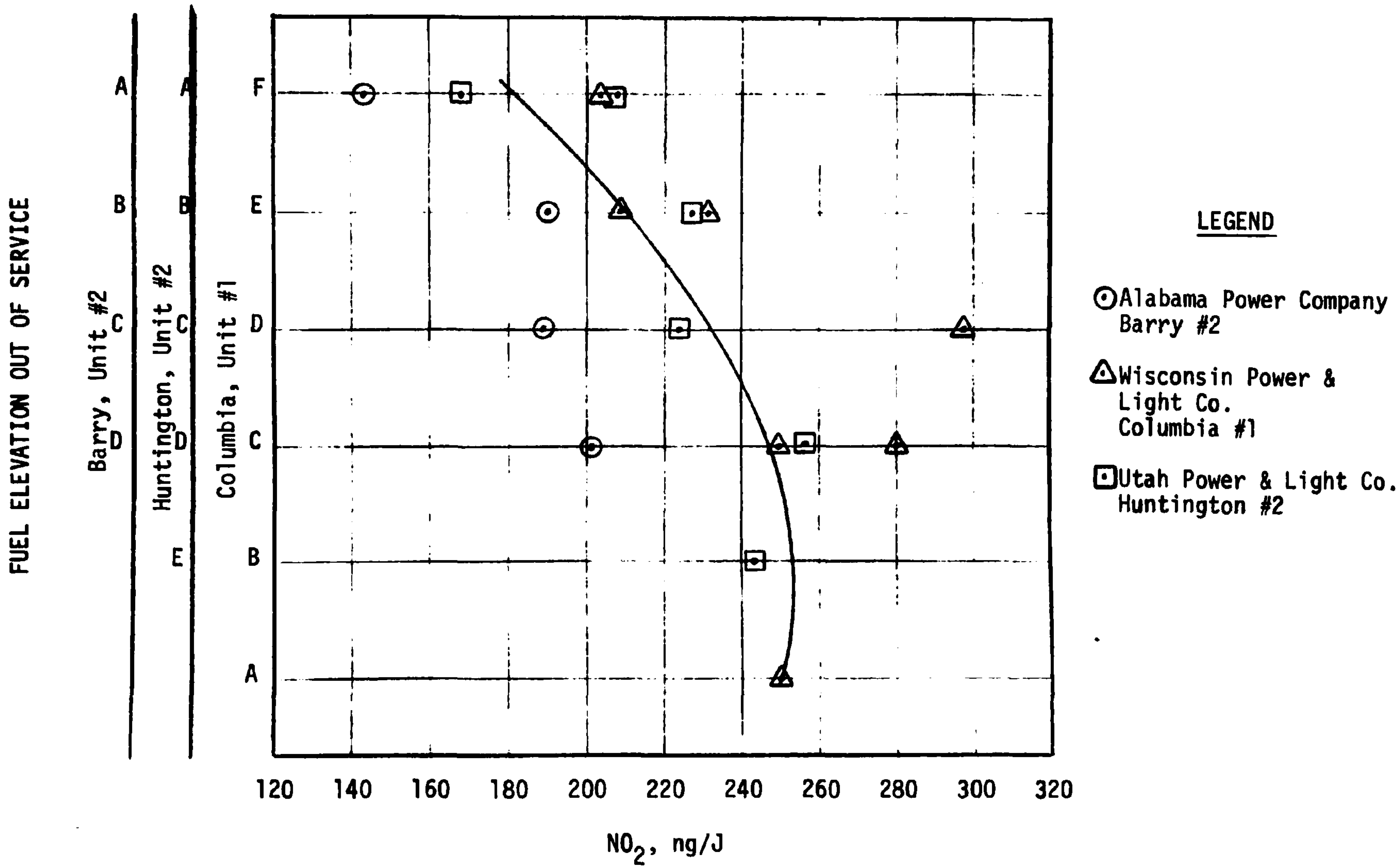



Figure 6: Fuel elevation out of service vs. $NO_2$, biased firing study

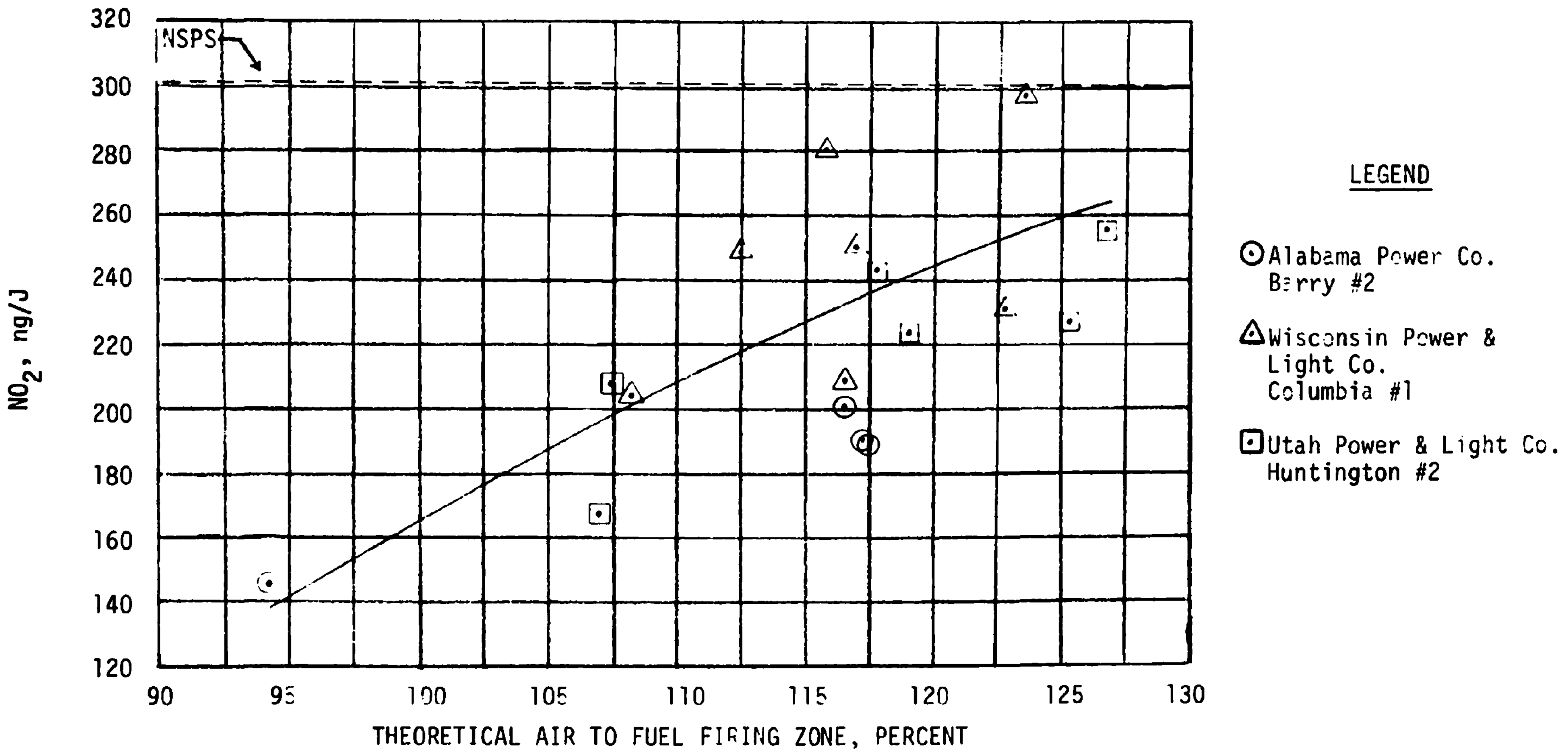



Figure 7: $NO_2$ vs. theoretical air, biased firing study, maximum load

systems were designed to introduce up to 15 percent of the total combustion air above the top level of fuel nozzles at MCR. Barry #2 was designed to introduce 20 percent of the total air as overfire air. During normal boiler operation the overfire air dampers are opened just enough to cool the overfire air registers.

As the overfire air dampers are opened the $NO_2$ emission levels are found to drop for a constant excess air level. This trend is shown in Figure 8. Six excess air levels have been shown, with the trend being similar for all excess air levels.

Theoretical air to the fuel firing zone and overfire air damper opening are closely related, with TA decreasing as the damper opening increases. Figure 9 is a plot of $NO_2$ versus TA for the damper variation tests for all three units. For these tests, as in the baseline and biased firing studies, the $NO_2$ emission levels are found to increase with increasing TA. The evidence shown in Figures 8 and 9 indicates that $NO_x$ is more dependent upon TA rather than EA.

Once the optimum excess air level and overfire air rate had been determined for each unit, the second test series were run. This test series involved a variation in tilt of the overfire air registers and fuel nozzles. The variation in tilt refers to how many degrees toward or away from each other the fuel nozzles and overfire air registers are moved. This variation is calculated by taking the difference in degrees that the overfire air registers are angled toward or away from the fuel nozzles, i.e., overfire air register tilt minus fuel nozzle tilt.

Tilt variation of the fuel nozzles and overfire air registers is designed to move the fuel firing zone both in the furnace and in its position relative to the overfire air registers. Movement of the fuel nozzles and overfire air registers away from each other accentuates the effect of staged combustion. Movement of the fuel nozzles and overfire air registers toward each other minimizes the effect of staged combustion because the air is being forced down into the firing zone.

Figure 10 is a plot of $NO_2$ versus the difference in tilt of the fuel nozzles and overfire air registers. $NO_2$ emission levels are found to be highest when the overfire air registers and fuel nozzles are angled toward each other and lowest when they are angled away from each other. From the standpoint of $NO_x$ reduction, the optimum tilt variation would be with the overfire air registers and fuel nozzles angled away from each other. However for ease of boiler operation, parallel operation of the overfire air registers and fuel nozzles would be best.

Figure 11 shows $NO_2$ plotted versus TA for the second series of tests in the overfire air study. Again, $NO_2$ emission levels are found to be directly proportional to TA.

In the final series of tests for each unit, the effects of load and furnace waterwall deposits on $NO_x$ formation are examined. Boiler operation was at the optimum conditions determined in the previous test series for each unit. Half, three-quarter and full load tests were conducted on each unit at clean and dirty furnace conditions. Figure 12 is a plot of the $NO_2$ emission levels

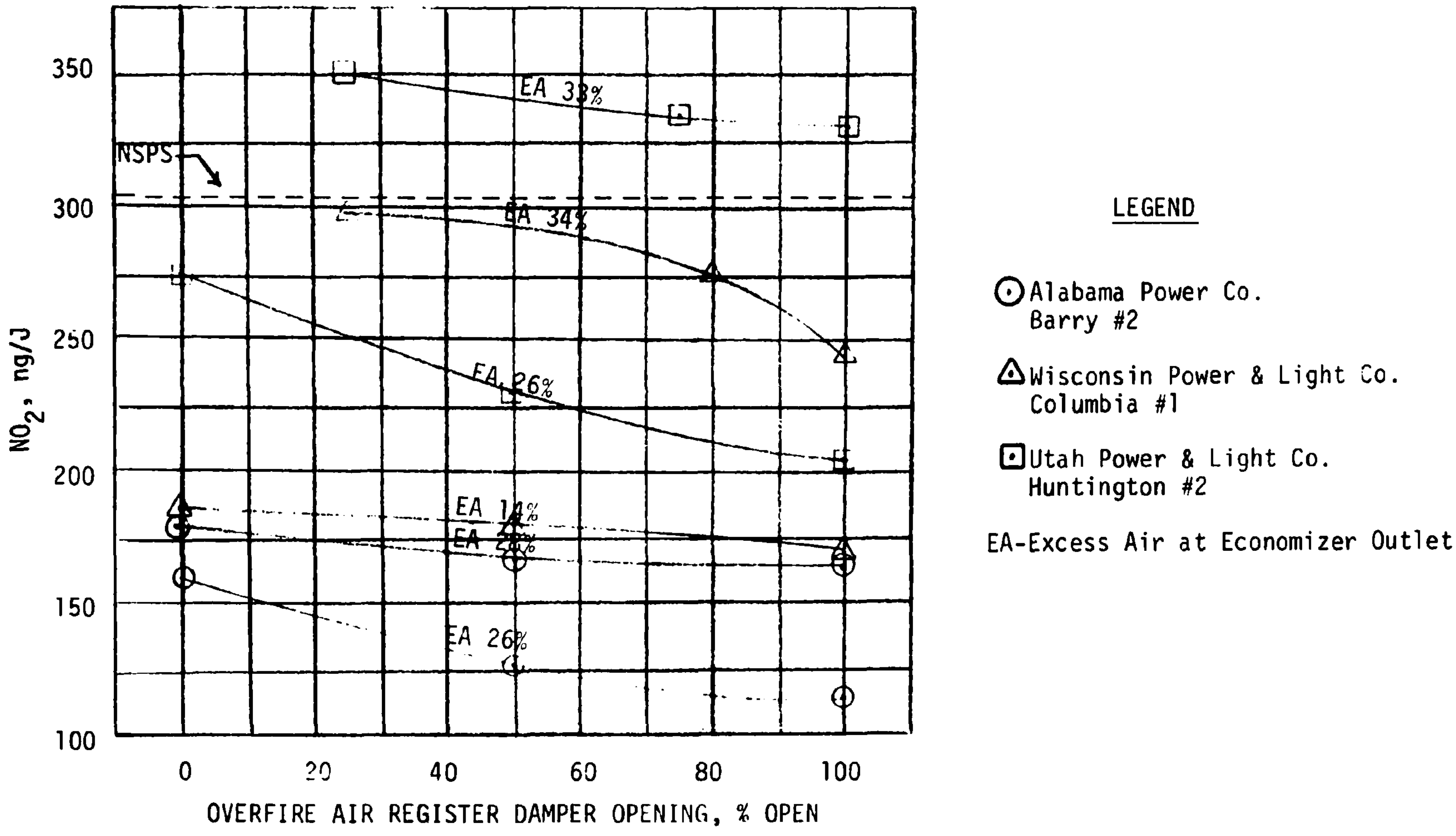



Figure 8: $NO_2$ vs. OFA damper opening, overfire study

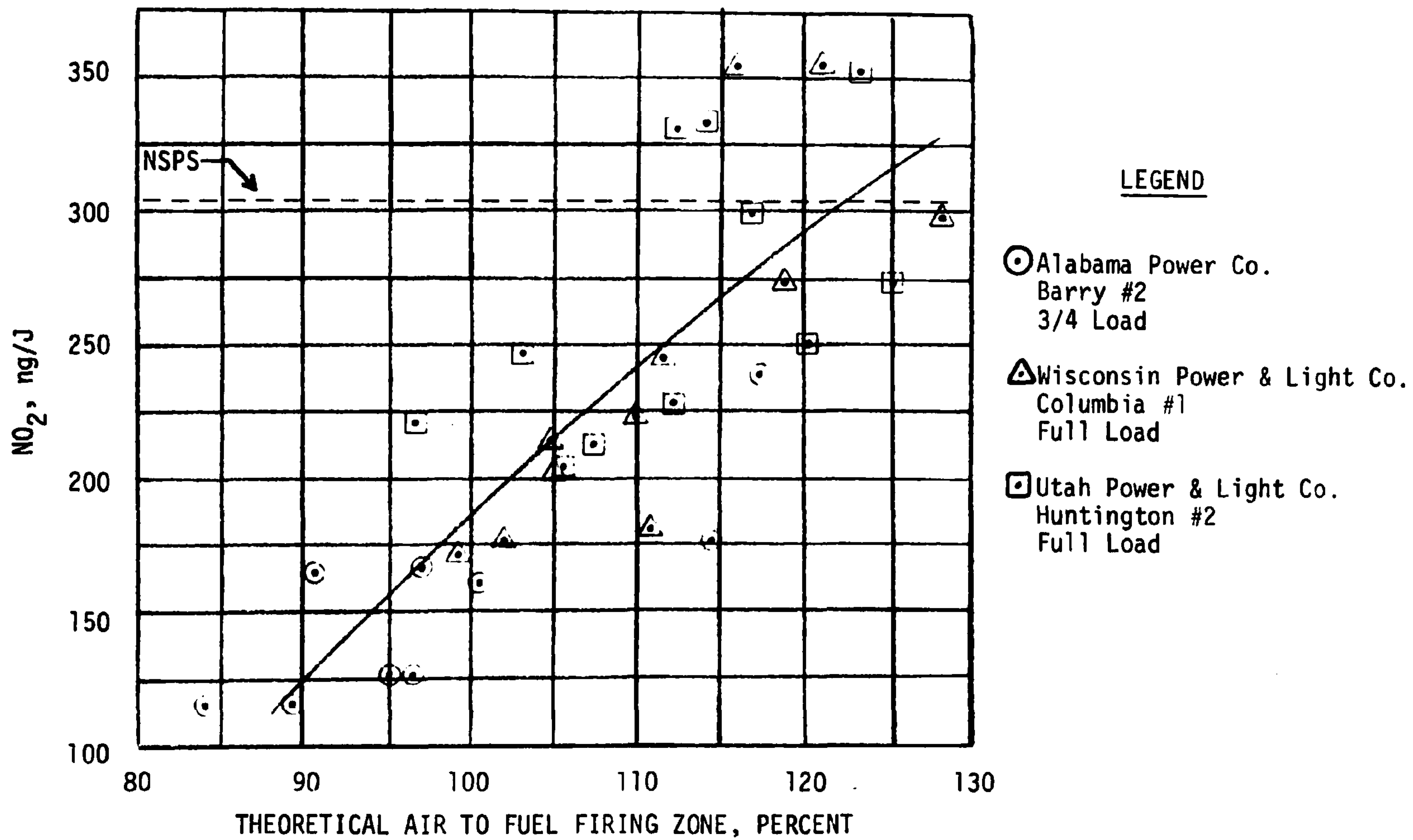



Figure 9: $NO_2$ vs. theoretical air, overfire air study, Test series 1

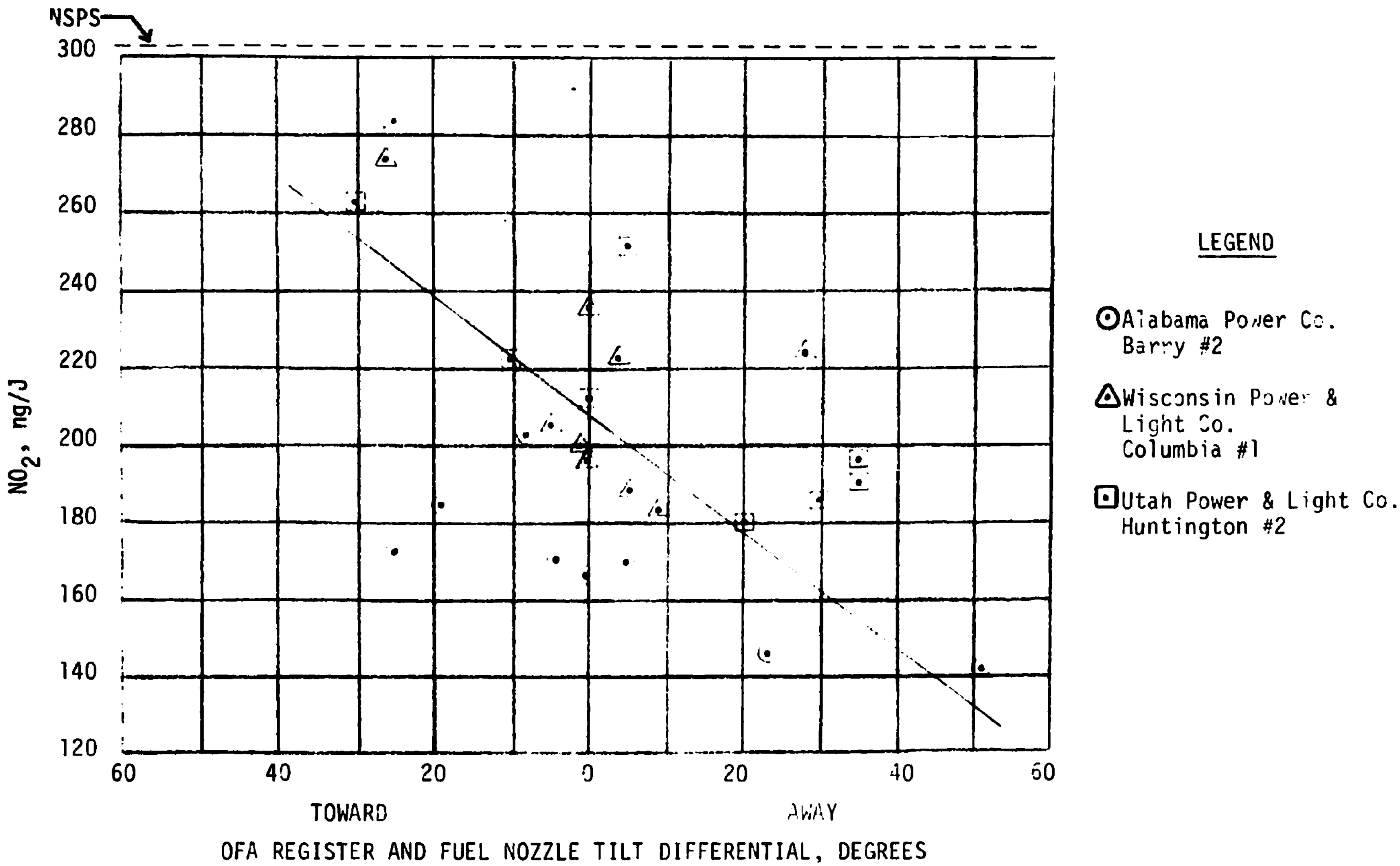



Figure 10: $NO_2$ Vs. tilt differential, overfire air study

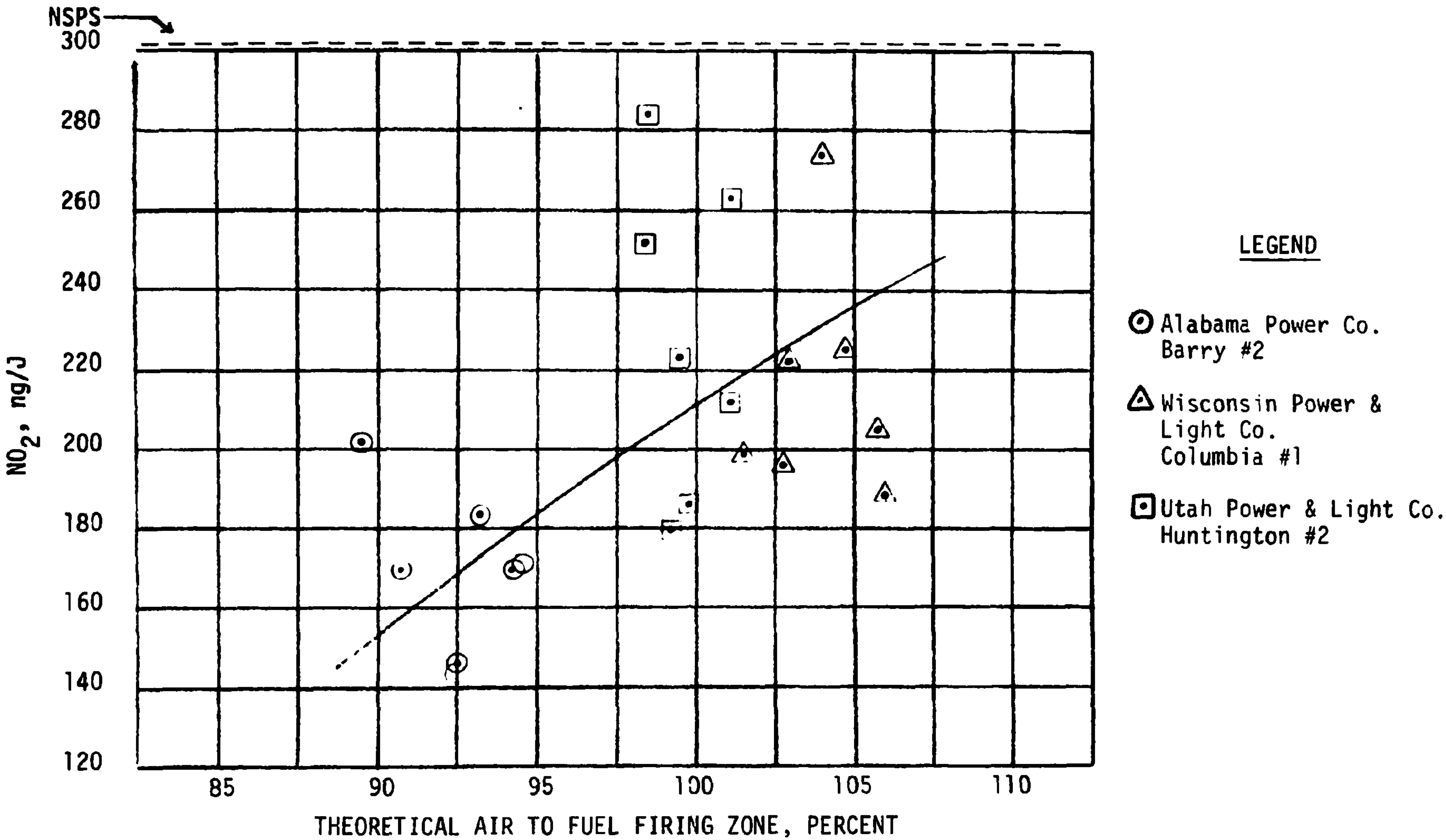



Figure 11: $NO_2$ vs. theoretical air, overfire air study,
Test series 2

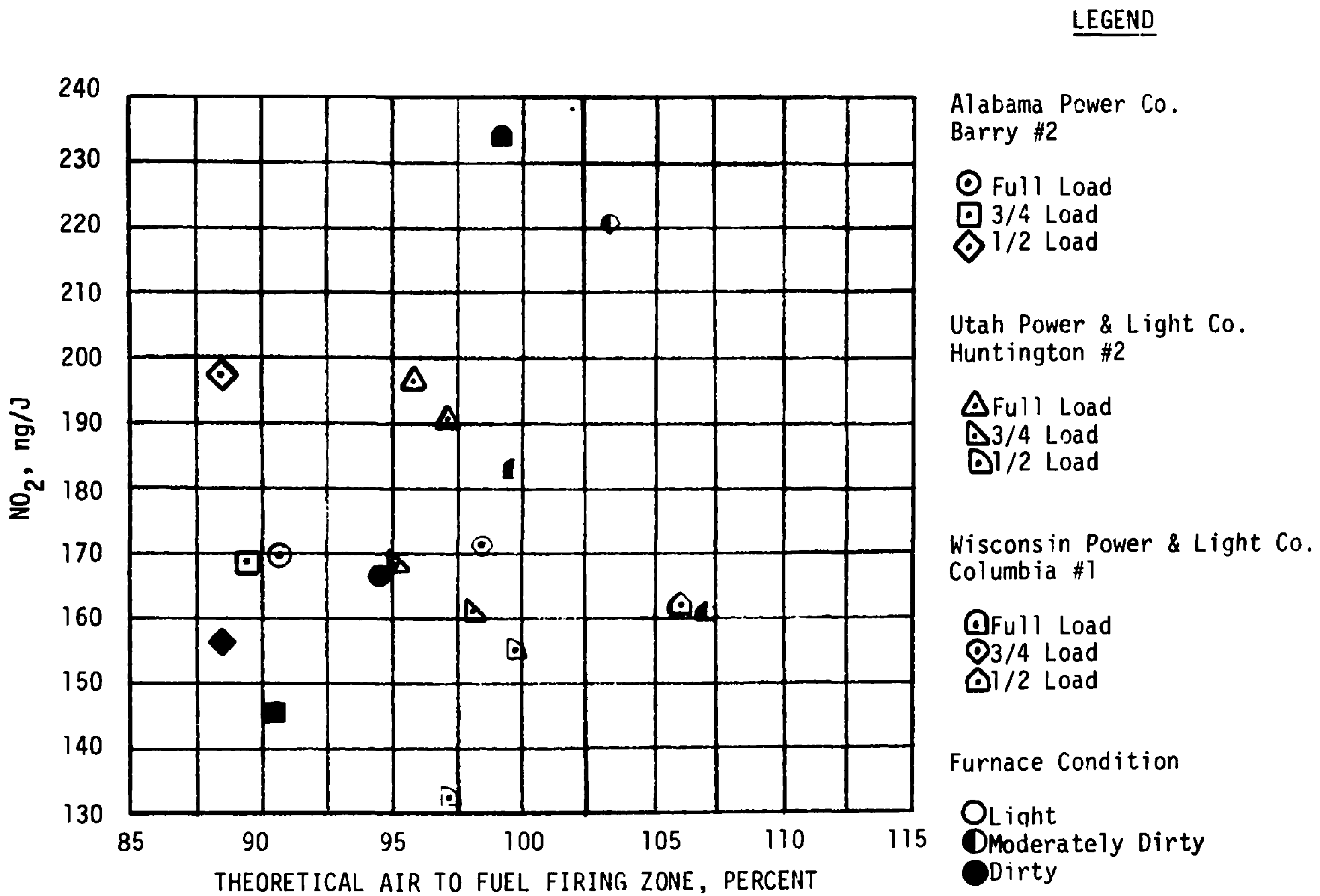



Figure 12: $NO_2$ vs. theoretical air, overfire air study, Test series 3

versus TA for each test in this series. This figure attempts to minimize the effect of TA and show the effect of load and furnace condition on $NO_2$ emission levels. Both Huntington #2 and Columbia #1 show an increase in $NO_2$ levels as unit load rises from half (1/2) load to full load. The effect of furnace condition on these units shows inconsistent variation in the results. Except for one half (1/2) load test, Barry #2 results also indicate an increase in $NO_2$ levels with increasing unit load.

For the overfire air studies, plots of CO emission levels and carbon heat loss versus TA produced the same trend that was established in the baseline operation studies. The CO levels and carbon heat losses were found to increase with decreasing theoretical air levels.

## BOILER PERFORMANCE

Figure 13 is a plot of unit efficiency versus excess air for the full load tests performed on the subject units. As can be seen in Figure 13, biased firing and overfire air boiler operation did not affect unit efficiency. In a previous section it was shown that $NO_2$ emission levels can be reduced through the use of overfire air. Therefore, these results indicate that it may be possible to reduce $NO_2$ emission levels without adversely affecting boiler performance or operation.

In general, unit efficiency is found to decrease with increasing excess air. The decrease in unit efficiency with increasing excess air levels can be attributed to the increasing economizer outlet gas flows and temperatures and therefore to increased dry gas losses.

The 2 to 3 percent difference in unit efficiency between Columbia Energy Center, Unit #1 and Barry Station, Unit #2 or Huntington Station, Unit #2 can be attributed to higher dry gas losses and moisture in the fuel losses for the Columbia Energy Center's Unit #1. These higher losses are due to the type of coal being fired at Columbia Energy Center, Unit #1.

## WATERWALL CORROSION COUPON EVALUATION

Thirty (30) day waterwall corrosion coupon evaluations were performed at the baseline and optimum overfire air conditions for each unit. The purpose of these evaluations was to determine what effect low excess air or staged combustion would have on waterwall tube wastage.

The method used to evaluate corrosive potential, waterwall tube wastage, in a boiler is by exposing samples of tube material to furnace conditions for finite periods of time and then measuring the weight losses. This is accomplished by inserting test probes consisting of five (5) coupons each into the furnace fuel firing zone and maintaining them at typical waterwall metal temperatures. Figure 14 depicts the type of probe and coupons used to obtain such information. This particular probe utilized air to keep the coupon at the desired temperature.

Typical instrumentation to automatically maintain the desired temperature consists of an electronic controller, and a pneumatic controller. The pneumatic controller operates as a switching device, using solenoid valves, to regulate the amount of cooling air going to the probe. The amount of air is based on a

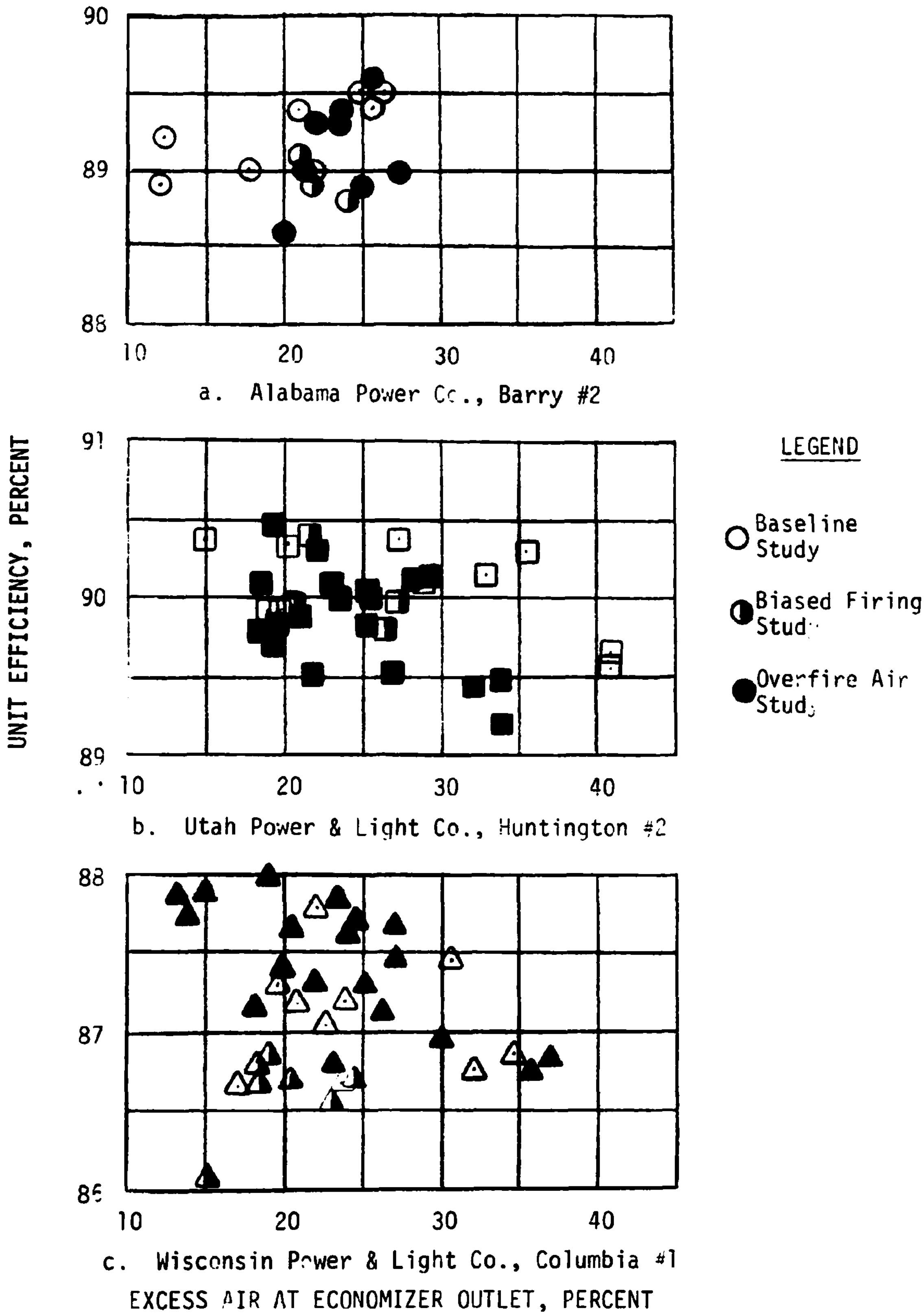



Figure 13: Unit efficiency vs. excess air

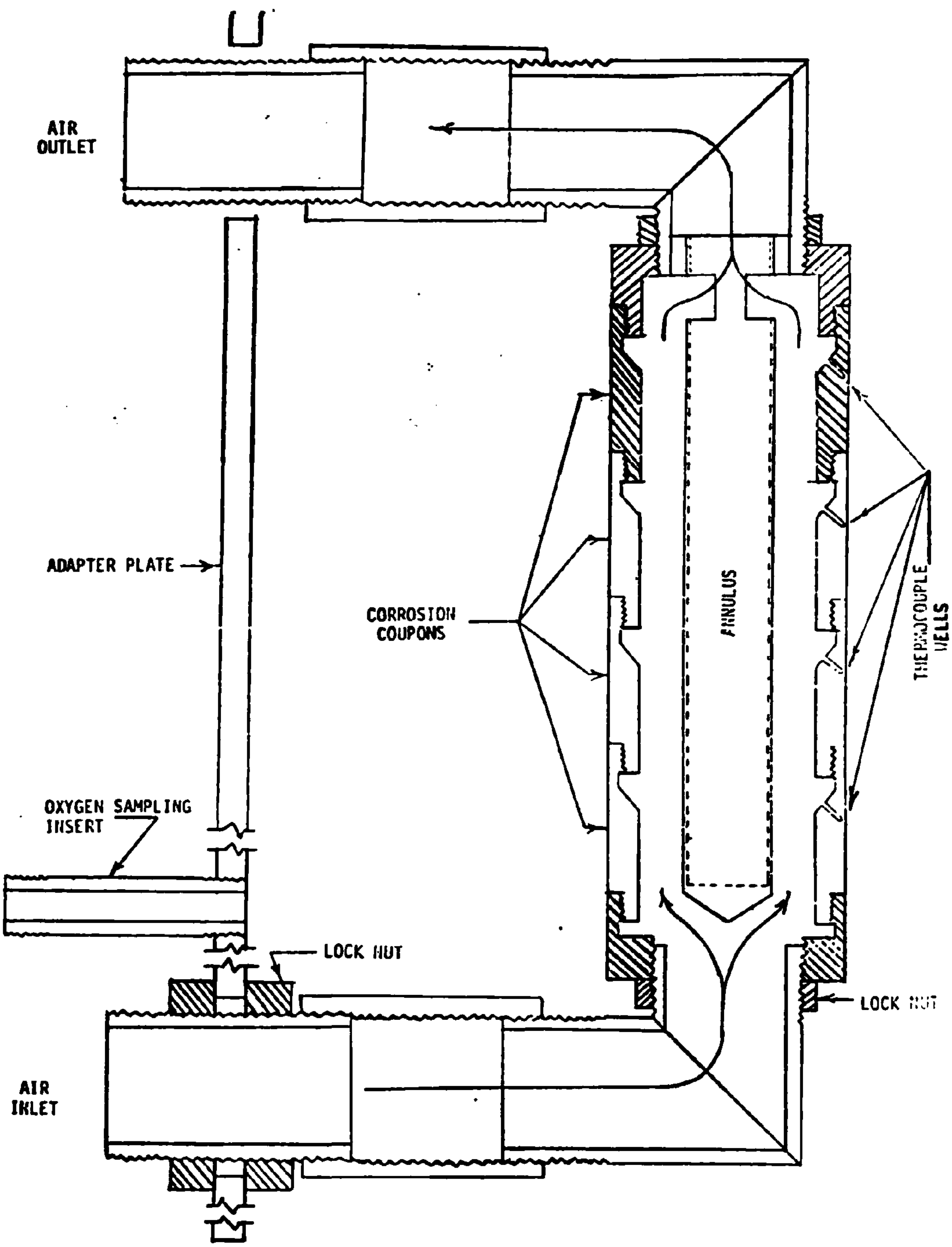



Figure 14: Corrosion Probe Assembly Drawing

signal from the electronic controller which is tied into the sensing thermocouple at the probe coupon.

At the end of the exposure period the coupons are evaluated for weight loss and visual evidence of attack. The average weight losses for the baseline and overfire air modes of boiler operation are shown in the following tables. The results indicate that waterwall tube wastage is unaffected by mode of boiler operation.

AVERAGE CORROSION COUPON WEIGHT LOSSES

| Unit | Baseline Operation | Overfire Air Operation |
|---|---|---|
| Alabama Power Company Barry Station, Unit #2 | 2.6381 $mg/cm^2$ | 4.4419 $mg/cm^2$ |
| Wisconsin Power & Light Co. Columbia Energy Center, Unit #1 | 8.0770 $mg/cm^2$ | 8.0933 $mg/cm^2$ |
| Utah Power & Light Co. Huntington Station, Unit #2 | 3.4266 $mg/cm^2$ | 2.6357 $mg/cm^2$ |

The weight losses for the Barry Station Unit #2 and the Huntington Station Unit #2 are within the range of losses which would be expected for the oxidation of carbon steel for a thirty (30) day period. This premise was verified by control studies conducted in C-E's Kreisinger Development Laboratory.

The weight losses measured at the Columbia Energy Center Unit #1 are slightly higher than expected. One possible reason for the higher losses is that some of the probes overheated during the thirty (30) day tests. Another possible reason for the higher weight losses is that the coal being burned at Columbia Energy Center's Unit #1 is a subbituminous type coal while Barry Station Unit #2 and Huntington Station Unit #2 both burn bituminous type coals. However, the results for the Columbia Energy Center tests show the weight losses are equivalent regardless of the mode of boiler operation.

## SECTION II - EPA CONTRACT 68-02-1486

### OBJECTIVES

The objective of this program was to investigate the effectiveness of employing staged combustion as a method of reducing $NO_x$ emission levels from tangentially fired boilers burning Western U.S. coals. Specifically this objective is broken down by task as follows:

### TASK I - UNIT SELECTION

The basis for selection of suitable test units follows:

1. One unit (Unit "A") firing a Western U.S. subbituminous coal and a second unit (Unit "B") firing a Western U.S. bituminous coal.

2. Both units were representative of current Combustion Engineering, Inc. design employing overfire air registers in an extended windbox as a means of $NO_x$ emission control. Neither unit required modifications with regard to those features necessary to permit evaluation of biased firing and staged combustion.

3. The size of the boilers allowed a diverse experimental program and permitted scale-up correlation of performance and emissions data to that developed under EPA Contract No. 68-02-1367 [2].

4. Two utilities willing to participate in the program which included absorbing generating losses incurred during the test program.

5. A utility which agreed to an outage of approximately one month for the installation of waterwall thermocouples on the unit that would be firing the Western U.S. subbituminous coal.

### TASK II - TEST PLANNING & FABRICATION OF TEST EQUIPMENT

This task included the preparation of a detailed test program for each unit designed to investigate the effects of the following process variables and combustion modifications on $NO_x$, $SO_x$, THC, CO and unburned combustibles.

<u>PROCESS VARIABLES</u>

Excess Air Level
Load
Furnace Wall Deposits

COMBUSTION MODIFICATIONS

Biased Firing
Overfire Air Firing

The test program provided for documentation of the effects of the test variables on the thermal and operational performance of the boilers. It also provided for the evaluation of long term and transient operation, thermal-efficiency, slagging, fireside corrosion, flame stability and other process responses considered essential to the commercially acceptable operation of the boilers.

The following were considered in the test program planning:

1. Analytical measurements and sampling techniques.

2. Emission measurements which included $NO_x$, $SO_x$, CO, THC and $O_2$. $CO_2$ was determined by calculation.

3. Necessary analysis of fuel properties relevant to furnace operation and emissions.

4. Measurement of process variables.

The test program utilized statistical test design methods and prior experience where possible to maximize the information output from each test.

TASK III - INSTALLATION OF INSTRUMENTATION

Task III involved the installation, on each unit, of the analytical instrumentation required for calculation of $CO_2$ and for measurement of flue gas constituents ($NO_x$, $SO_x$, CO, THC, $O_2$ and unburned carbon). Also installed was the necessary instrumentation required to characterize the effects that combustion modifications have on unit performance; i.e., fireside corrosion and heat absorption. Instrumentation to determine waterwall absorption rates was installed only on Unit A. Instrumentation to determine unit absorption rates and thermal performance of the reheater, superheater, economizer and air heater sections were installed on both Units A and B.

TASK IV - BASELINE OPERATION - UNITS A & B

Similar but separate test programs were conducted on Units A & B to determine the effect of unit load, furnace wall deposits and excess air variation on baseline gaseous emission levels and unit performance. During this portion of the test program only a minimum amount of air necessary for cooling was admitted through the overfire air registers.

There were nineteen (19) tests performed for the combination of conditions indicated in Test Matrix 1.

TEST MATRIX 1

| | | E-1 | E-2 | E-3 |
|---|---|---|---|---|
| D-1 | L-1 | 1 | 2 | 3 |
| | L-2 | | 4 | |
| | L-3 | 5 | 6 | 7 |
| D-2 | L-1 | 8 | 9 | 10 |
| | L-2 | | | |
| | L-3 | 11 | | 12 |
| D-3 | L-1 | 13 | 14 | 15 |
| | L-2 | | 16 | |
| | L-3 | 17 | 18 | 19 |

TEST CONDITIONS

Percent Excess Air

| | |
|---|---|
| Minimum | E-1 |
| Normal | E-2 |
| Maximum | E-3 |

Furnace Wall Deposits

| | |
|---|---|
| Clean | D-1 |
| Moderate | D-2 |
| Heavy | D-3 |

Unit Load

| | |
|---|---|
| Maximum | L-1 |
| 3/4 Maximum | L-2 |
| 1/2 Maximum | L-3 |

A baseline operation waterwall corrosion rate test of a four (4) week duration was conducted after the completion of the baseline emissions test program. This study was performed at normal operating conditions with maximum load being carried whenever possible. The baseline operation corrosion rate test was conducted on both Units A & B.

TASK V - BIASED FIRING OPERATION - UNITS A & B

A program was conducted to establish the effect of operating with various fuel elevations out of service and of varying the excess air levels on gaseous emission levels and unit performance. Specifically, this portion of the program established maximum emissions control at full load and throughout the normal load range without utilizing the overfire registers; however, air was admitted through the dampers of the idle fuel nozzle elevations.

Eighteen (18) tests were conducted on Unit A at the conditions specified in Test Matrix 2.

TEST MATRIX 2

| | E-1 | | | E-2 | | |
|---|---|---|---|---|---|---|
| | L-1 | L-2 | L-3 | L-1 | L-2 | L-3 |
| B-1 | 1 | 5 | | 11 | 14 | |
| B-2 | 2 | | | | | |
| B-1 B-2 | | | 8 | | | 17 |
| B-3 | | 6 | | 12 | | |
| B-4 | 3 | | | | 15 | |
| B-3 B-4 | | | 9 | | | |
| B-5 | | | | 13 | | |
| B-6 | 4 | 7 | | | 16 | |
| B-5 B-6 | | | 10 | | | 18 |

TEST CONDITIONS

**Firing Elev. Out of Serv.**

| | |
|---|---|
| Top | B-1 |
| Top Middle | B-2 |
| Top Center | B-3 |
| Bottom Center | B-4 |
| Bottom Middle | B-5 |
| Bottom | B-6 |

**Unit Load**

| | |
|---|---|
| Maximum | L-1 |
| 3/4 Maximum | L-2 |
| 1/2 Maximum | L-3 |

**Percent Excess Air**

| | |
|---|---|
| Minimum | E-1 |
| Normal | E-2 |

For Unit B, there were sixteen (16) tests conducted at the conditions specified in Test Matrix 3.

TEST MATRIX 3

| | E-1 | | | E-2 | | |
|---|---|---|---|---|---|---|
| | L-1 | L-2 | L-3 | L-1 | L-2 | L-3 |
| B-1 | 1 | 4 | | 9 | 12 | |
| B-2 | | 5 | | 10 | | |
| B-1 B-2 | | | 7 | | | |
| B-3 | 2 | | | | 13 | |
| B-2 B-3 | | | | | | 15 |
| B-4 | | 6 | | 11 | | |
| B-3 B-4 | | | 8 | | | |
| B-5 | 3 | | | | 14 | |
| B-4 B-5 | | | | | | 16 |

TEST CONDITIONS

Firing Elev. Out of Serv.

| | |
|---|---|
| Top | B-1 |
| Top Center | B-2 |
| Center | B-3 |
| Bottom Center | B-4 |
| Bottom | B-5 |

Unit Load

| | |
|---|---|
| Maximum | L-1 |
| 3/4 Maximum | L-2 |
| 1/2 Maximum | L-3 |

Percent Excess Air

| | |
|---|---|
| Minimum | E-1 |
| Normal | E-2 |

TASK VI - OVERFIRE AIR OPERATION - UNITS A & B

The overfire air operation test program was the same for both Units A & B. The test program, utilizing the overfire air system, investigated the effect of overfire air admission rates on gaseous emission levels at various unit loads and operating conditions. Those conditions which were found to be optimum from the standpoint of both effectiveness in reducing $NO_x$ emission levels and maintaining safe unit operation were evaluated to determine their acceptability for long term operation.

The first series of tests in this portion of the program were to determine the effect on the $NO_x$ emission levels and unit performance, when varying the overfire air rate with respect to excess air.

There were eleven (11) tests conducted at maximum load under the conditions identified in Test Matrix 4.

TEST MATRIX 4

| | E-1 | E-2 | E-3 |
|---|---|---|---|
| A-1 | 6 | 1 | |
| A-2 | | 2 | 9 |
| A-3 | 7 | 3 | |
| A-4 | | 4 | 10 |
| A-5 | 8 | 5 | 11 |

TEST CONDITIONS

Overfire Air Rate

| | |
|---|---|
| None | A-1 |
| 1/4 Maximum | A-2 |
| 1/2 Maximum | A-3 |
| 3/4 Maximum | A-4 |
| Maximum | A-5 |

Percent Excess Air

| | |
|---|---|
| Minimum | E-1 |
| Normal | E-2 |
| Maximum | E-3 |

Having established the optimum overfire air rate and excess air level, this condition was used in conducting a series of fuel nozzle and overfire air register tilt variation tests.

The objective of this evaluation was to determine the effect of overfire air register tilt on the $NO_x$ emission levels, steam temperatures and furnace wall deposits.

There were seven (7) tests performed at maximum unit load under the conditions listed in Test Matrix 5.

TEST MATRIX 5

| | F-1 | F-2 | F-3 |
|---|---|---|---|
| R-1 | 12 | 13 | |
| R-2 | 14 | 15 | 16 |
| R-3 | | 17 | 18 |

TEST CONDITIONS

Fuel Nozzle Tilt

| | |
|---|---|
| Maximum Minus | F-1 |
| Horizontal | F-2 |
| Maximum Plus | F-3 |

Overfire Air Register Tilt

| | |
|---|---|
| Maximum Minus | R-1 |
| Horizontal | R-2 |
| Maximum Plus | R-3 |

The objective of the final series of tests for this test program was to determine the effect on $NO_x$ emission levels and unit performance when operating at the previously established optimum conditions, while varying unit load and furnace wall deposits.

There were six (6) tests conducted at the conditions identified in Test Matrix 6.

TEST MATRIX 6

| | OC-1 | |
|---|---|---|
| | D-1 | D-3 |
| L-1 | 19 | 20 |
| L-2 | 21 | 22 |
| L-3 | 23 | 24 |

TEST CONDITIONS

Unit Load

| | |
|---|---|
| Maximum | L-1 |
| 3/4 Maximum | L-2 |
| 1/2 Maximum | L-3 |

Furnace Wall Deposits

| | |
|---|---|
| Clean | D-1 |
| Heavy | D-3 |

Unit Operating Conditions

| | |
|---|---|
| Optimum Conditions | OC-1 |

To determine the effect of long term and transient overfire air operation on the furnace waterwall wastage rate, a waterwall corrosion study was conducted for a four (4) week period. This study was conducted at optimum conditions for $NO_x$ reduction, as determined in the previously outlined test program, with maximum load being maintained whenever possible.

TASK VII - PREPARATION OF TEST REPORT AND ANALYSIS OF DATA

The test report includes all data obtained during the test program and the analysis of that data.

Specific areas of analysis and reporting are:

1. The reporting of emissions data with respect to modes of operation and coal type.
2. The analysis of emission data with respect to Contract 68-02-1367, for a unit that is equipped with a modified overfire air system.
3. The reporting of emission data with respect to unit performance.
4. The reporting of the corrosion probe study with respect to overfire air operation and coal type.
5. The analysis of corrosion probe wastage data with respect to Contract 68-02-1367.
6. The scale-up considerations for design of new overfire air systems resulting from this study and Contract 68-02-1367.
7. The possible changes to cost estimates for overfire air systems in new and existing boilers if this study indicates previously developed cost estimates based on Contract 68-02-1367 should be revised.

## DISCUSSION

### TASK I - UNIT SELECTION

The two units selected for participation in this test program were:

UNIT A - Wisconsin Power & Light Co.
Columbia Energy Center, Unit #1

UNIT B - Utah Power & Light Co.
Huntington Canyon, Unit #2

These units are representative of current Combustion Engineering, Inc. boiler design. Both units incorporate overfire air registers in an extended windbox as a means of $NO_x$ emission control. A typical windbox arrangement for one corner of a unit is shown in Figure 15. The primary air, which conveys the coal, is introduced through the center portion of the tilting coal nozzles. Secondary air is introduced selectively through openings at the periphery of the coal nozzles and/or through the air nozzles. Windbox air dampers located in the fuel and air compartments regulate the distribution of the secondary air. The quantity of air flow is controlled by the induced draft and forced draft fan system [7].

Unit A, Columbia Energy Center, Unit #1, is a controlled circulation, balanced draft, radiant, reheat boiler firing pulverized coal through six elevations of tilting tangential fuel nozzles. Unit capacity at maximum continuous rating (MCR) is 479 kg/s (3,800,000 LBS/HR) main steam flow at a superheat outlet temperature and pressure of 541°C (1005°F) and 18.1 MPa (2620 PSIG), respectively. The Columbia Energy Center, Unit #1 fires a Montana Rosebud seam subbituminous 'C' coal. A side elevation of Columbia Energy Center, Unit #1 is shown in Figure 16.

Unit B, Huntington Canyon, Unit #2, is also a controlled circulation, balanced draft, radiant, reheat boiler firing pulverized coal through five elevations of tilting tangential fuel nozzles. The unit capacity at the maximum continuous rating (MCR) is 382 kg/s (3,036,000 LBS/HR) main steam flow with a superheat outlet temperature and pressure of 541°C (1005°F) and 18.2 MPa (2645 PSIG), respectively. This unit fires a high Volatile 'B' bituminous coal supplied from the nearby Peabody Coal Company's Deer Creek Mine. A side elevation of Huntington Canyon, Unit #2 is shown in Figure 17.

In both units, superheat outlet temperatures are controlled by spray desuperheating. Reheat outlet temperatures are controlled by fuel nozzle tilt and spray desuperheating.

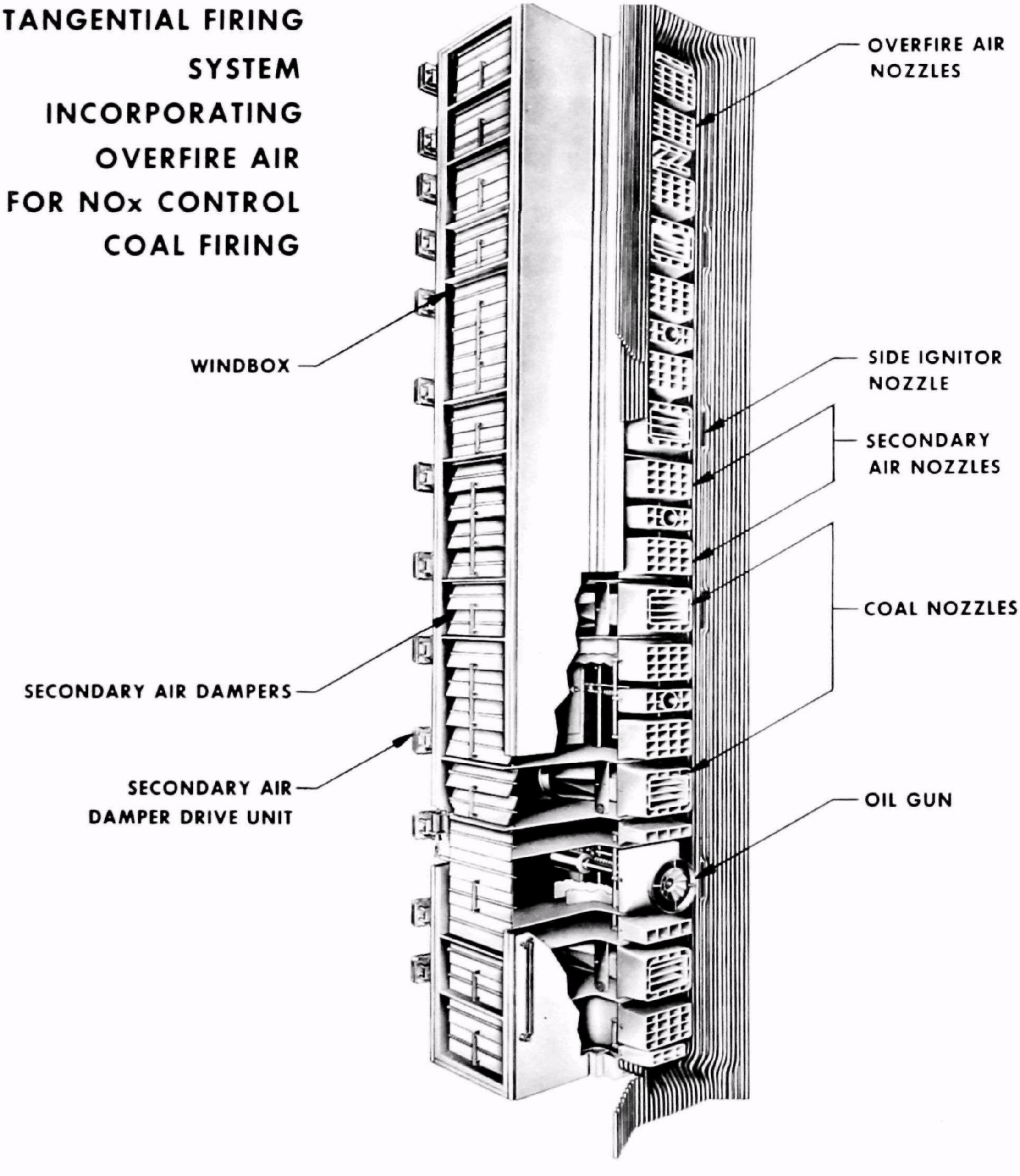



Figure 15: Typical windbox of tangential firing system

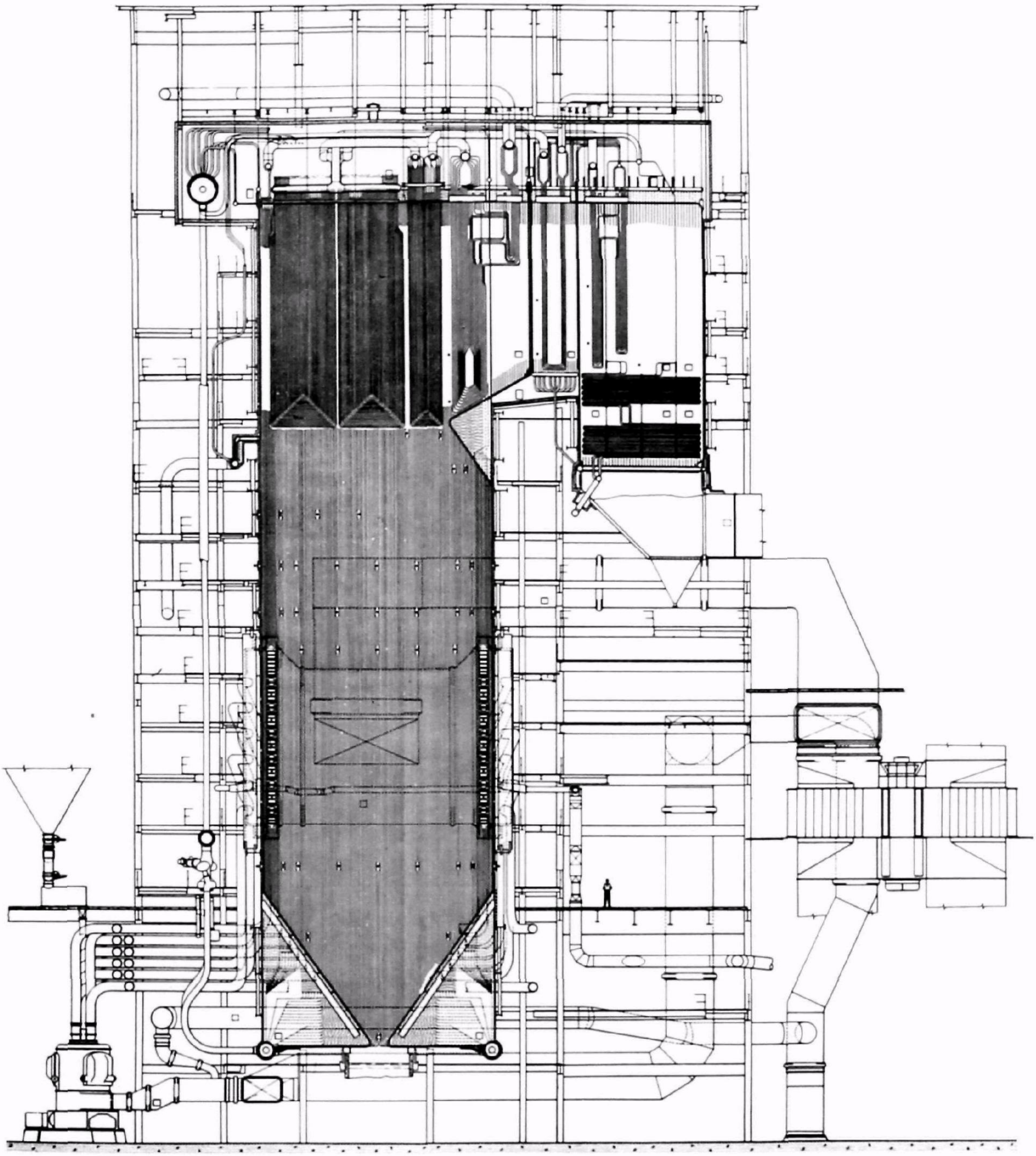


Figure 16. Unit side elevation, Wisconsin Power and Light Company, Columbia Energy Center No. 1

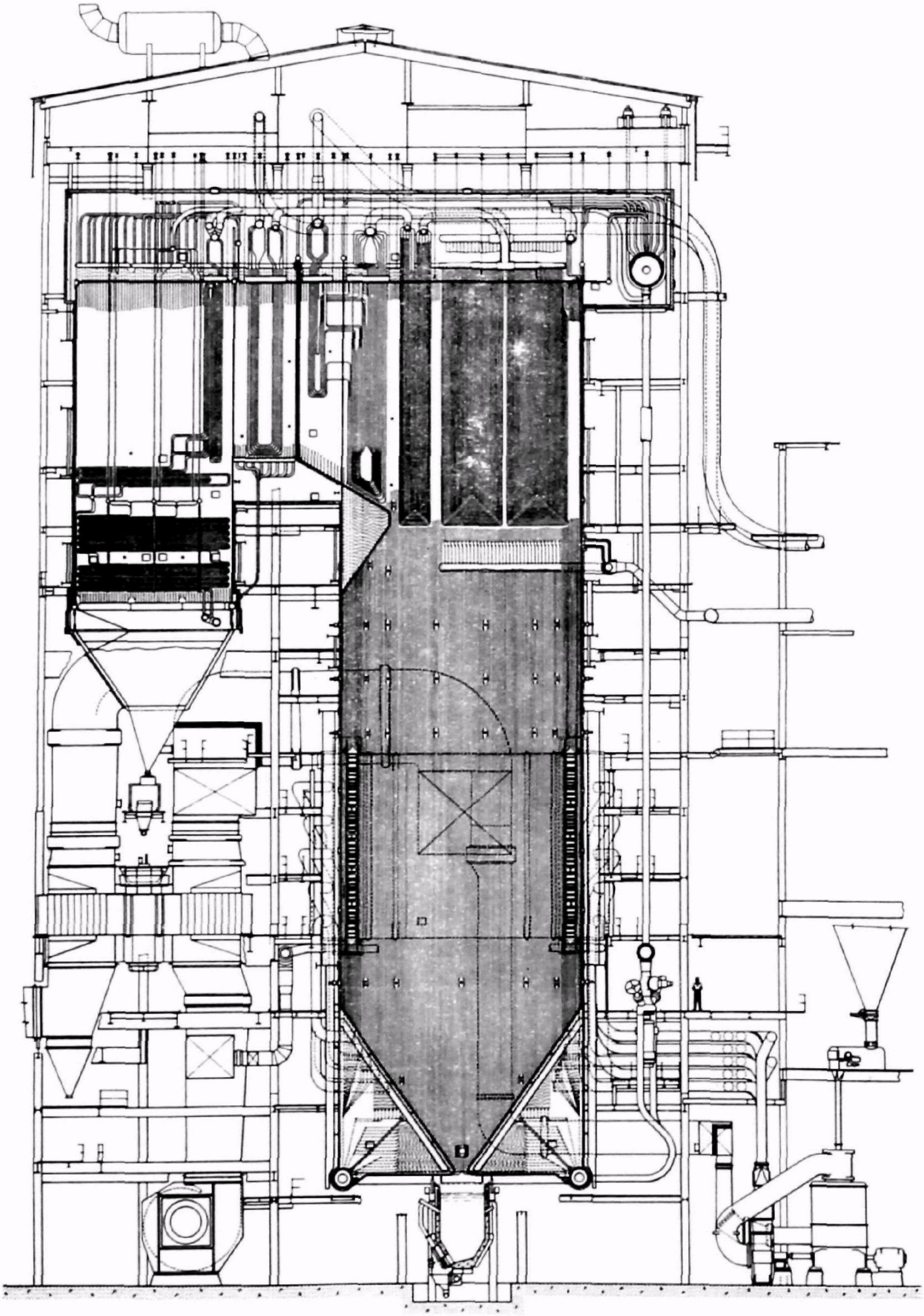


Figure 17. Unit side elevation, Utah Power and Light Company Huntington Station No. 2

TASK II - TEST PLANNING & FABRICATION OF TEST EQUIPMENT

The test program was designed to investigate the effect of excess air level, unit load, furnace wall deposits, biased firing, and overfire air operation with respect to $NO_x$ and related gaseous emission levels, furnace waterwall corrosion and unit performance. The instrumentation required to achieve the above mentioned goals included such items as fabrication of corrosion probes, probe control systems, gas temperature and sampling probes, calibration of thermocouples, analyzers and pressure gauges and the packaging of equipment for shipping to the test sites.

At the test sites, flue gas samples for the determination of $NO_x$, $SO_x$, THC and CO were obtained from the boiler economizer outlet ducts. The percent oxygen in the flue gas entering and leaving the air preheaters was also obtained for the determination of air preheater leakage and unit efficiency.

The type of instrumentation used in determining the emission concentrations and the general locations of these instruments are described in the discussion of Task III - Installation of Instrumentation. Unit steam and gas-side performance was monitored using calibrated thermocouples, pressure gauges and manometers as required. The general locations of these instruments are also described in the discussion of Task III - Installation of Instrumentation. Type E chordal thermocouples were installed in the furnace waterwalls at Wisconsin Power and Light Co.'s, Columbia Energy Center, Unit #1.

Coal samples were obtained during each test for later analysis. Fuel analysis, unit emission levels, steam flow rates, absorption rates, gas and air weights and efficiencies were calculated for each test. The calculating methods and procedures used are listed in the discussion of Task III - Installation of Instrumentation.

The test program documented and discussed in detail all tools and techniques regarding analytical measurements and sampling techniques and calculating procedures used.

TASK III - INSTALLATION OF INSTRUMENTATION

Instrumentation necessary to conduct the baseline, biased firing and overfire air test programs on the selected units was installed and calibrated. This instrumentation consisted of the following:

| MEASUREMENT | INSTRUMENT OR METHOD | LOCATION OF MEASUREMENT OR CALCULATION PROCEDURE |
|---|---|---|
| <u>Flue Gas Constituents</u> | | |
| Nitrogen Oxides - $NO_x$ | Chemiluminescence Analyzer | Economizer Gas Outlet |
| Carbon Monoxide - CO | Infrared Analyzer | Economizer Gas Outlet |
| Total Hydrocarbons - THC | Flame Ionization Analyzer | Economizer Gas Outlet |

| MEASUREMENT | INSTRUMENT OR METHOD | LOCATION OF MEASUREMENT OR CALCULATION PROCEDURE |
|---|---|---|
| <u>Flue Gas Constituents (Cont.)</u> | | |
| Oxygen - $O_2$ | Paramagnetic Analyzer | Economizer Gas Outlet and Air Heater Gas Inlet and Outlet |
| Sulfur Dioxide - $SO_2$ | Wet Chemistry | Economizer Gas Outlet |
| Carbon Dioxide - $CO_2$ | Calculated | Combustion Calculations |
| Unburned Combustibles | Cyclone Dust Collector<br>ASME Dust Collector | Economizer Gas Outlet - Unit A<br>Air Heater Gas Outlet - Unit B |
| <u>Steam and Water Flows</u> | | |
| Feedwater | Mercury Manometer | Feedwater Orifice |
| SH Desuperheat Spray | Calculated | Heat and Mass Balance |
| RH Desuperheat Spray | Calculated | Heat and Mass Balance |
| Reheat | Calculated | Heat and Mass Balance |
| Superheat | Calculated | Heat and Mass Balance |
| <u>Air and Gas Flows</u> | | |
| Total Flue Gas | Calculated | Heat and Combustion Calculations |
| Total Air | Calculated | Heat and Combustion Calculations |
| Overfire Air | Calculated | Mass Balance |
| Air Heater Leakage | Calculated | Mass Balance |
| <u>Miscellaneous Flows</u> | | |
| Coal | Coal Scales | Coal Feeders - Plant Instrumentation |
| <u>Pressures</u> | | |
| Steam and Water | Calibrated Gauges | Economizer Inlet<br>Drum<br>Superheat Outlet<br>Reheat Inlet |

| MEASUREMENT | INSTRUMENT OR METHOD | LOCATION OF MEASUREMENT OR CALCULATION PROCEDURE |
|---|---|---|
| <u>Pressures (Cont.)</u> | | |
| | | Reheat Outlet<br>Superheat Spray Water<br>Reheat Spray Water<br>High Pressure Heater Shell Side |
| Air and Gas | Plant Instrumentation | FD Fan Outlet<br>AH Air Inlet<br>AH Air Outlet<br>Windbox<br>Furnace<br>Economizer Outlet<br>AH Gas Inlet<br>AH Gas Outlet<br>ID Fan Inlet |
| <u>Temperatures</u> | | |
| Steam and Water | Calibrated Stainless Steel Type E Well and Type E Button Thermocouples | Economizer Inlet<br>Economizer Outlet<br>SH Desuperheat Inlet<br>SH Desuperheat Outlet<br>Superheat Outlet<br>RH Desuperheat Inlet<br>RH Desuperheat Outlet<br>Reheat Outlet<br>SH DESH Spray Water<br>RH DESH Spray Water<br>HP Heater Inlet Steam<br>HP Heater Drain<br>HP Heater FW Inlet<br>HP Heater FW Outlet |
| | Calibrated Stainless Steel Sheathed Type E Chordal Thermocouples | Furnace Waterwall Tubes |
| Air and Gas | Type E Thermocouples | Air Heater Gas Inlet<br>Air Heater Gas Outlet<br>Air Heater Air Inlet<br>Air Heater Air Outlet |
| <u>Miscellaneous</u> | | |
| Coal Samples | ASTM Procedures | Coal Feeders |
| Wall Deposit Patterns | Visual Observation | Furnace Waterwalls |
| Waterwall Corrosion | Corrosion Probes | Front Furnace Waterwall |

The same instrumentation and measurements as required in support of the baseline, biased firing and overfire air test programs on Unit A were utilized on Unit B, with the exception of the chordal thermocouples installed in the furnace waterwall tubes.

All test measurements were supplemented by monitoring and recording the normally available plant operating instrumentation.

## COLUMBIA ENERGY CENTER, UNIT #1

### TASKS IV, V & VI - TEST DATA ACQUISITION AND ANALYSIS

Wisconsin Power and Light Company's, Columbia Energy Center, Unit No. 1 has two "hot precipitators", i.e. the electrostatic precipitators are located between the boiler economizer outlets and the air preheater gas inlets. The use of the hot precipitators necessitated the sampling of the flue gas at three locations; economizer outlet, air preheater gas inlet, and air preheater gas outlet.

Flue gas samples for determination of $NO_2$, CO, $O_2$ and THC emission levels were obtained from each of the two economizer outlet ducts. The flue gas samples were drawn using a twelve (12) point grid in each duct. The $SO_2$ sample was drawn from a single point in the left economizer outlet duct using a heated sample line. The fly ash sample for carbon loss analysis was also obtained from a single point in the left economizer outlet duct.

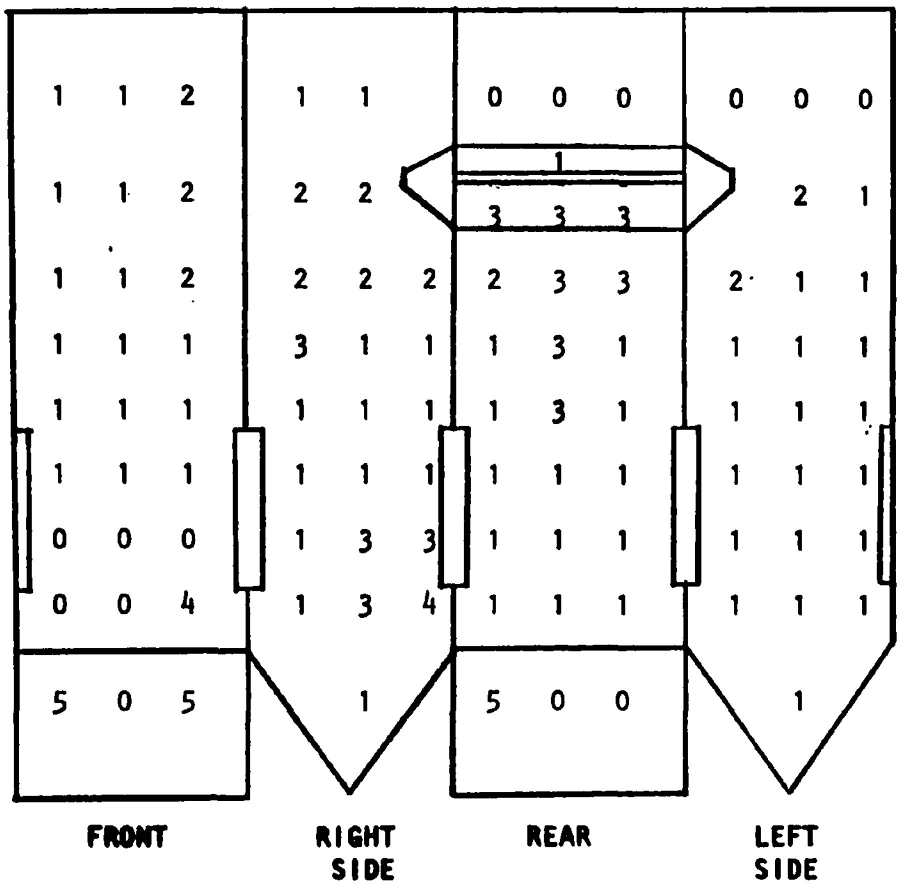
The percent oxygen in the flue gas entering and leaving the two air preheaters was drawn from an eighteen (18) point grid in each air preheater gas inlet and outlet duct. The grids were arranged so as to allow sampling on centroids of equal area. The percent oxygen in the flue gas entering and leaving the air preheaters is required for the determination of the air preheater leakage. The percent oxygen at these two points plus the percent oxygen in the flue gas leaving the economizer is used in the calculation of unit efficiency.

Visual observations of the furnace waterwalls were recorded for each test. However, visual observations of the furnace waterwalls were hampered due to the insufficient number and location of the observation doors. Typical wall deposit patterns taken during clean, moderate and heavy furnace slagging conditions at full load operation are shown on Figures 18, 19 and 20. These slag patterns are typical for all modes of boiler operation.

Chordal thermocouples were installed in the furnace waterwalls of Columbia Energy Center, Unit No. 1. The chordal thermocouples are utilized to determine the waterwall absorption rates and are therefore useful in monitoring furnace performance. The use of the chordal thermocouples is further explained in a separate subsection, Furnace Performance.

The Coal Feeders at Columbia #1 are pressurized. As a result, coal samples were initially obtained from the conveyor belts feeding the coal bunkers, with one sample being obtained for each test for later analysis. The samples could only be obtained when the bunkers were being filled, which was two to three times per day. This sampling method was not considered desirable, as it was impossible to know if the coal being fed to the coal bunkers was representative of the coal being burned during any one test. Gate valves were installed in the pipes feeding the coal from the bunkers to the feeders. With the installation of the gate valves, samples were obtained from each coal feeder during

## FURNACE WATERWALL DEPOSIT PATTERN



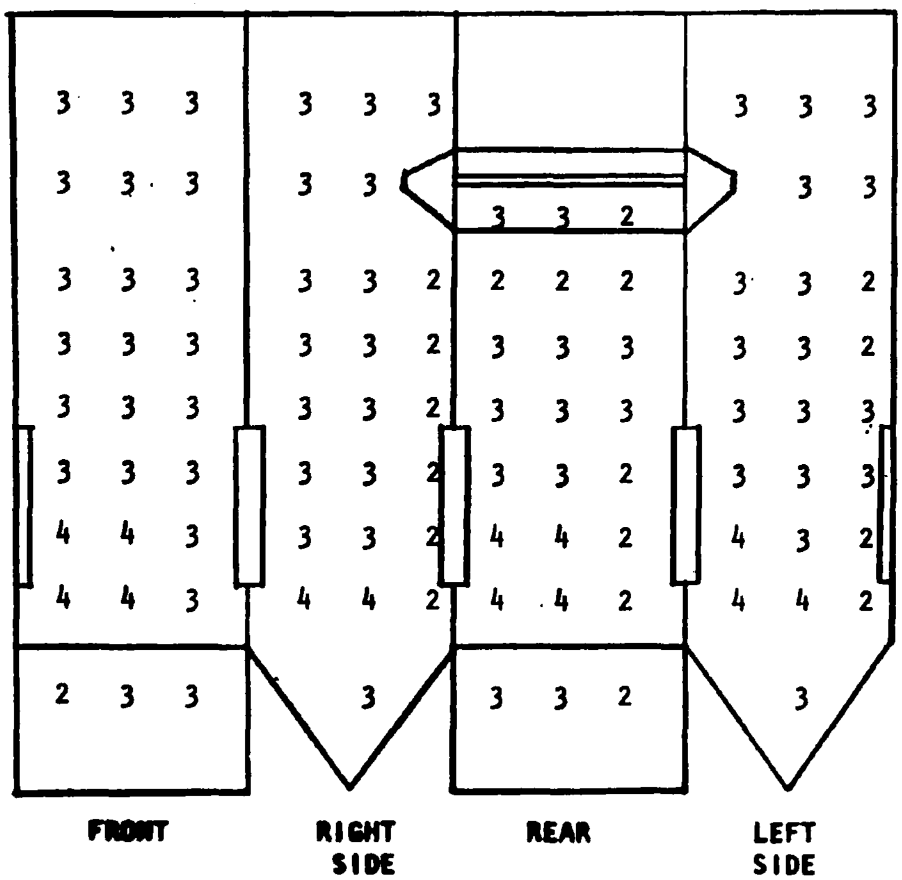

**KEY**

| | |
|---|---|
| NO ASH | 0 |
| FUZZY <13 MM | 1 |
| LIGHT 13 MM - 25 MM | 2 |
| LIGHT TO MED. 25 MM - 50 MM | 3 |
| MED. TO HEAVY 50 MM - 100 MM | 4 |
| HEAVY >100 MM | 5 |
| RUNNING SLAG | 6 |

NOTE: 25.4 MM = 1 INCH

Figure 18: Furnace waterwall deposit pattern, clean furnace

## FURNACE WATERWALL DEPOSIT PATTERN



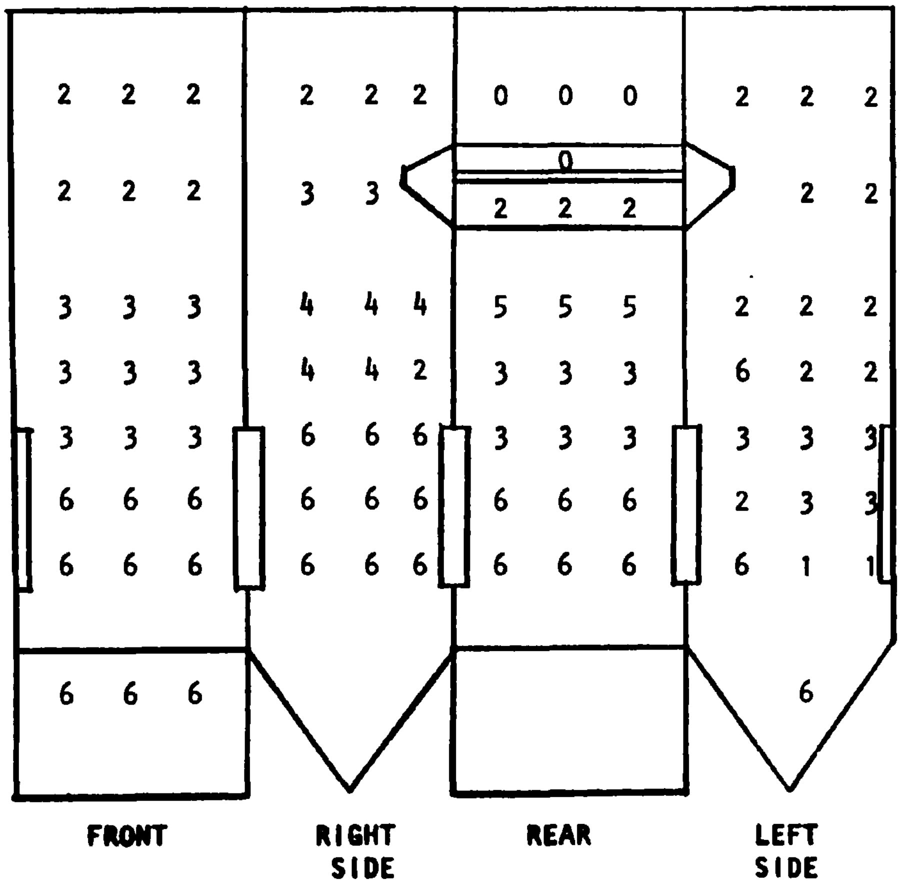

**KEY**

| | |
|---|---|
| NO ASH | 0 |
| FUZZY <13 MM | 1 |
| LIGHT 13 MM - 25 MM | 2 |
| LIGHT TO MED. 25 MM - 50 MM | 3 |
| MED. TO HEAVY 50 MM - 100 MM | 4 |
| HEAVY >100 MM | 5 |
| RUNNING SLAG | 6 |

NOTE: 25.4 MM = 1 INCH

Figure 19: Furnace waterwall deposit pattern, moderate slag furnace

## FURNACE WATERWALL DEPOSIT PATTERN




**KEY**

| | |
|---|---|
| NO ASH | 0 |
| FUZZY <13 MM | 1 |
| LIGHT 13 MM - 25 MM | 2 |
| LIGHT TO MED. 25 MM - 50 MM | 3 |
| MED. TO HEAVY 50 MM - 100 MM | 4 |
| HEAVY ≫100 MM | 5 |
| RUNNING SLAG | 6 |

NOTE: 25.4 MM = 1 INCH

Figure 20: Furnace waterwall deposit pattern, heavy slag furnace

each test and were blended to form a composite sample for each test.

The test data and results for the tests conducted at Wisconsin Power and Light Company's, Columbia #1 are tabulated in Appendix A. Summaries of the emissions test data for the baseline, biased firing and overfire air operation studies are tabulated on Sheets A-1 through A-6. During some of the testing in March and May of 1976, CO emission levels were not monitored due to malfunctioning of the CO analyzer. These tests are reported as not available, (NA), on the emissions test data summary sheets. Unit Performance test data for the three studies are tabulated on Sheets A-7 through A-13. The calculated unit performance test results are tabulated on Sheets A-14 through A-21. Unit efficiency is determined using the Heat Losses Method (ASME Power Test Code, PTC 4.1-1964, reaffirmed 1973). Sheets A-22 through A-35 are a tabulation of the average waterwall absorption rates, as measured at each chordal thermocouple for each test. A set of unit board and computer data was obtained for each test and is tabulated on Sheets A-36 through A-56.

All test data and results are reported in SI Metric units, with the exception of the board and computer data. The board and computer data is reported in the engineering units provided by plant instrumentation.

The thirty (30) day waterwall corrosion coupon evaluations were conducted using a specially designed probe consisting of four individual coupons. The waterwall corrosion coupon evaluations are described and discussed under a separate subsection in this report.

## TASK IV - BASELINE OPERATION STUDY

### Load and Excess Air Variation - Clean Furnace

Tests 1 through 7 were performed to determine the effect of varying excess air on unit emission levels and performance. These tests were conducted at three unit loads with clean furnace conditions. The slag observed on the furnace waterwalls ranges from 0 to 25.4 mm (1 in.) in thickness.

Initially, maximum and minimum excess oxygen levels of six (6) percent and three and one-half (3.5) percent at the economizer outlet were set by Wisconsin Power and Light Co. as acceptable modes of unit operation at full load. Wisconsin Power and Light later requested that the minimum excess oxygen limit be raised to four (4) percent. At reduced loads these limits were slightly higher. On a few occasions, excess oxygen values as low as two and one-half (2.5) percent were experienced, when measured using test instrumentation. The limits set by Wisconsin Power and Light were exceeded on those occasions due to a discrepancy between plant and test instrumentation. The Plant oxygen alalyzer was being used to monitor and control unit operations. At times the Plant analyzer was reading approximately one percent (1%) higher than test instrumentation.

During initial testing of Columbia, Unit No. 1, mechanical stops on the induced draft fans prevented the unit from reaching full load during high excess air operation tests. The mechanical stops were changed during a unit outage in June, 1976 enabling the unit to achieve full load during subsequent high excess air operation tests.

Comparison of $NO_2$ emission levels with unit load shows $NO_2$ levels were generally higher at half load than at full load. This might be attributed to the fact that the excess air levels are higher at half load than at full load.

CO emission levels are found to be higher at full load unit operation than at half load operation. This can be attributed to the fact that at lower loads the unit operates at higher excess air levels.

The effect of excess air level and unit loading on unit efficiency, carbon heat loss, unburned hydrocarbons and sulfur dioxide emission levels is discussed in conjunction with the other baseline tests.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Furnace Condition |
|---|---|---|---|---|---|---|---|
| 1 | 441 | 322.9 | 4.8 | 20.7 | 117.8 | 86.95 | Clean |
| 2 | 442 | 260.2 | 4.8 | 21.8 | 118.9 | 87.49 | Clean |
| 3 | 400 | 303.7 | 5.4 | 34.7 | 131.4 | 86.28 | Clean |
| 4 | 334 | 246.3 | NA | 35.6 | 132.5 | 87.35 | Clean |
| 5 | 267 | 291.2 | 1.5 | 27.7 | 126.7 | 87.94 | Clean |
| 6 | 269 | 335.2 | 1.7 | 37.5 | 136.2 | 87.05 | Clean |
| 7 | 268 | 333.8 | 2.2 | 43.5 | 141.4 | 87.23 | Clean |

Load and Excess Air Variation - Moderately Dirty Furnace

Tests 8 through 12 were conducted with a moderately dirty furnace. The slag observed on the furnace waterwalls ranged from 25.4 mm (1 in.) to 76.2 mm (3 in.) in thickness and was in a plastic state in the thicker areas. The excess air levels and unit loads were allowed to vary per the test program.

The $NO_2$ emission levels for tests 8 through 12 are shown in the following table. Examination of this table shows only small changes in emission levels for the full load tests. This could be due to small changes in excess air levels. For the half load tests there is a distinct change in $NO_2$ level with a change in excess air level. At similar excess air levels, the full load tests have higher $NO_2$ levels than the half load tests.

At similar unit loads, CO emission levels do not show any appreciable change with changes in excess air levels. Comparison of full and half load tests show CO emission levels to be higher at full load. As with tests 1 through 7, this difference can be partially attributed to the fact that the boiler operates at higher excess air levels at half load.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Furnace Condition |
|---|---|---|---|---|---|---|---|
| 8 | 427 | 295.7 | 5.1 | 19.4 | 116.5 | 87.04 | Moderate |
| 9 | 432 | 290.2 | 4.9 | 23.7 | 120.7 | 86.85 | Moderate |
| 10 | 394 | 310.6 | 5.1 | 30.6 | 127.5 | 86.93 | Moderate |
| 11 | 263 | 270.5 | 1.5 | 20.4 | 117.2 | 87.26 | Moderate |
| 12 | 265 | 368.3 | 1.9 | 52.5 | 145.0 | 86.41 | Moderate |

## Load and Excess Air Variation - Dirty Furnace

Tests 13 through 19 were conducted with heavy furnace wall deposits. Furnace wall deposits ranged from 50.8 mm (2 in.) to 101.6 mm (4 in.) thick. The slag was usually in a plastic state and at times built up to 305 mm (12 in.) to 610 mm (24 in.) thick on the lower furnace walls. This buildup was caused by the slag slowly flowing down the furnace walls. The excess air levels and unit loads were varied per the test program.

As shown in the following table, there is a correlation between $NO_2$ emission levels and excess air level at half load. At full load this correlation is not evident, as the $NO_2$ at the low excess air level is higher than expected.

As with the earlier baseline tests, the CO levels for the half load tests are lower than for the full load tests.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Furnace Condition |
|---|---|---|---|---|---|---|---|
| 13 | 432 | 315.7 | NA | 17.1 | 114.3 | 86.57 | Heavy |
| 14 | 426 | 309.5 | 4.9 | 22.6 | 119.7 | 76.75 | Heavy |
| 15 | 397 | 334.3 | 5.6 | 32.2 | 129.0 | 76.20 | Heavy |
| 16 | 329 | 252.9 | NA | 35.7 | 132.5 | 85.56 | Heavy |
| 17 | 264 | 294.6 | 1.2 | 26.1 | 122.8 | 87.65 | Heavy |
| 18 | 267 | 347.7 | 1.3 | 39.5 | 134.3 | 87.15 | Heavy |
| 19 | 263 | 369.2 | 1.4 | 54.8 | 144.6 | 86.23 | Heavy |

## Analysis of Results

The changes in $NO_2$, CO and carbon heat loss versus theoretical air to the fuel firing zone are shown on Figures 21, 22 and 23. These parameters are plotted versus theoretical air to the fuel firing zone rather than the total excess air. For the baseline operation study the TA is essentially the same as the total air.

Figure 21 shows that $NO_2$ correlates reasonably well with TA. Increasing TA results in increasing $NO_2$ emission levels. This correlation is in agreement with other research, which has shown that $NO_2$ emission levels are proportional to the concentration of oxygen available for combustion. Comparison of full load and half (1/2) load test at similar TA shows that the half (1/2) load tests have lower $NO_2$ levels. The two three-quarter (3/4) load tests shown on Figure 21 do not correlate with the full or half (1/2) load tests with respect to TA or unit load.

With the exception of one supposedly clean test, furnace waterwall deposits appear to have some effect on $NO_2$ emission levels. As Figure 21 indicates, those tests performed with heavier furnace waterwall deposits generally have higher $NO_2$ levels.

While the data plotted is not sufficient proof to the above statement, it does support the argument that $NO_2$ emission levels are affected by furnace waterwall deposit conditions.

Wisconsin Power & Light Co.
Columbia Energy Center
Unit #1

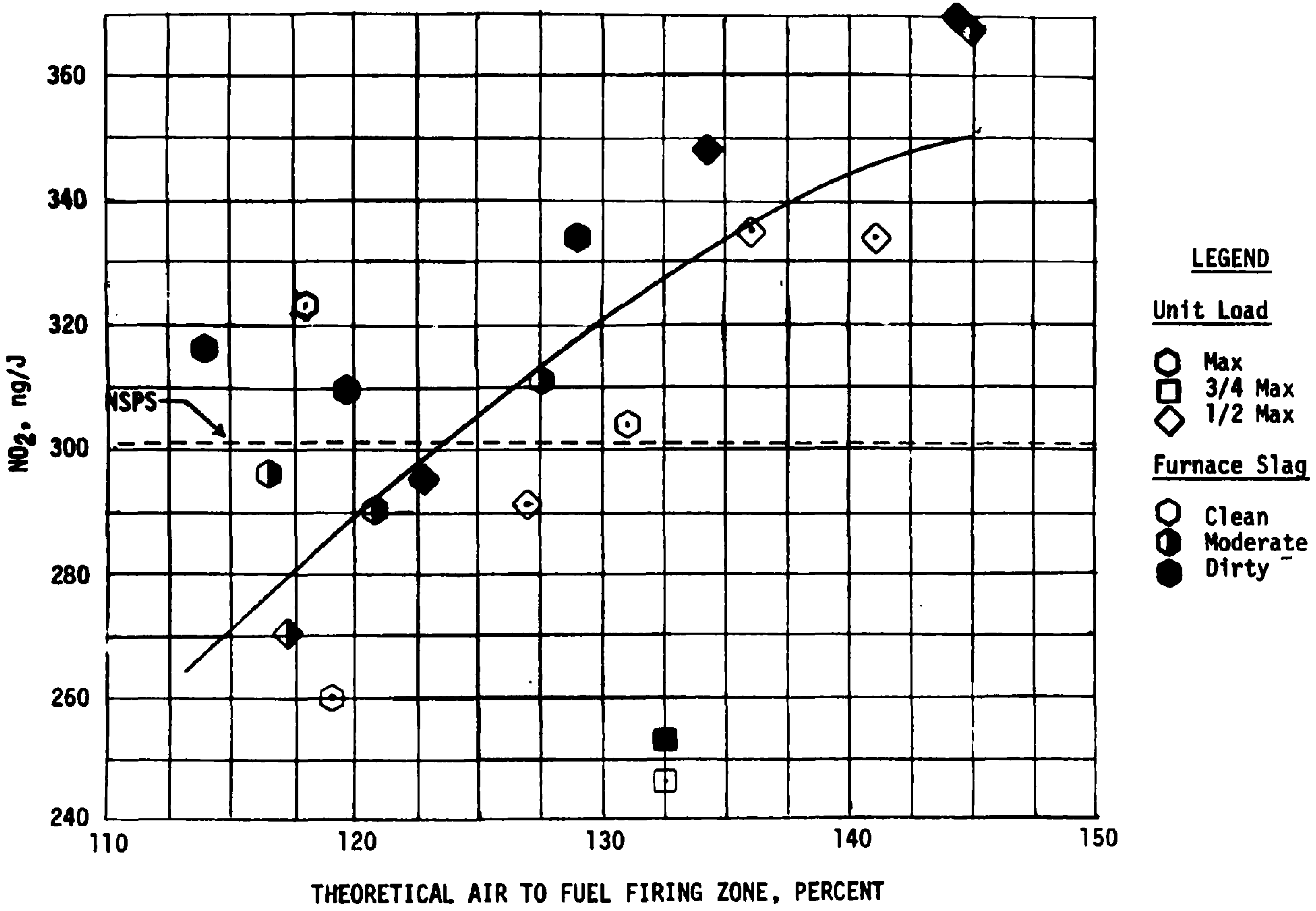



Figure 21: $NO_2$ vs. theoretical air to fuel firing zone, baseline study

Wisconsin Power & Light Co.
Columbia Energy Center
Unit #1

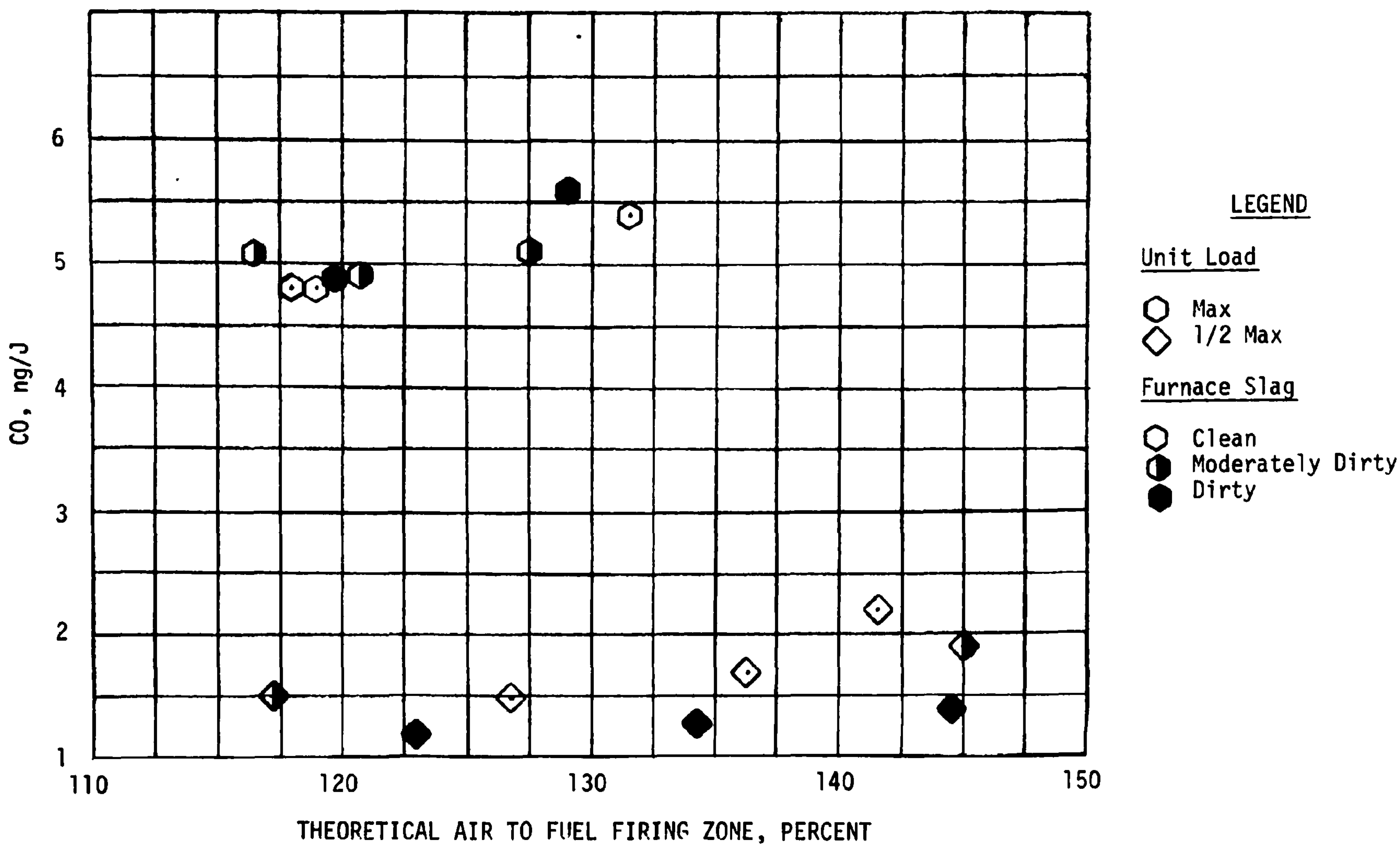



Figure 22: CO vs. theoretical air to fuel firing zone, baseline study

Wisconsin Power & Light Co.
Columbia Energy Center
Unit #1

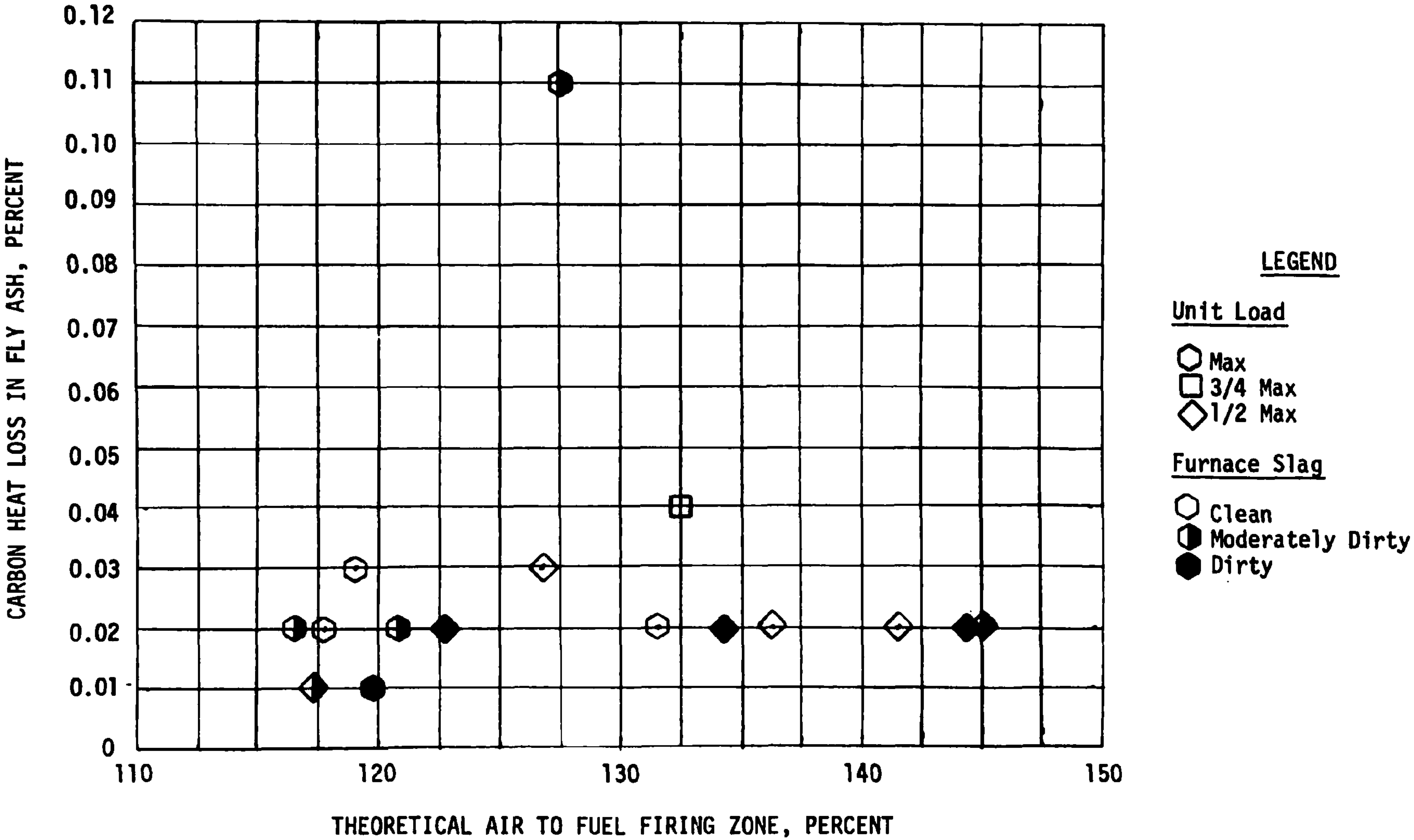



Figure 23: Carbon heat loss vs. theoretical air, baseline study

Figure 22 does not show any variation in CO emission levels with changes in TA. However, it does show that unit loading has a significant effect on CO emission levels. The CO levels at full load are approximately five (5) times the CO levels at half (1/2) load. It should be noted that the half (1/2) load tests were performed in May, 1976, while the full load tests were performed in March, 1976. Besides changes in tilt, the only other significant change other than load was that the fuel and auxiliary nozzle compartment damper settings were changed. The fuel nozzle compartment dampers were opened from an average 50% open to 100% open, while the auxiliary nozzle compartment dampers were closed from approximately 100% open to approximately 50% open. Whether this would have any effect on CO emission levels is unknown.

The percent carbon heat loss in the fly ash versus theoretical air to the fuel firing zone is shown in Figure 23. The carbon heat loss values for tests 13 and 15 have not been plotted on Figure 23, as they were too high to be shown on this figure. With the exception of these two tests and the one high test shown, carbon heat loss appears to be unaffected by variations in TA, unit load and furnace waterwall deposits.

Figure 24 is a plot of unit efficiency versus excess air at the economizer outlet. This figure indicates that unit efficiency is inversely proportional to excess air at the economizer outlet. By examining the full load and half (1/2) load test separately, the decrease in unit efficiency with increasing excess air at the economizer outlet is more apparent.

The $SO_2$ emission levels were monitored for each test and are reported on Sheets A1 and A2. No correlation was evident between $SO_2$ emission levels and excess air, unit loading or furnace waterwall deposits. It was not possible to control the $SO_2$ emission levels as they are more a function of the sulfur content of the fuel rather than the mode of boiler operation.

Unburned hydrocarbon emission levels were monitored and were found to be at such low levels as to be unmeasurable.

A thirty (30) day baseline waterwall corrosion coupon test was conducted in April and May of 1975. Boiler operation was normal with full load being maintained as much as possible. The waterwall corrosion coupon test is discussed in the section, Waterwall Corrosion Coupon Evaluation.

## TASK V - BIASED FIRING STUDY

### Fuel Elevations Out of Service Variation

Eighteen (18) tests were conducted at Columbia Energy Centers', Unit #1 to determine the effect on $NO_2$ emission levels when taking various fuel elevations out of service (biased firing). These tests were performed at three unit loadings and two excess air levels.

As shown by the data in the following table, the $NO_2$ emission levels are lowest with the top and/or top middle elevation of fuel nozzles out of service (Tests 1, 2, 5, 8, 14 and 17). When comparing tests with similar operating conditions (Tests 5 vs. 14 or 8 vs. 17), it can be seen that increasing excess air level results in increasing $NO_2$ emission levels.

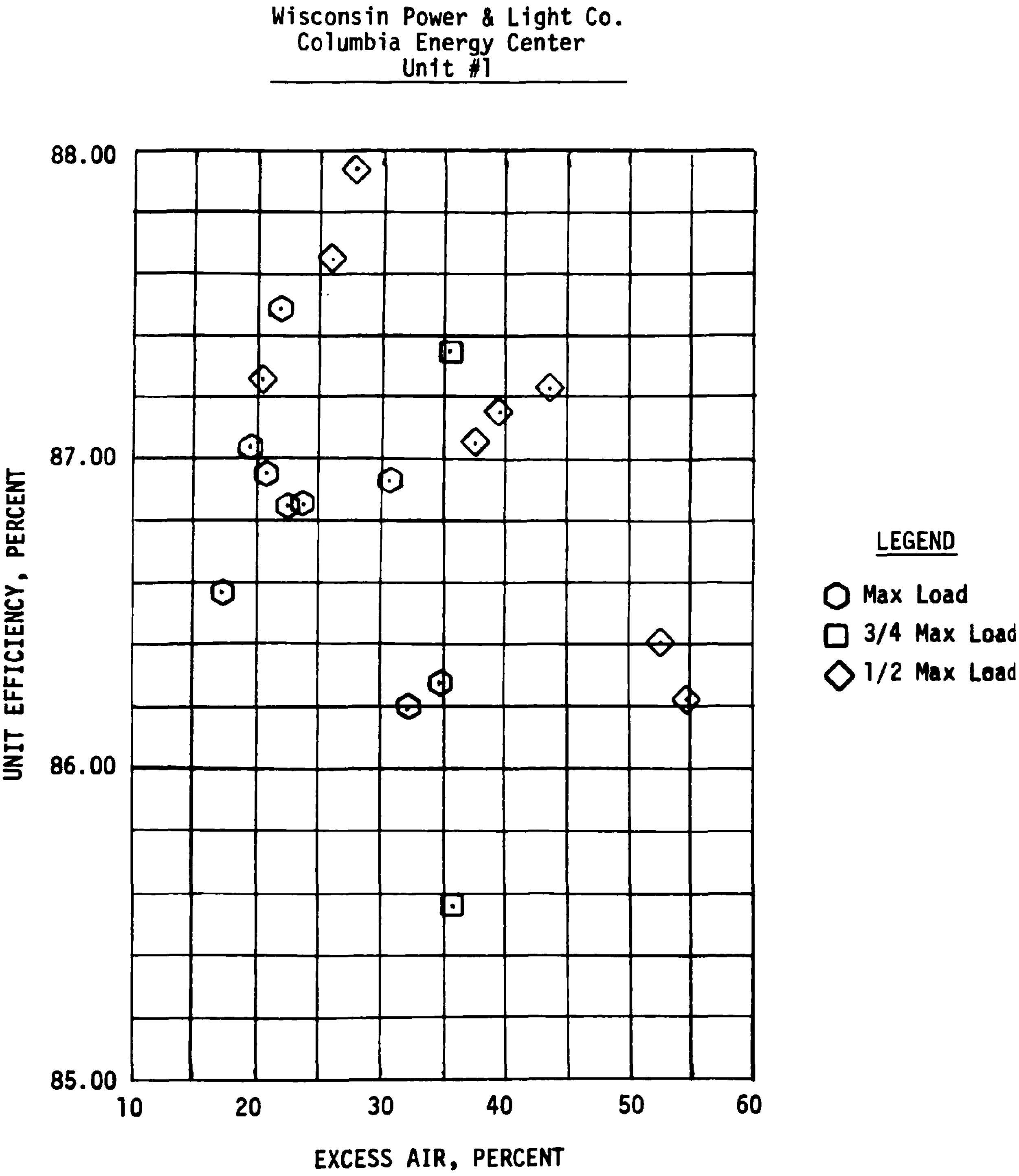



Figure 24: Unit efficiency vs. excess air, baseline study

CO emission levels appear to be affected only by unit load with the levels being higher for full and three-quarter load than for half load. The CO analyzer was inoperative during much of the biased firing testing due to problems with the analyzer source assembly and excessive electrical noise.

No thirty (30) day waterwall corrosion coupon evaluation was performed following the biased firing operation study.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air to Firing Zone-% | Unit Effic. % | Fuel Nozzle Elevation Out of Service |
|---|---|---|---|---|---|---|---|
| 1 | 426 | 203.9 | NA | 20.4 | 108.2 | 86.19 | Top |
| 2 | 428 | 209.1 | NA | 18.4 | 116.6 | 86.54 | Top Middle |
| 3 | 433 | 249.2 | NA | 15.2 | 112.6 | 85.56 | Bottom Center |
| 4 | 431 | 250.3 | NA | 19.0 | 116.9 | 86.52 | Bottom |
| 5 | 352 | 215.9 | 8.0 | 26.1 | 110.0 | 86.76 | Top |
| 6 | 352 | 260.2 | 4.2 | 21.7 | 117.5 | 87.71 | Top Center |
| 7 | 344 | 227.3 | 44.8 | 30.7 | 125.6 | 86.30 | Bottom |
| 8 | 263 | 162.2 | 1.4 | 19.7 | 94.4 | 87.17 | Top & Top Middle |
| 9 | 258 | 245.1 | 1.2 | 34.2 | 133.5 | 87.93 | Top Cen. & Bottom Cen. |
| 10 | 268 | 266.8 | 1.6 | 29.2 | 128.4 | 87.37 | Bottom & Bottom Mid. |
| 11 | 417 | 231.2 | NA | 23.1 | 122.7 | 85.73 | Top Middle |
| 12 | 417 | 297.2 | 5.4 | 24.6 | 123.4 | 86.49 | Top Center |
| 13 | 438 | 280.4 | NA | 18.4 | 115.8 | 86.69 | Bottom Center |
| 14 | 353 | 222.5 | 22.6 | 34.1 | 117.9 | 86.92 | Top |
| 15 | 325 | 231.7 | NA | 35.8 | 132.9 | 86.37 | Bottom Center |
| 16 | 350 | 246.4 | NA | 41.3 | 135.8 | 86.11 | Bottom |
| 17 | 261 | 228.7 | 1.2 | 35.9 | 105.8 | 86.62 | Top & Top Middle |
| 18 | 264 | 316.9 | 2.1 | 36.6 | 135.8 | 86.67 | Bottom & Bottom Mid. |

## Analysis of Results

$NO_2$ emission levels versus theoretical air to the fuel firing zone are plotted on Figure 25. This figure indicates a trend similar to the baseline study tests, with increasing $NO_2$ levels for increasing TA. No effect due to a variation in unit load is evident in Figure 25. The furnace waterwalls were moderately dirty for most of the biased firing tests and therefore no effect on $NO_2$ levels due to furnace waterwall deposits was observed.

Figure 26 is a plot of fuel firing elevation out of service versus $NO_2$ emissions level. The lowest $NO_2$ emissions levels were obtained with the upper fuel firing elevations removed from service and with the respective compartment dampers 100% open. Overfire air operation is simulated with this method of unit operation. The highest $NO_2$ levels were obtained when the center fuel firing elevations were removed from service. Removal of the bottom fuel firing elevation from service gives a slight reduction from the higher $NO_2$ levels obtained with the center levels removed from service.

CO emission level or carbon heat loss versus TA are not plotted. Preliminary plots gave no indication that TA, unit load or furnace wall deposits had any effect on CO emission levels or carbon heat losses.

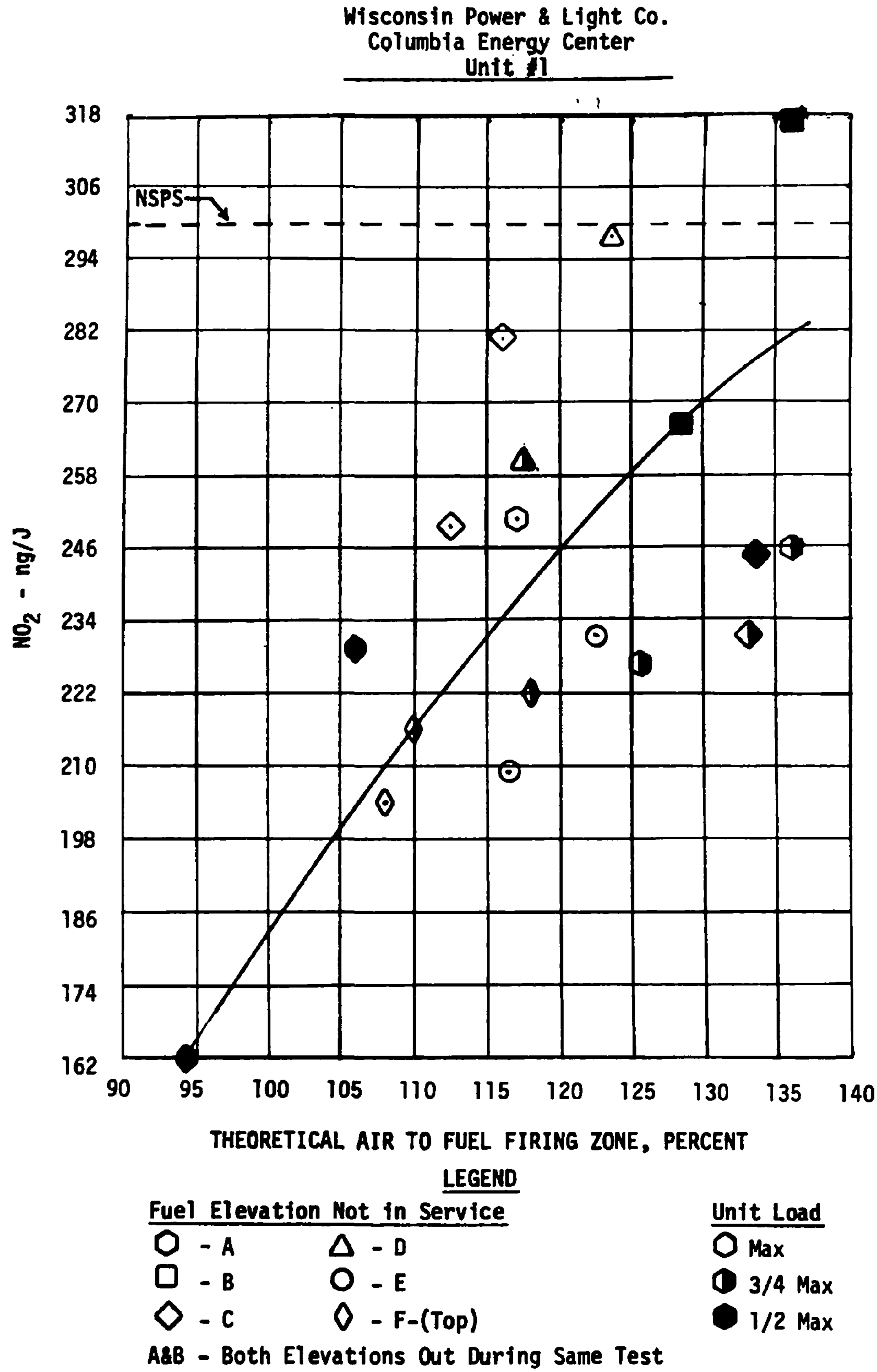



Figure 25: $NO_2$ vs. TA, biased firing study

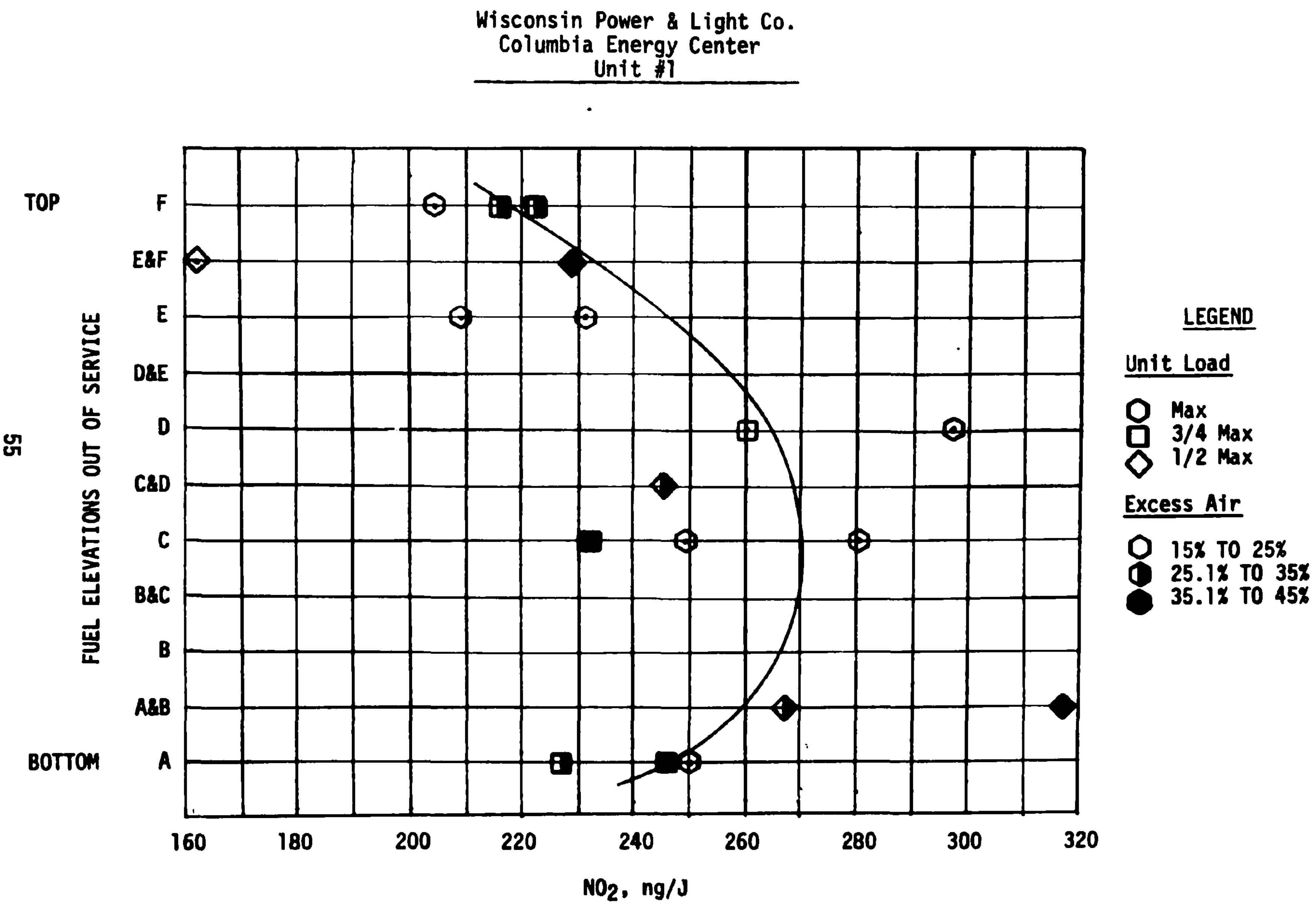



Figure 26: Fuel elevation out of service vs. $NO_2$, biased firing study

Figure 27 shows steam generator efficiency versus percent excess air at the economizer outlet. Although there is more scatter than in the baseline tests, the trend of decreasing unit efficiency with increasing excess air is still evident. The variation in the fuel elevations firing may have contributed to the scatter in the data.

$SO_2$ emission levels were monitored for each test and are reported on data sheets A-3 and A-4.

Unburned hydrocarbon emission levels were monitored and were at such low levels as to be unmeasurable.

TASK VI - OVERFIRE AIR OPERATION STUDY

Excess Air and Overfire Air Rate Variation

Tests 1 through 11 were conducted to determine the effect on the $NO_2$ emission levels and unit performance when varying the overfire air rate with respect to excess air level. For tests 1 through 11, the overfire air registers were held at horizontal tilt while the fuel nozzle tilts were allowed to vary from a -8 degrees to a +8 degrees. The fuel nozzles were allowed to vary to maintain acceptable superheat and reheat temperatures.

The following table shows that $NO_2$ emission levels increase with increasing theoretical air to the fuel firing zone. Except for tests 1 and 2, $NO_2$ emission levels are found to correlate well with excess air level. The $NO_2$ levels for tests 1 and 2 are much higher than expected. No obvious reason for the high $NO_2$ levels can be found. However one possible explanation is that the furnace wall deposits were considerably different for test 1 and 2. Examination of the waterwall slag patterns for tests 1 and 2 shows that during these tests the slag was 50.8 mm (2 in.) to 101.6 mm (4 in.) thick, glassy and running down the furnace walls. For the remaining tests the slag was about 25.4 mm (1 in.) to 101.6 mm (4 in.) thick and mostly plastic; however, it was not glassy or running down the walls as fast. The problem with the glassy slag is that it reradiates back to the fire increasing the bulk flame temperatures.

Due to the problems encountered with the CO analyzer the CO levels were only monitored for tests 1 and 2. Based on the results of test 1 through 11, the optimum excess air operating level was found to be the minimum, approximately 15 percent at the economizer outlet. The optimum overfire air rate is with the overfire air dampers 100 percent open. This mode of operation will allow 15 to 20 percent of the total combustion air to be introduced above the top level of fuel nozzles depending upon unit load.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | OFA Dampers % Open |
|---|---|---|---|---|---|---|---|
| 1 | 425 | 356.1 | 4.9 | 23.9 | 120.9 | 86.19 | 0 |
| 2 | 426 | 354.9 | 4.9 | 23.2 | 115.7 | 86.54 | 25 |
| 3 | 439 | 222.8 | NA | 21.8 | 109.7 | 85.56 | 50 |
| 4 | 445 | 203.4 | NA | 19.7 | 105.2 | 86.52 | 70 |
| 5 | 444 | 215.4 | NA | 20.4 | 104.6 | 86.76 | 95 |

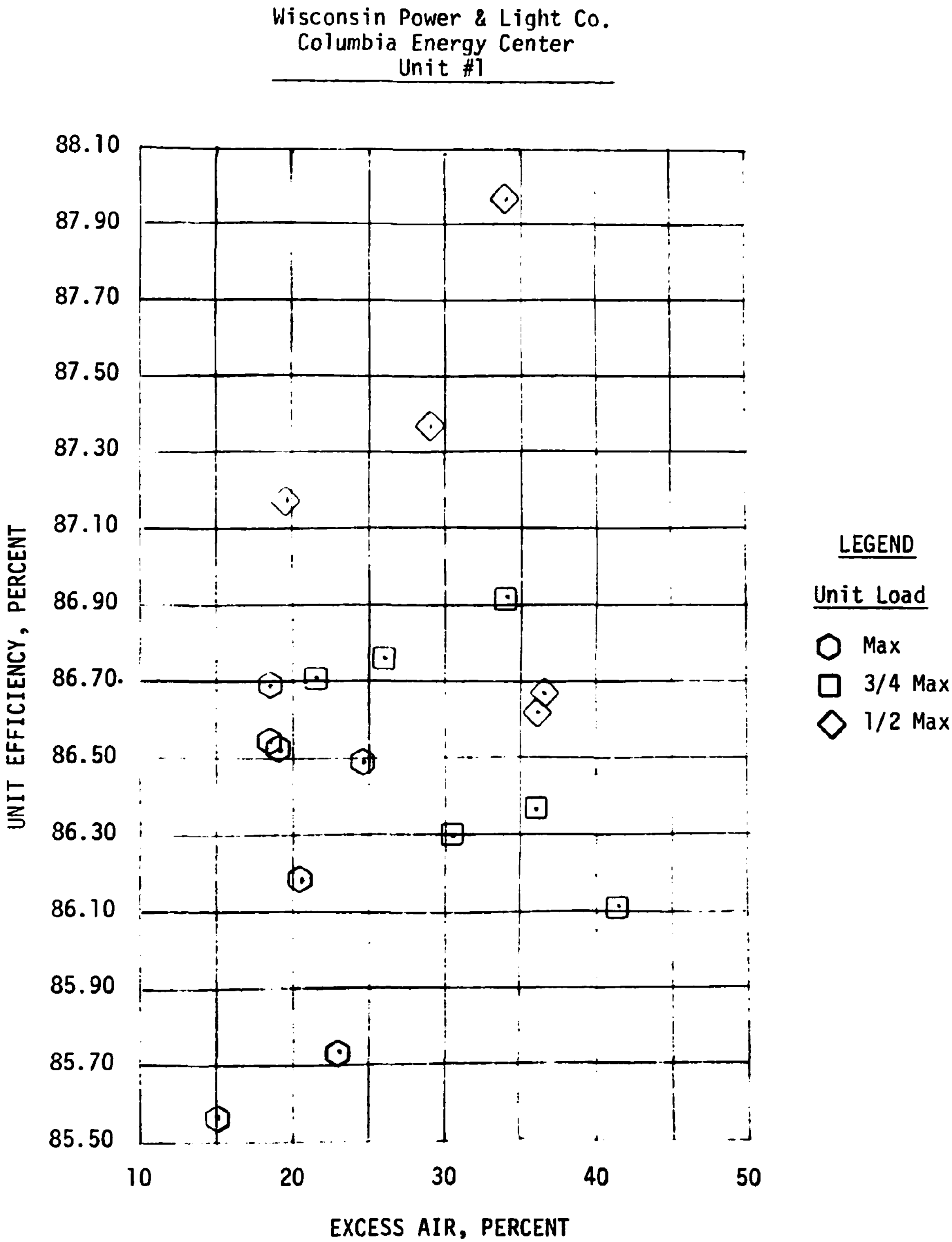



Figure 27: Unit efficiency vs. excess air, biased firing study

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | OFA Dampers % Open |
|---|---|---|---|---|---|---|---|
| 6 | 446 | 182.7 | NA | 13.3 | 110.7 | 86.71 | 0 |
| 7 | 441 | 177.9 | NA | 13.9 | 101.8 | 86.30 | 50 |
| 8 | 439 | 171.4 | NA | 15.1 | 99.0 | 87.17 | 100 |
| 9 | 398 | 299.2 | NA | 36.8 | 128.2 | 87.97 | 25 |
| 10 | 390 | 274.7 | NA | 35.8 | 118.8 | 87.37 | 80 |
| 11 | 389 | 246.5 | NA | 30.0 | 111.5 | 85.73 | 100 |

Overfire Air Register Tilt Variation

Seven (7) tests were conducted to determine the effect of fuel nozzle and overfire air register tilt variation on $NO_2$ emission levels and unit performance. These tests, 12 through 18, were conducted at the optimum overfire air rate (dampers 100 percent open) established in tests 1 through 11. Although tests 1 through 11 indicated an excess air level of approximately 15 percent to be optimum for low $NO_x$ formation, an average excess air level of 24 percent was maintained for tests 12 through 18. The higher excess air level was easier to maintain from the standpoint of boiler operation and did not result in significantly higher $NO_2$ levels.

The overfire air registers were varied from a -5 degrees to a +30 degrees, while the fuel nozzles were varied from a -5 degrees to a +26 degrees. During a unit outage in early June, 1976 the fuel nozzle tilt mechanism was modified. The bottom two fuel firing elevations were prevented from going below a horizontal tilt, but could travel upward to a maximum +26 degrees. The upper four fuel firing elevations were allowed to travel from a -10 degrees to a +26 degrees. When the bottom two fuel firing elevations were at horizontal, the upper four elevations were at a -10 degrees. As the tilts moved upward, the upper four fuel firing elevations rose farther and faster, so that at the maximum upward tilt all the fuel firing elevations were at a +26 degrees.

For these tests the furnace waterwall slagging conditions ranged from light to moderate waterwall deposits. The slag was in a plastic state in those areas of the waterwalls where the slag was 25.4 mm (1 in.) or thicker and could be seen slowly flowing down the lower waterwalls.

The following table shows that $NO_2$ emission levels were reduced by movement of the fuel nozzles and overfire air registers away from each other. While tests 16 through 18 have higher $NO_2$ levels than test 12 through 15 the trends are similar. The differences in the $NO_2$ levels can be attributed to small variations in boiler operation on a daily basis and to the location of the fuel firing zone in the furnace. For tests 16, 17 and 18 the fuel firing zone was higher in the furnace than tests 12 through 15. With the fuel firing zone higher in the furnace, the waterwall surface area available for cooling of the flame is greatly reduced. The loss of cooling of the flame can result in an increase in flame temperature, which can result in an increase in thermal $NO_2$ formation.

Parallel operation of the fuel nozzles and overfire air registers is as effective as when they are moved away from each other. Therefore, for ease of testing and boiler operation, parallel tilt conditions were chosen for the mode of boiler operation in tests 19 through 24.

CO emission levels are not found to be greatly affected by tilt variation. The one test with high CO levels could be the result of the maximum upward fuel nozzle and overfire air register tilts. At these high tilts, the residence time of the hot combustion gases in the furnace would be reduced. This reduction in residence time could affect the oxidation of CO to $CO_2$.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Fuel Nozzle Tilt Degrees | OFA Register Tilt Degrees |
|---|---|---|---|---|---|---|---|---|
| 12 | 446 | 195.5 | 4.9 | 23.9 | 102.8 | 87.20 | -5 | -5 |
| 13 | 444 | 205.4 | 1.5 | 26.9 | 105.7 | 86.90 | 0 | -5 |
| 14 | 443 | 188.5 | 3.0 | 26.9 | 106.0 | 87.28 | -5 | 0 |
| 15 | 425 | 198.9 | NA | 18.3 | 101.5 | 86.43 | +1 | 0 |
| 16 | 438 | 273.7 | 2.2 | 24.6 | 103.9 | 87.45 | +26 | 0 |
| 17 | 440 | 224.6 | 4.5 | 26.2 | 104.7 | 86.88 | +2 | +30 |
| 18 | 441 | 223.4 | 17.0 | 23.2 | 103.1 | 87.13 | +26 | +30 |

Load and Furnace Waterwall Deposit Variation at Optimum Conditions

Tests 19 through 24 were conducted at the optimum excess air level, overfire air rate and fuel nozzle and overfire air register tilts determined in tests 1 through 18. These tests were performed to determine the effect on $NO_x$ emission levels and unit performance at the optimized conditions, while varying unit load and furnace wall deposits. The excess air level ranged from a low of 19 percent at full load to a high of 34 percent at half load. The overfire air register dampers were 100 percent open. The fuel nozzles and overfire air registers were essentially parallel for tests 19 through 24. The tilts ranged from horizontal tilt to a +10 degree tilt for the overfire air registers and a +1 to +12 degree tilt for the fuel nozzles.

The following table shows that $NO_2$ formation is affected by furnace waterwall condition for the three-quarter (3/4) and full load tests. Except for tests 23 and 24, $NO_2$ emission levels increase with increasing furnace waterwall deposits. $NO_2$ emission levels are also affected by unit load, with higher $NO_2$ levels at higher loads.

Except for test 19, CO emission levels are unaffected by unit load or furnace waterwall deposits. The CO levels for test 19 are considerably higher than tests 20 through 24. The higher CO level may be due to the lower excess air level.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Furnace Condition |
|---|---|---|---|---|---|---|---|
| 19 | 441 | 182.8 | 22.1 | 19.1 | 99.7 | 87.66 | Moderate |
| 20 | 438 | 234.8 | 1.1 | 25.4 | 99.3 | 86.63 | Heavy |
| 21 | 350 | 171.8 | 1.2 | 30.0 | 98.6 | 87.53 | Clean |

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Furnace Condition |
|---|---|---|---|---|---|---|---|
| 22 | 342 | 220.6 | 1.1 | 28.5 | 103.4 | 87.39 | Moderate |
| 23 | 263 | 161.9 | 1.2 | 32.5 | 106.1 | 88.47 | Clean |
| 24 | 259 | 161.0 | 1.6 | 34.2 | 107.0 | 87.78 | Moderate |

Analysis of Results

$NO_2$, CO and carbon heat loss values versus theoretical air to the fuel firing zone are shown on Figures 28, 29 and 30, respectively. Although only tests 1 through 11 were conducted to determine the effect of TA variation all 24 tests are shown on Figures 28, 29 and 30.

Figure 28 shows that $NO_2$ emission levels increase with increasing theoretical air to the fuel firing zone. Furnace waterwall deposits and unit load are also indicated on Figure 28. On this boiler, comparison of tests with similar TA's, but different waterwall deposits give no indication that furnace waterwall slagging has any effect on $NO_2$ emission levels. Two half (1/2) load and two three-quarter (3/4) load tests were performed for the overfire air operation study. The two half (1/2) load tests have the lowest $NO_2$ emission levels, while the $NO_2$ emission levels for the three-quarter (3/4) load tests are of the same magnitude as the full load tests.

CO versus theoretical air to the fuel firing zone is plotted in Figure 29. This figure indicates a possible increase in CO levels at theoretical air levels of approximately 100% to 105%. While this is the expected trend, the data plotted in Figure 29 is insufficient to support such a trend. However, carbon heat loss follows a similar trend when plotted versus TA. Figure 30 is a plot of carbon heat loss for the overfire air study. For theoretical air levels in the range from 100% to 110% carbon heat losses are found to rise rapidly. This is also an expected trend and is what previous studies have shown to be true for both carbon heat loss and CO.

The second task in the overfire air study involved the effect of overfire air register tilt variation on $NO_2$, CO and carbon heat loss. The $NO_2$ emission levels for these tests are plotted versus the tilt differential between the fuel nozzles and overfire air registers as shown on Figure 31. Preliminary plots of CO and carbon heat loss versus the difference in tilts yeilded no useful information and therefore no plots have been included. The difference in tilts refers to how many degrees toward or away from each other the fuel nozzles and overfire air registers are moved. This difference is calculated by taking the difference in degrees that the overfire air registers are angled toward or away from the fuel nozzles.

Figure 31 indicates that the maximum $NO_2$ levels are obtained when the fuel nozzles and overfire air registers are angled toward each other. With the exception of one test (#17), minimum $NO_2$ levels are obtained when the fuel nozzles and overfire air registers are angled away from each other. Most of these tests were performed with clean furnace waterwalls, while test 17 had moderately dirty waterwalls. The $NO_2$ levels for test 17 were higher than expected. This might be attributed to the heavier waterwall deposits observed for this test.

WISCONSIN POWER & LIGHT CO.
COLUMBIA ENERGY CENTER
UNIT #1

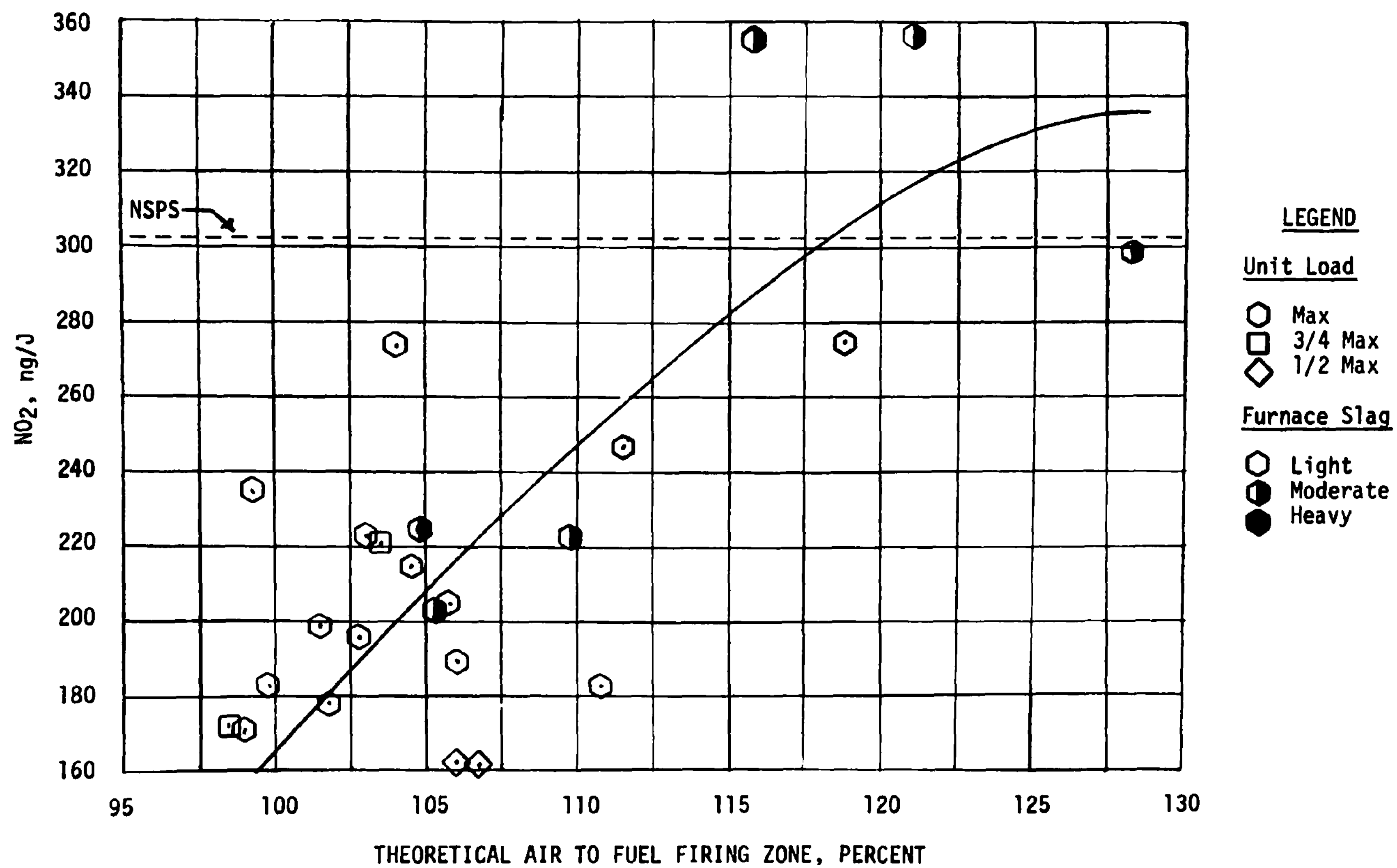



Figure 28: $NO_2$ vs. theoretical air to fuel firing zone, overfire air study

WISCONSIN POWER & LIGHT CO.
COLUMBIA ENERGY CENTER
UNIT #1

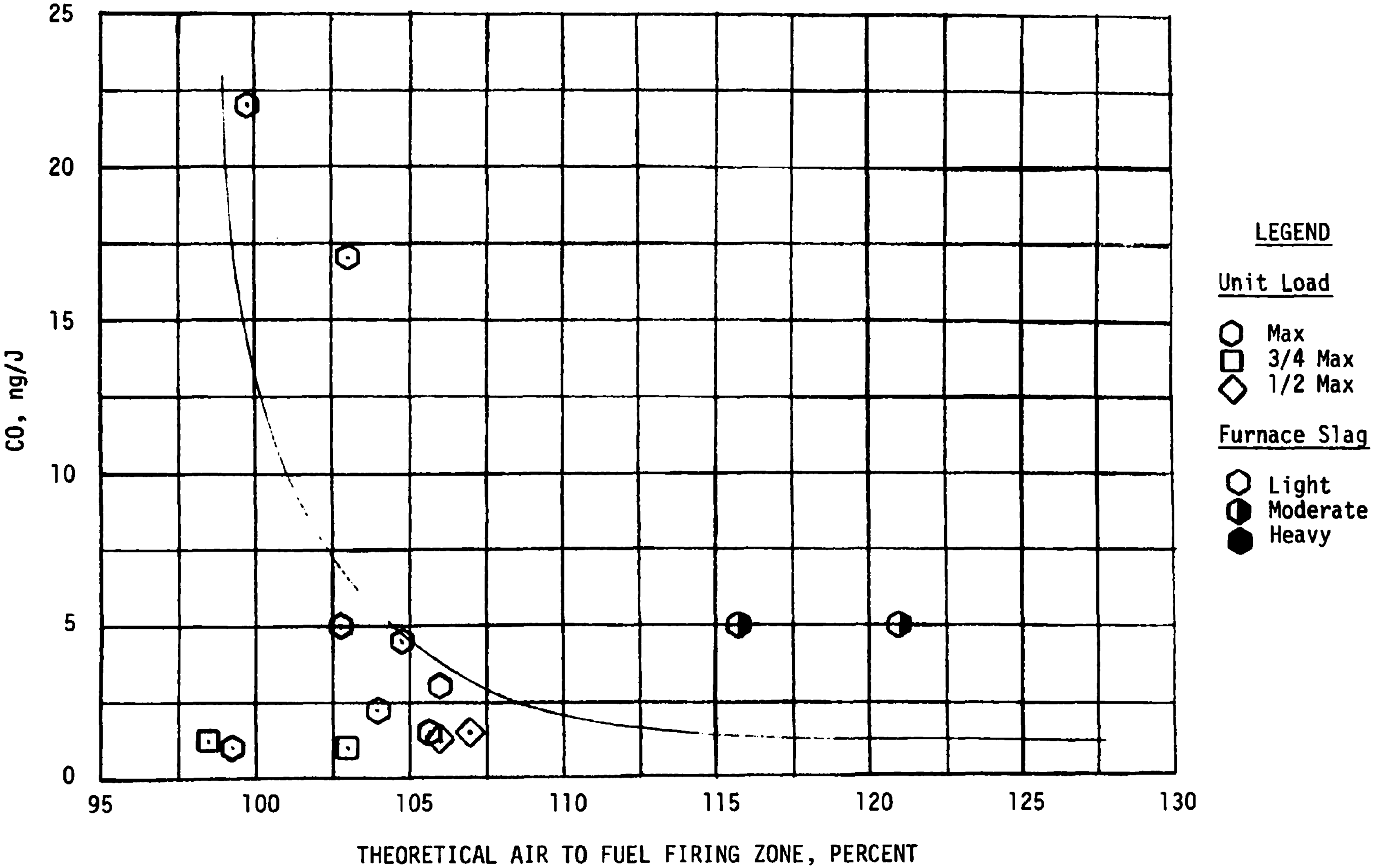



Figure 29: CO vs. theoretical air to fuel firing zone, overfire air study

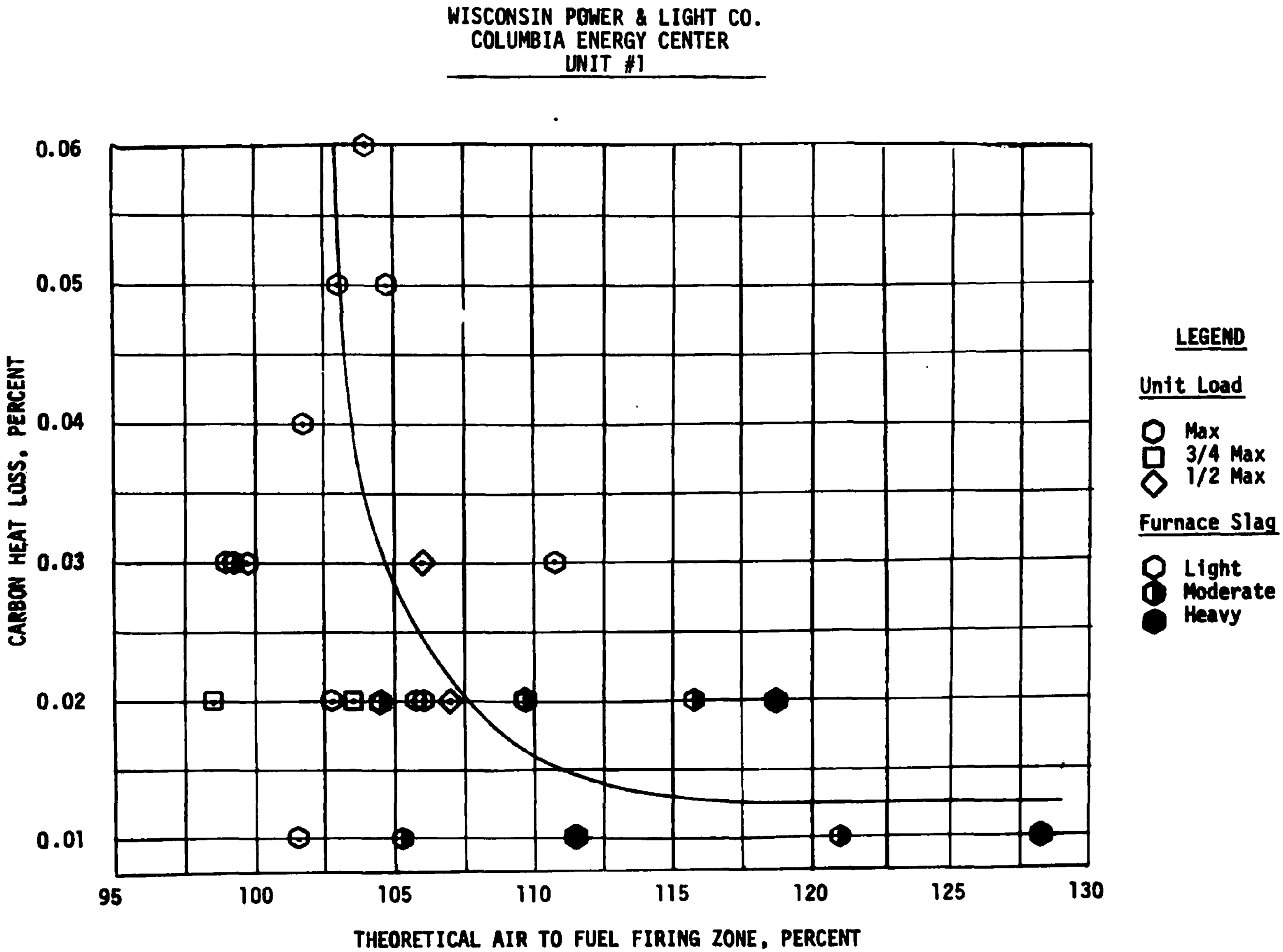



Figure 30: Carbon heat loss vs. theoretical air, overfire air study

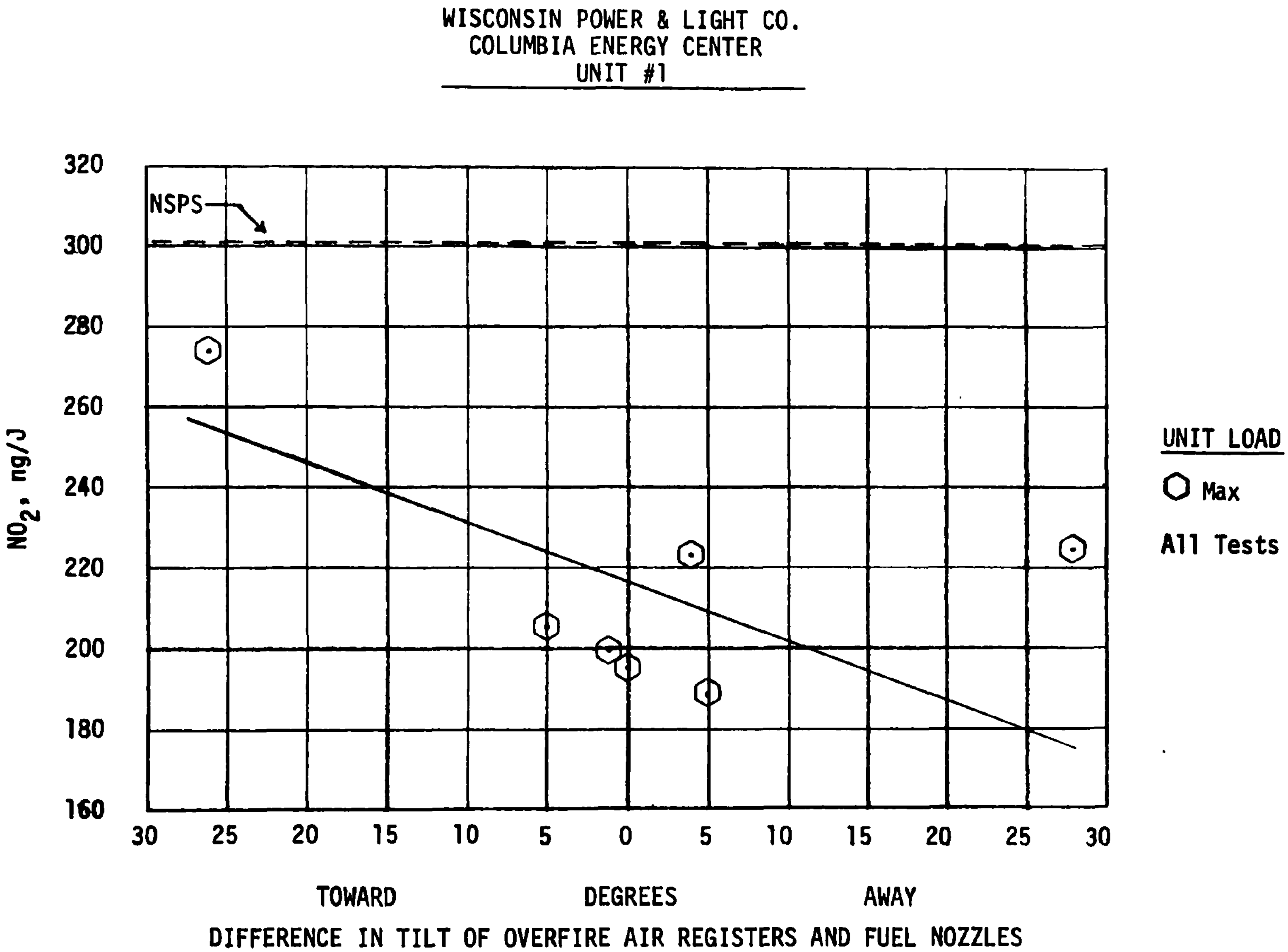



Figure 31: $NO_2$ vs. difference in tilt, overfire air study

Figure 32 shows unit efficiency versus excess air at the economizer outlet. Examination of only the full load tests shows that a decrease in unit efficiency is evident with increasing excess air at the economizer outlet. Such a trend is in agreement with the baseline tests and with previous studies at Alabama Power Company's, Barry Station, Unit #2 [2].

$SO_2$ emission levels were monitored for each test and are reported on Sheets A-5 and A-6. No correlation between $SO_2$ emission levels and excess air level, unit load, or furnace waterwall deposits was apparent.

Unburned hydrocarbons were monitored for all overfire air tests and were at such low levels as to be unmeasurable.

A thirty (30) day waterwall corrosion coupon evaluation was conducted in January and February of 1977. The overfire air register dampers were allowed to modulate between 5% open at half load and 75% to 100% open at full load. Unit loading was varied per Wisconsin Power and Light Company's System demands with full load being maintained as much as possible. The waterwall corrosion study is discussed in the section, "Waterwall Corrosion Coupon Evaluation."

## FURNACE PERFORMANCE

Furnace performance at Columbia Energy Center, Unit #1 was monitored by the use of Type "E", chordal thermocouples installed in the furnace waterwalls. A schematic of the thermocouple locations is shown in Figure 33. Furnace performance is measured by furnace waterwall absorption rates. Tabulations of the average waterwall absorption rates, as measured at each chordal thermocouple, are presented in Appendix A on Sheets A22 through A35.

Waterwall temperatures and corresponding absorption rates were found to vary significantly with furnace waterwall deposit conditions. For comparison of the waterwall absorption rates, the full load (MCR) tests for the three different modes of boiler operation are shown on Figures 34, 35 and 36. The average horizontal strip absorption rate profiles of the front and right side walls for these tests are plotted versus the distance above or below the firing zone center.

The baseline test profiles show very little heat absorption variation from the hopper slopes to the furnace outlet. The baseline profiles indicate uniform heavy slagging in the combustion zone which results in slightly depressed rates in that area. The biased firing test profiles also show very little variation over the entire furnace height. The absorption rate profiles for the overfire air tests show little variation from the firing zone center down to the hopper slopes. There is a peaking effect just above the firing zone center and a distinct split in the absorption rate profiles between the upper fuel nozzles and the furnace outlet. This split can be traced to a change in the fuel and auxiliary air damper openings. Those tests conducted in March, 1976 had fuel air damper openings of approximately 30 to 50 percent open and auxiliary air damper openings of approximately 100 percent open. The fuel and auxiliary air damper openings were changed following the testing in March, 1976. Those tests performed in May and June of 1976 had fuel air damper openings of approximately 100 percent open and auxiliary air damper openings ranging from 30 to 50 percent open.

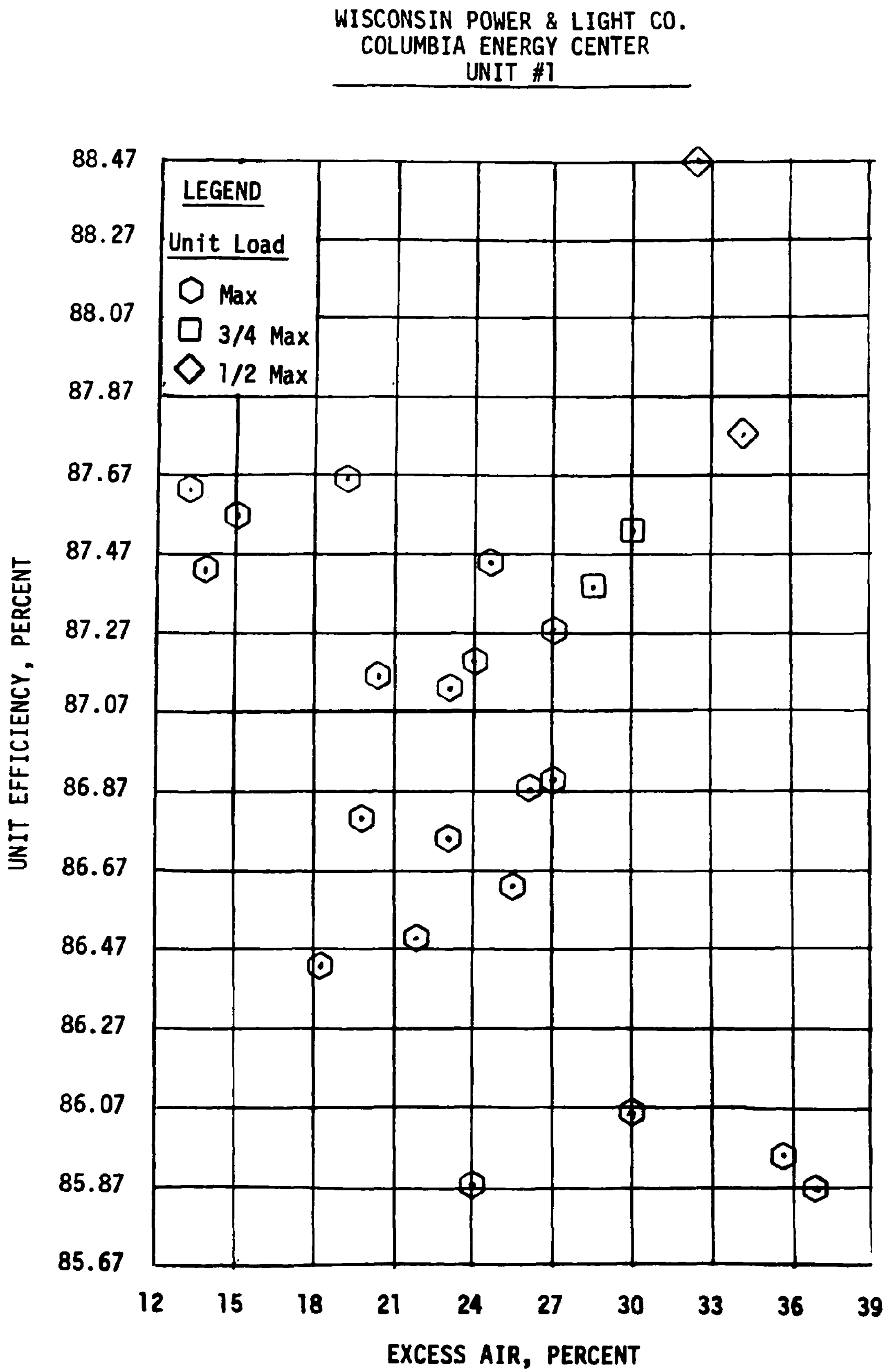



Figure 32: Unit efficiency vs. excess air, overfire air study

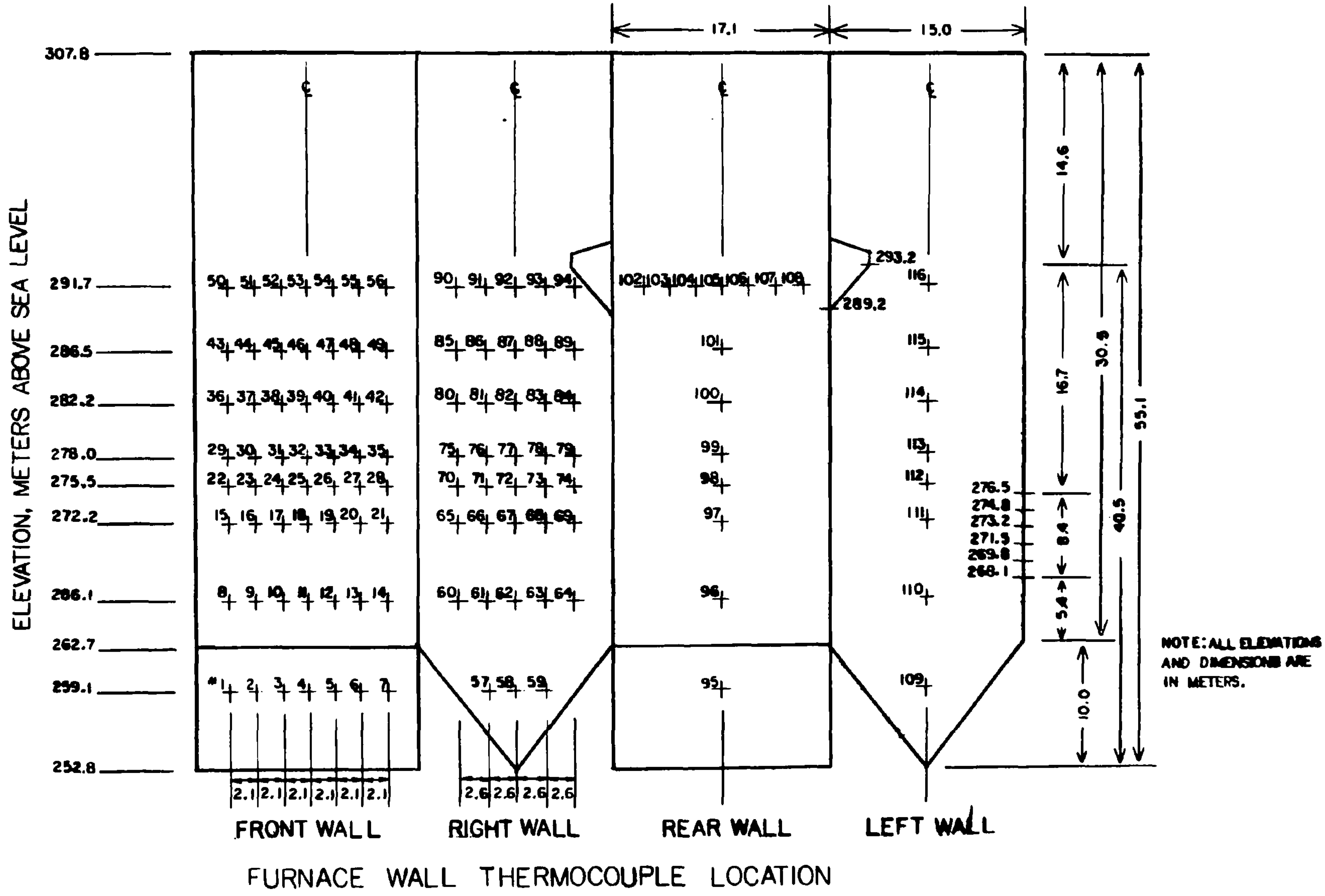



Figure 33: Chordal Thermocouple Locations

# FURNACE HEAT ABSORPTION RATE PROFILES
## HORIZONTAL STRIP RATES

WISCONSIN POWER & LIGHT CO.
COLUMBIA #1

Baseline Tests - MCR

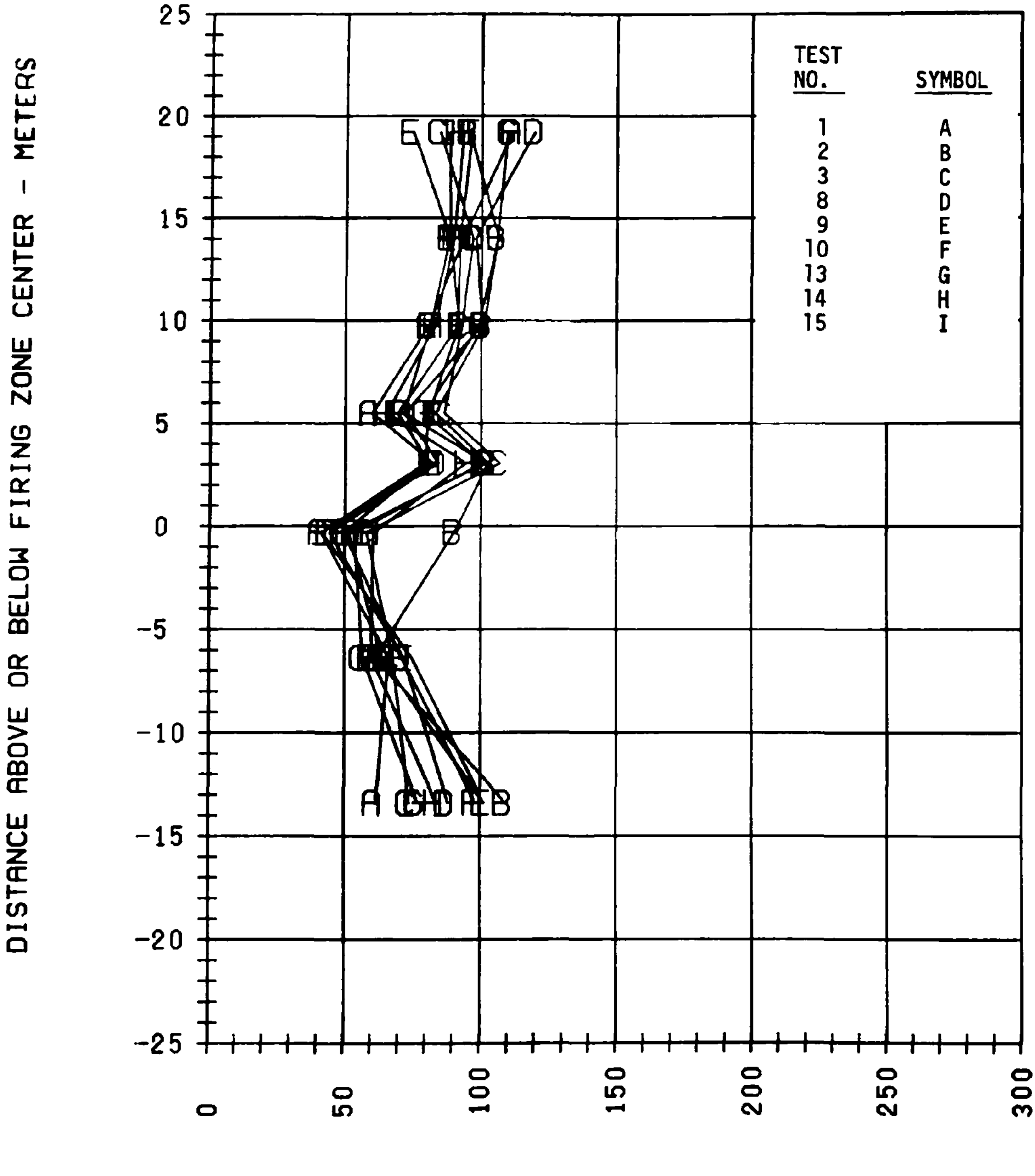



Figure 34: Elevation vs. furnace heat absorption

# FURNACE HEAT ABSORPTION RATE PROFILES
## HORIZONTAL STRIP RATES

WISCONSIN POWER & LIGHT CO.
COLUMBIA #1

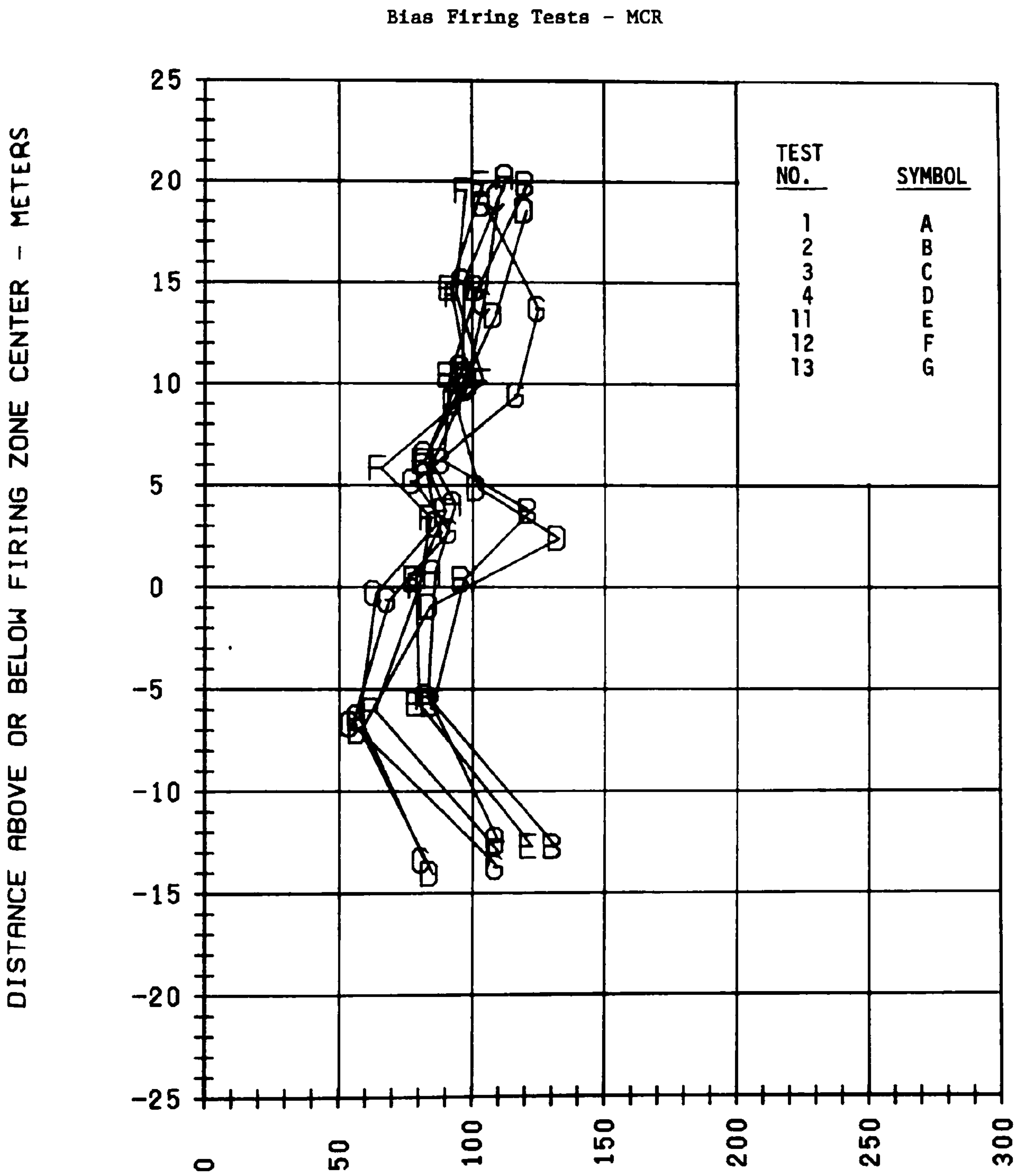



Figure 35: Elevation vs. furnace heat absorption

# FURNACE HEAT ABSORPTION RATE PROFILES
## HORIZONTAL STRIP RATES

WISCONSIN POWER & LIGHT CO.
COLUMBIA #1

Overfire Air Tests - MCR

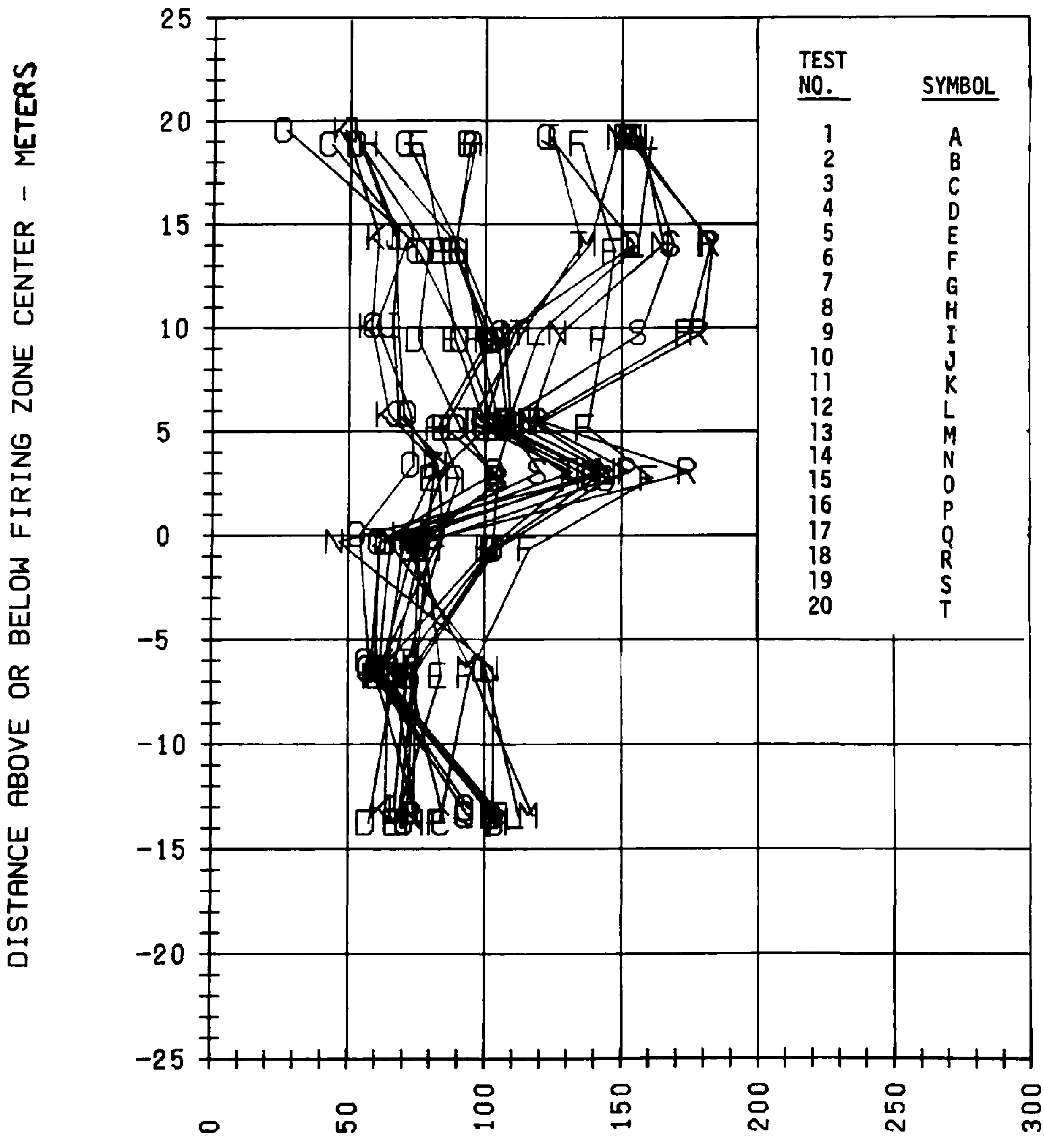



Figure 36: Elevation vs. furnace heat absorption

As mentioned previously, furnace waterwall deposits had a significant effect on waterwall temperatures and corresponding absorption rates. Obtaining the desired slagging conditions proved very difficult and somewhat unpredictable during the testing at Columbia Energy Center, Unit #1. One of the biggest difficulties was in observing the furnace waterwalls to obtain an accurate visual determination of the furnace waterwall deposits.

WATERWALL CORROSION COUPON EVALUATION

Following completion of the steady state phases of the baseline and overfire air test programs, thirty (30) day waterwall corrosion coupon evaluations were performed. The purpose of these evaluations was to determine whether any measurable changes in coupon weight losses could be obtained for the two modes of firing under study.

The individual probes were exposed at five locations on the furnace front wall as shown on Figure 37. The coupon temperatures were maintained at the same levels for each 30 day run and a typical tract of the control temperature range for each of the twenty coupons is shown on Figure 38.

The individual coupon weights were determined before and after each thirty day test and the individual coupon and average probe weight losses are shown on Sheets A57 and A58. The weight losses are calculated as $mg/cm^2$ of coupon surface area.

Figures 39 and 40 show the unit load schedules for each of the 30 day test periods.

The overfire air portion of the study was conducted as close as possible to the "optimum" operating conditions determined during the overfire air steady state tests.

Throughout the overfire air study the overfire air dampers were maintained at the full open configuration over the range of unit loading shown on Figure 40 with the following exceptions. From January 22 through January 24, January 27 through January 29 and February 8 through February 17 the OFA dampers were opened 75%. Also during a unit start-up on February 25 the dampers were opened from 0 to 20% and then maintained at 40% open during February 26 and February 27.

The percent oxygen was monitored daily during each thirty day study at each probe location and was found to range between 3 and 19 percent $O_2$ during both the baseline and overfire air studies.

The weight losses calculated for the baseline and overfire air runs were found to be the same with the average weight losses for all five probes as follows:

| Baseline | Overfire Air |
|---|---|
| 8.0770 $mg/cm^2$ | 8.0933 $mg/cm^2$ |

These values are greater than the range of losses experienced at Barry #2, Huntington Canyon #2 and during a control study conducted at C-E's Kreisinger Laboratory by a factor of approximately 2 to 1.

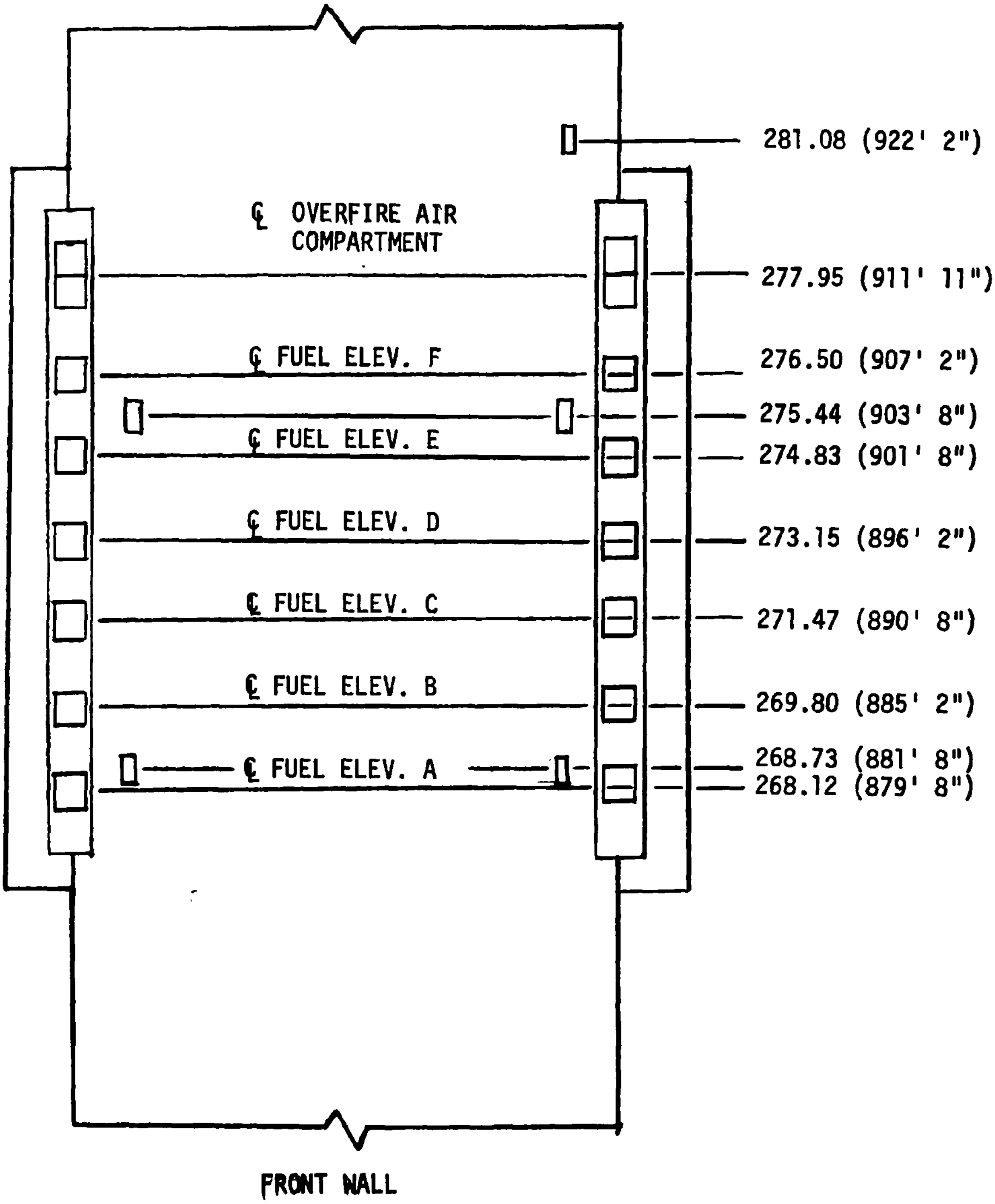



Figure 37. Waterwall corrosion probe locations, Columbia No. 1

Wisconsin Power & Light Co.
Columbia Energy Center
Unit No. 1

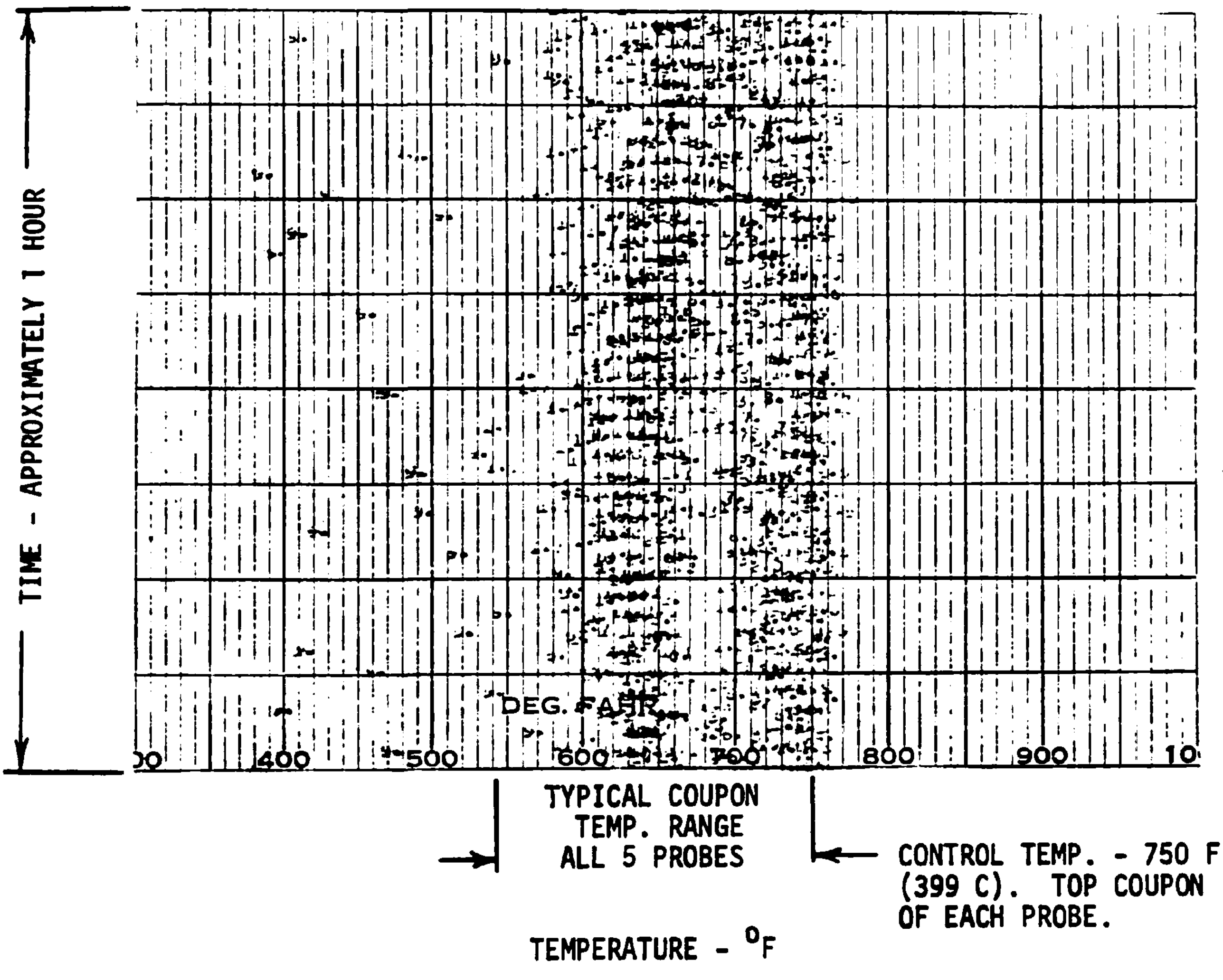
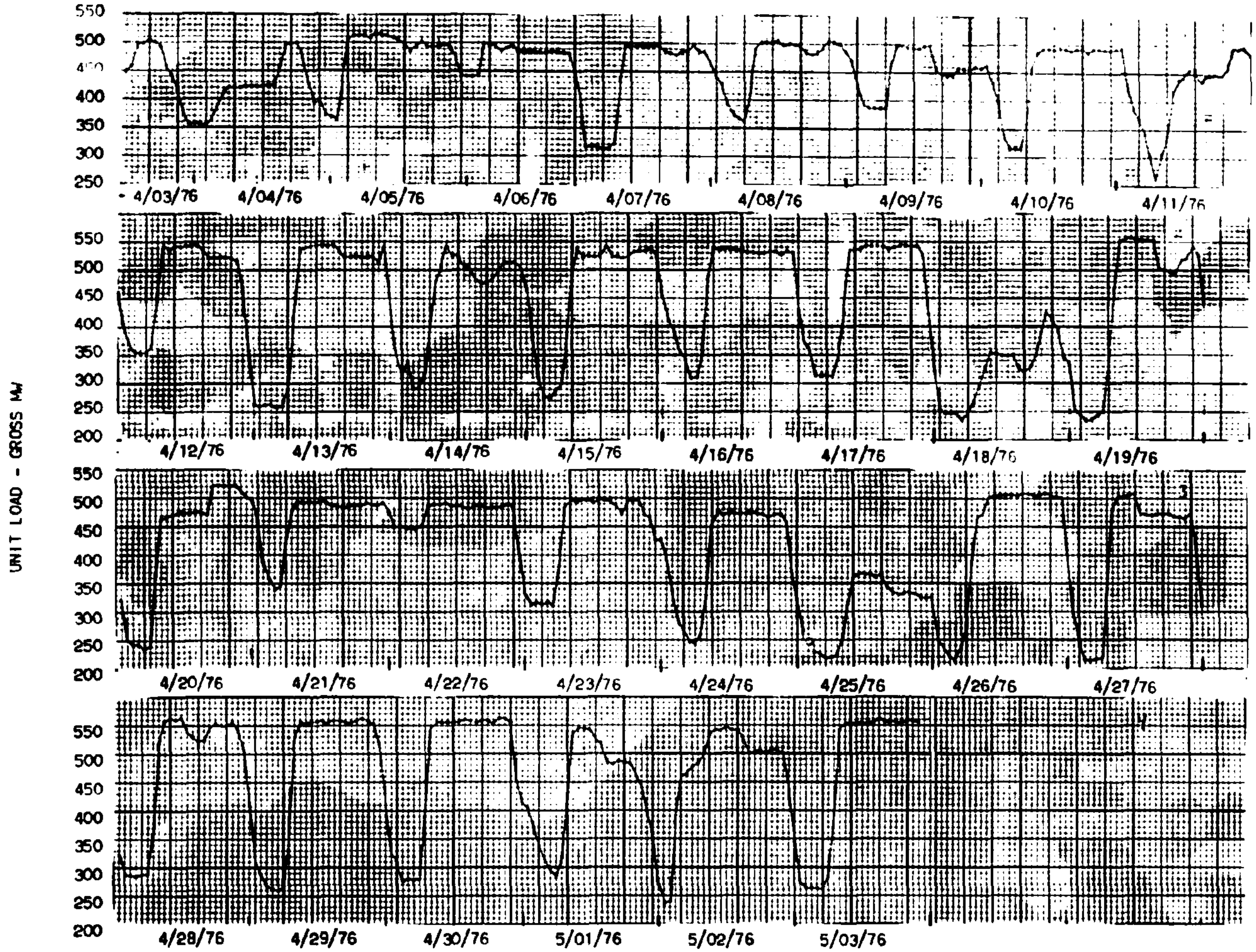



Figure 38. Typical corrosion probe temperature range

WISCONSIN POWER & LIGHT CO.
COLUMBIA ENERGY CENTER
UNIT #1

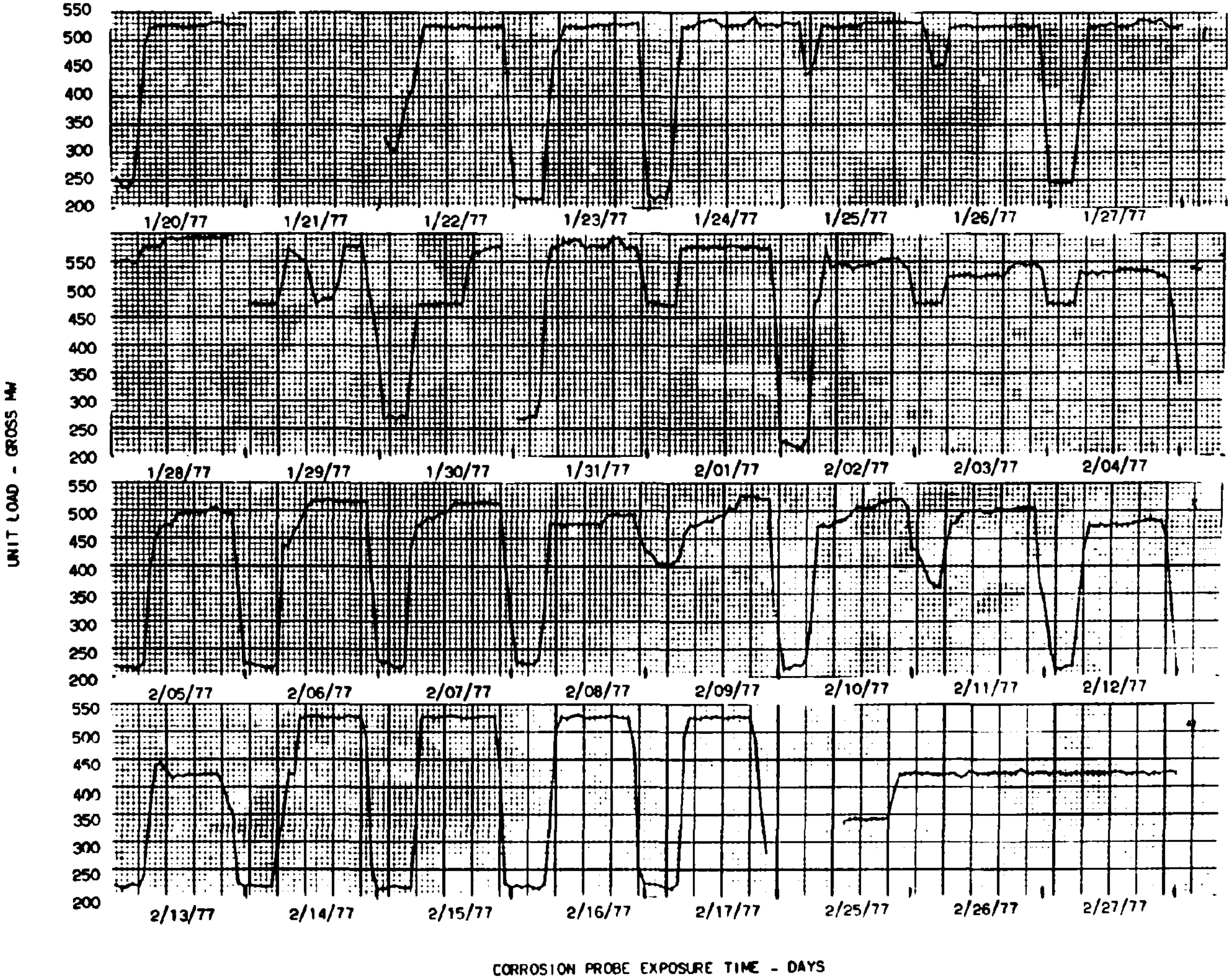



AVG. GROSS MW/HR -
30 DAY PERIOD
421.3 MW/HR

CORROSION PROBE EXPOSURE TIME - DAYS

FIGURE 39: GROSS MW LOADING VS. TIME - BASELINE CORROSION PROBE STUDY

WISCONSIN POWER & LIGHT CO.
COLUMBIA ENERGY CENTER
UNIT #1




AVG. GROSS MW/HR -
30 DAY PERIOD
442.8 MW/HR

FIGURE 40: GROSS MW LOADING VS. TIME - OVERFIRE AIR CORROSION PROBE STUDY

The results indicate that while there was no change in weight loss between the baseline and overfire air runs something resulted in the losses being consistently higher than expected based on previously obtained data.

Review of test logs reveals a possible explanation. During both runs periodic overheating (up to approximately 540°C) of individual probes occurred due to partial slagging of the probe coupons. This occasionally created a situation where the coupon containing the control thermocouple would be covered with slag while the other coupons of a given probe were still clean. The control thermocouple would then reduce air flow to the entire probe causing the clean coupons to overheat. This situation was corrected when encountered by switching the temperature control to a hotter coupon. The frequency of occurrance was approximately the same for both runs.

Chemical analysis of the coupon deposits also tends to support this observation as the fusibility temperatures of the inner deposits on some of the affected probes were very high. This coupled with the fused state of the initial deposits indicates possible overheating. Coal ash and deposit analysis are shown on Figures 41 and 42.

# WATERWALL CORROSION COUPON DATA SUMMARY

## AS FIRED ASH AND COUPON DEPOSIT ANALYSIS

## BASELINE STUDY

| Sample Location | Pulverized Coal | Probe A Outer | Probe B[1] Initial | Probe C Outer | Probe D Outer | Probe E Outer |
|---|---|---|---|---|---|---|
| Ash Fusibility-°F | | | | | | |
| Initial Deformation Temp. | 2130 | 2000 | I.S.[2] | 2010 | 2010 | 1960 |
| Softening Temp. | 2170 | 2080 | | 2080 | 2080 | 2010 |
| Fluid Temp. | 2290 | 2270 | | 2270 | 2310 | 2140 |
| Ash Composition-%by Weight | | | | | | |
| $SiO_2$ | 38.6 | 33.9 | 9.4 | 37.7 | 41.4 | 28.8 |
| $Al_2O_3$ | 17.5 | 14.4 | 4.3 | 14.7 | 16.4 | 10.0 |
| $Fe_2O_3$ | 6.7 | 34.8 | 74.8 | 29.4 | 21.5 | 45.3 |
| CaO | 13.5 | 11.6 | 3.0 | 12.4 | 14.4 | 9.2 |
| MgO | 3.7 | 3.1 | 0.7 | 3.4 | 3.4 | 2.1 |
| $Na_2O$ | 0.4 | 0.1 | 0.1 | 0.2 | 0.4 | 0.3 |
| $K_2O$ | 0.5 | 0.3 | <0.1 | 0.3 | 0.3 | 0.4 |
| $TiO_2$ | 0.9 | 0.7 | 0.3 | 0.8 | 0.9 | 0.5 |
| $SO_3$ | 15.2 | 1.0 | 4.3 | 0.9 | 1.1 | 1.7 |
| $P_2O_5$ | --- | --- | 0.4 | --- | --- | 0.1 |
| Total | 97.0 | 99.9 | 97.4 | 99.8 | 99.8 | 98.4 |

1. Outer Sample Not Available
2. I.S. - Insufficient Sample

Figure 41: As-fired ash and coupon deposit analysis, baseline study

# WATERWALL CORROSION COUPON DATA SUMMARY

## AS FIRED ASH AND COUPON DEPOSIT ANALYSIS

## OVERFIRE AIR STUDY

| Sample Location | Pulverized Coal | Probe G[1] Initial | Probe H Outer | Probe I Outer | Probe J Outer | Probe K Outer |
|---|---|---|---|---|---|---|
| Ash Fusibility-°F | | | | | | |
| Initial Deformation Temp. | 2110 | I.S.[2] | 1920 | 1930 | I.S.[2] | 1930 |
| Softening Temp. | 2170 | | 1940 | 1940 | | 1950 |
| Fluid Temp. | 2260 | | 2060 | 2060 | | 2060 |
| Ash Composition-%by Weight | | | | | | |
| $SiO_2$ | 41.3 | 6.9 | 20.7 | 20.5 | 12.8 | 21.5 |
| $Al_2O_3$ | 17.2 | 3.6 | 8.3 | 8.1 | 5.3 | 7.9 |
| $Fe_2O_3$ | 7.6 | 76.4 | 56.8 | 55.8 | 69.9 | 57.7 |
| CaO | 13.4 | 3.5 | 6.9 | 6.8 | 4.9 | 6.8 |
| MgO | 4.0 | 1.0 | 2.0 | 1.8 | 1.3 | 1.8 |
| $Na_2O$ | 0.6 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 |
| $K_2O$ | 0.5 | 0.5 | 0.5 | 0.5 | 0.3 | 0.4 |
| $TiO_2$ | 0.8 | 0.3 | 0.5 | 0.5 | 0.3 | 0.4 |
| $SO_3$ | 14.0 | 6.5 | 3.4 | 3.7 | 2.5 | 2.8 |
| $P_2O_5$ | --- | --- | --- | --- | --- | --- |
| Total | 99.4 | 99.2 | 99.6 | 98.2 | 97.7 | 99.7 |

1. Outer Sample Not Available
2. I.S. - Insufficient Sample

Figure 42: As-fired ash and coupon deposit analysis, overfire air study

## HUNTINGTON STATION, UNIT #2

### TASKS IV, V & VI - TEST DATA ACQUISITION AND ANALYSIS

Flue gas samples for determination of $NO_2$, CO, $O_2$ and THC emission levels were obtained at each of the two economizer outlet ducts. The flue gas samples were drawn from twelve (12) point grids arranged on centroids of equal area in each duct. The $SO_2$ sample was drawn from a single point in the left economizer outlet duct using a heated sample line. The fly ash sample for carbon loss analysis was obtained from a single point in the left air preheater flue gas outlet duct.

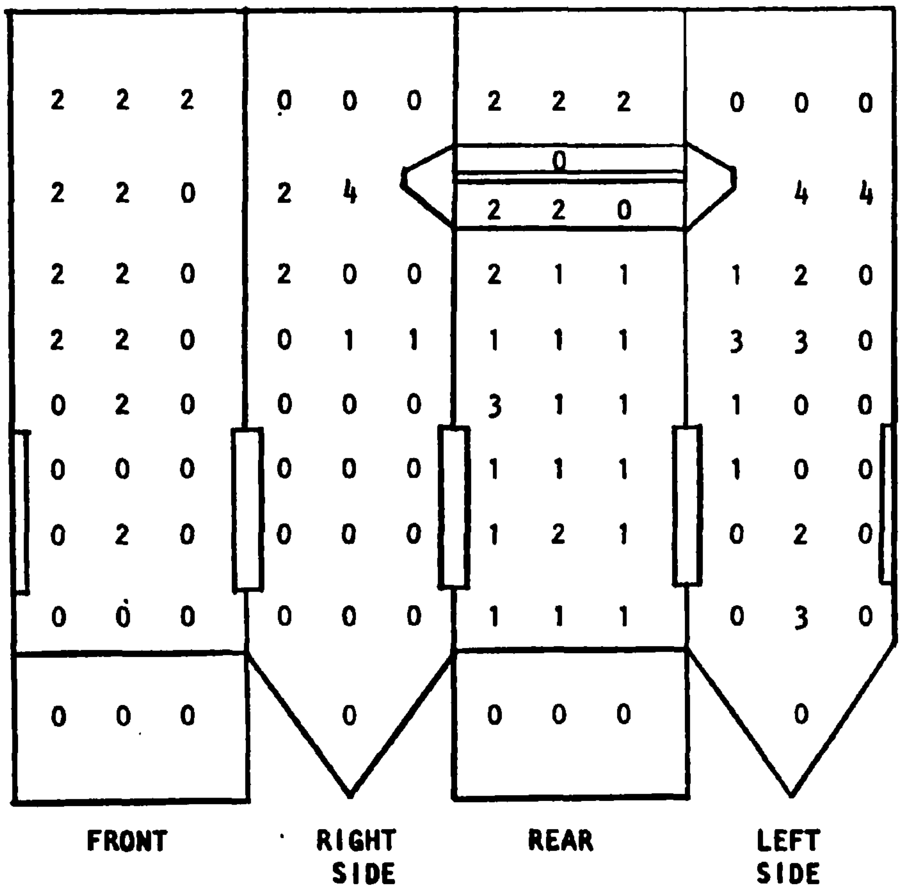
Coal samples were obtained from each feeder and blended to form a composite sample. Each sample was analyzed by the fuels lab at Combustion Engineering Inc.'s Kreisinger Development Laboratory. During some of the testing the Deer Creek Mine Coal was mixed with coal from Peabody Coal Company's Wilberg Mine and from Amercian Coal Company's Church Mine. The Wilberg and Deer Creek Mines were mining the same coal seam but from opposite sides of the mountain. The Church coal was trucked in from a mine 10 to 15 miles south of the plant. Analysis of the Church, Wilberg and Deer Creek coals showed that the coals had very similar characteristics. Although analysis showed the coals to be very similar, visual observations of the furnace waterwalls showed a definite increase in furnace waterwall deposits when firing a blended coal. A blended coal may display properties more unsatisfactory to unit performance than any of the component coals fired separately [8]. Typical slag patterns taken during clean, moderate and heavy slagging conditions at full load operation are shown on Figures 43, 44 and 45. These slag patterns are typical for all modes of boiler operation.

These coals were not blended for those tests conducted in April, May or July of 1975. For those tests conducted in September, October or December of 1975, the coals were usually blended. However, it was impossible to tell on any one day what percent of each coal was being used. The Wilberg and Church Mine coals were always blended with the Deer Creek Mine coal and were never used exclusively.

Summaries of the emissions test data for the baseline, biased firing and overfire air operation studies are tabulated in Appendix B on Sheets B-1 through B-6. Unit performance test data for the three studies are tabulated on Sheets B-7 through B-13. The calculated unit performance test results are tabulated on Sheets B-14 through B-23. Unit efficiency is determined using the Heat Losses Method (ASME Power Test Code, PTC 4.1-1964, Reaffirmed 1973). A set of unit board and computer data was obtained for each test and is tabulated on Sheets B-24 through B-44.

All test data and results are reported in SI Metric Units with the exception of the board and computer data, which are reported in the engineering units provided by plant instrumentation.

## FURNACE WATERWALL DEPOSIT PATTERN



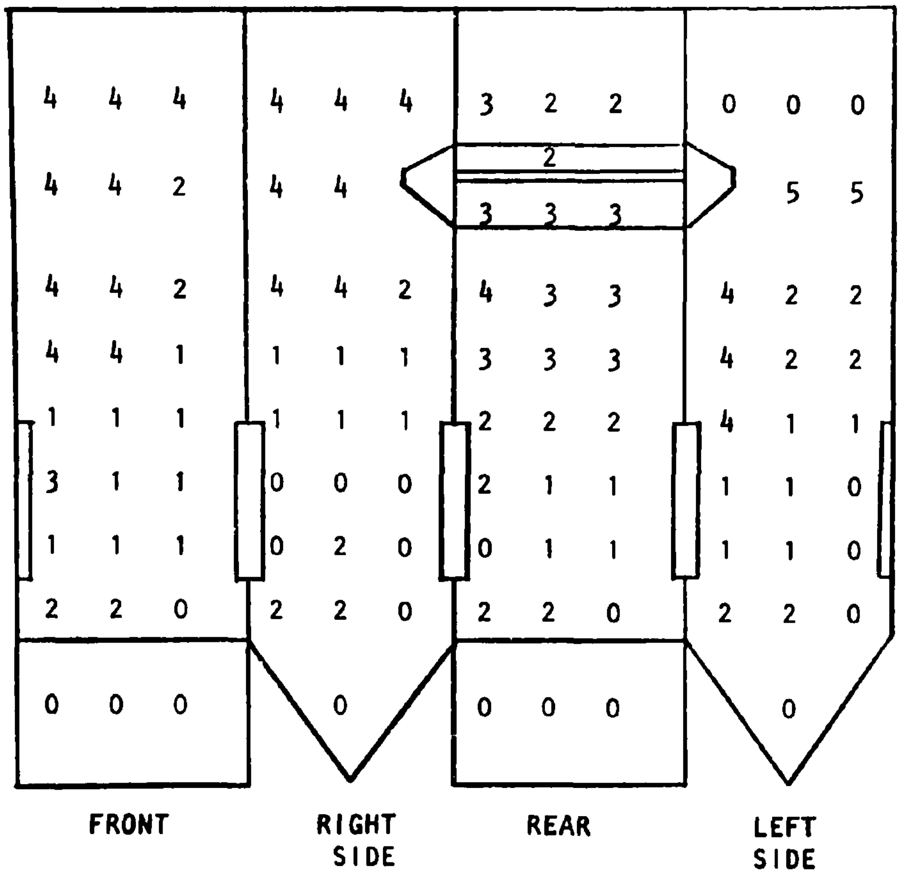

**KEY**

| | |
|---|---|
| NO ASH | 0 |
| FUZZY ≤13 MM | 1 |
| LIGHT 13 MM - 25 MM | 2 |
| LIGHT TO MED. 25 MM - 50 MM | 3 |
| MED. TO HEAVY 50 MM - 100 MM | 4 |
| HEAVY ≥100 MM | 5 |
| RUNNING SLAG | 6 |

NOTE: 25.4 MM = 1 INCH

Figure 43: Furnace waterwall deposit pattern, clean furnace

## FURNACE WATERWALL DEPOSIT PATTERN



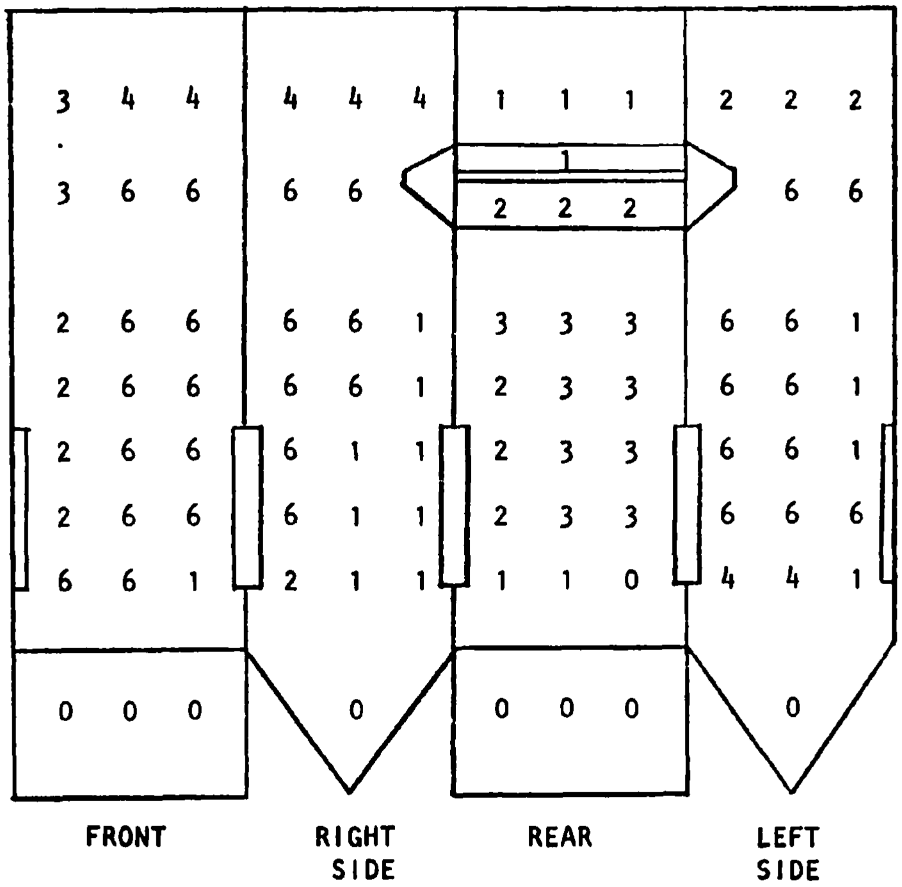

**KEY**

| | |
|---|---|
| NO ASH | 0 |
| FUZZY <13 MM | 1 |
| LIGHT 13 MM - 25 MM | 2 |
| LIGHT TO MED. 25 MM - 50 MM | 3 |
| MED. TO HEAVY 50 MM - 100 MM | 4 |
| HEAVY ≥100 MM | 5 |
| RUNNING SLAG | 6 |

NOTE: 25.4 MM = 1 INCH

Figure 44: Furnace waterwall deposit pattern, moderate slag furnace

# FURNACE WATERWALL DEPOSIT PATTERN




**KEY**

| | |
|---|---|
| NO ASH | 0 |
| FUZZY <13 MM | 1 |
| LIGHT 13 MM - 25 MM | 2 |
| LIGHT TO MED. 25 MM - 50 MM | 3 |
| MED. TO HEAVY 50 MM - 100 MM | 4 |
| HEAVY >100 MM | 5 |
| RUNNING SLAG | 6 |

NOTE: 25.4 MM = 1 INCH

Figure 45: Furnace waterwall deposit pattern, heavy slag furnace

The thirty (30) day waterwall corrosion coupon evaluations were conducted using a specially designed probe consisting of four individual coupons. The waterwall corrosion coupon evaluations are described and discussed under a separate subsection in this report.

TASK IV - BASELINE OPERATION STUDY

Load and Excess Air Variation - Clean Furnace

Tests 1 through 7 were conducted to determine the effect of varying excess air on unit emission levels and performance. These tests were conducted at three unit loads with clean furnace conditions. Maximum and minimum excess air levels of 40 percent and 15 percent respectively were considered by Utah Power and Light Co. as acceptable modes of unit operation at full load. These limits were exceeded on a few occasions.

As shown in the following table, $NO_2$ emission levels increased with increased excess air. At equivalent levels of theoretical air to the fuel firing zone (TA), $NO_2$ emission levels were higher at full load than at half load.

CO emission levels did not change appreciably with changes in excess air level or unit loading. The effect of excess air level and unit loading on unit efficiency, carbon heat loss and unburned hydrocarbon and sulfur dioxide emission levels is discussed in conjunction with the other baseline tests.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Furnace Condition |
|---|---|---|---|---|---|---|---|
| 1 | 376 | 248.0 | NA* | 18.9 | 116.4 | 98.92 | Clean |
| 2 | 380 | 262.8 | 6.9 | 27.4 | 124.8 | 90.37 | Clean |
| 2A | 377 | 332.4 | 7.7 | 32.9 | 130.1 | 90.16 | Clean |
| 3 | 380 | 357.0 | 8.2 | 40.9 | 137.8 | 89.56 | Clean |
| 4 | 298 | 328.0 | NA | 28.9 | 126.9 | 90.05 | Clean |
| 5 | 204 | 249.2 | 4.8 | 23.7 | 122.9 | 91.05 | Clean |
| 6 | 203 | 284.3 | 4.8 | 32.1 | 131.1 | 91.05 | Clean |
| 7 | 202 | 360.3 | 5.0 | 50.0 | 150.0 | 90.51 | Clean |

Load and Excess Air Variation - Moderately Dirty Furnace

Tests 8 through 12 were to have been conducted with a moderately slagged furnace. However, when operating with the Deer Creek Mine Coal, it was difficult to obtain any appreciable amounts of slag on the furnace waterwalls. As a result of this, tests 8 through 12 were actually conducted with clean furnace waterwalls. Excess air levels and unit load were allowed to vary per the test program.

The $NO_2$ levels for Tests 8 through 12, as shown in the following table, are also found to be proportional to the excess air levels. Although tests 8 through 12 were conducted with excess air levels, unit loads and furnace wall deposits similar to tests 1 through 7, the $NO_2$ emission levels are generally lower. One

* NA - CO values not available due to operational difficulties with CO analyzer.

possible explanation for this difference in $NO_2$ emission levels for similar tests is the effect of fuel nozzle tilt. The fuel nozzles had a higher upward tilt for tests 1 through 7. While the higher tilts reduce the residence time of the hot gases in the furnace, they also decrease the furnace waterwall surface available for cooling. The decrease in surface cooling area results in a higher flame temperature, which can cause higher $NO_2$ emission levels. The only exception to this is Test #8 which correlates well with Test #1. As in Tests 1 through 7, at similar theoretical air levels to the fuel firing zone, $NO_2$ emission levels are again higher for full load tests than half load tests.

CO emission levels again did not show any appreciable change with changes in excess air level or unit loading. The only exception to this is Test #9 which when compared to a similar test (#2 or 2A) has an unusually high CO level for the excess air level at which the unit was operating.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Furnace Condition |
|---|---|---|---|---|---|---|---|
| 8 | 378 | 267.1 | 6.9 | 19.5 | 117.5 | 89.93 | Clean |
| 9 | 377 | 258.6 | 37.5 | 29.0 | 126.3 | 90.10 | Clean |
| 10 | 375 | 295.3 | NA | 40.9 | 137.8 | 89.64 | Clean |
| 11 | 203 | 232.6 | 4.6 | 27.4 | 126.4 | 91.07 | Clean |
| 12 | 208 | 318.8 | 5.0 | 48.8 | 147.6 | 90.75 | Clean |

Load and Excess Air Variation - Dirty Furnace

The test program called for Tests 13 through 19 to be conducted with heavy furnace wall deposits. As in Tests 8 through 12 it was difficult to obtain any appreciable amount of slag on the furnace waterwalls. However, moderately thick furnace wall deposits of 12.7 mm (1/2") to 50.8 mm (2") were obtained. Excess air and unit load were again varied per the test program.

As shown in the following table increasing $NO_2$ emission levels are again found with increasing excess air levels. Again, for similar TA's, $NO_2$ emission levels for full load are higher than $NO_2$ levels at half load. There is no other obvious correlation between $NO_2$ emission level and unit loading.

Excess air variation and unit load again showed no obvious effect on CO emission levels.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Furnace Condition |
|---|---|---|---|---|---|---|---|
| 13 | 377 | 213.8 | 10.4 | 15.0 | 113.1 | 90.38 | Moderate |
| 14 | 375 | 253.7 | 7.2 | 20.2 | 118.1 | 90.34 | Moderate |
| 15 | 375 | 319.1 | 8.3 | 35.5 | 132.6 | 90.30 | Moderate |
| 16 | 298 | 285.2 | 4.1 | 23.0 | 121.3 | 90.78 | Moderate |
| 17 | 204 | 215.7 | 4.5 | 25.2 | 124.3 | 90.74 | Moderate |
| 18 | 206 | 233.0 | NA | 28.9 | 127.9 | 90.43 | Moderate |
| 19 | 205 | 333.1 | 5.0 | 47.8 | 146.6 | 90.34 | Moderate |

Analysis of Results

The changes in $NO_2$, CO and carbon heat loss versus TA are shown on Figures 46, 47 and 48, respectively. For the baseline operation study the TA is essentially the same as the total air.

Figure 46 shows that $NO_2$ emission levels correlate reasonably well with theoretical air to the fuel firing zone. Increasing TA results in increased $NO_2$ emission levels. This correlation is in agreement with previous studies which have shown that $NO_2$ emission levels are proportional to the concentration of oxygen available for combustion.

Based on the data as plotted in Figure 46, it can be concluded that there is some variation of $NO_2$ emission levels with unit load. As discussed previously for similar theoretical air levels to the fuel firing zone, $NO_2$ emission levels for full load unit operation are higher than $NO_2$ levels at half load unit operation. $NO_2$ emission levels for three-quarter (3/4) load operation are of the same order of magnitude as full load $NO_2$ levels.

There is no distinct variation of $NO_2$ emission levels with furnace waterwall deposits. The results of those tests performed with moderately dirty furnace wall deposits have too much scatter to show any correlation between $NO_2$ levels and furnace wall deposits. This lack of correlation may be partially attributed to the fact that visual observations of furnace waterwall deposits is very subjective. While furnace wall deposits for Tests 13 through 19 were considered to be moderately dirty, they may have in fact been very similar to furnace waterwall conditions for Tests 1 through 12.

With the exception of Test #9, Figure 47 shows that CO emission levels did not show any appreciable variation with changes in TA. As mentioned previously Test #9 had an unusually high CO level when considering the furnace slag conditions and the excess air level at which the unit was operating. Below 120 percent TA, Figure 47 shows a slight rise in CO emission levels. This rise in CO levels below 120 percent TA is in agreement with baseline studies at Alabama Power Company's, Barry Station, Unit #2. However, the data as presented in Figure 47 is insufficient to be considered a trend for this study.

Unit loading had no significant effect on CO emission levels. CO emission levels for the half load and three-quarter load tests are lower than the CO levels for full load tests. However, as the CO levels for all the unit loads are of the same order of magnitude, it is difficult to distinguish what effects changes in unit loading have on CO levels. Any distinction is further hampered by the fact that the half load tests are performed at higher excess air levels than full or three-quarter load tests. The higher excess air level operation at lower loads would promote more complete combustion resulting in lower CO levels. Boilers are operated at higher excess air levels at half load for temperature control purposes, i.e., to maintain superheat and reheat outlet temperatures and therefore the maximum and minimum excess air limits were shifted upward for half load operation. Furnace waterwall slag conditions are found to have no effect on CO emission levels.

Figure 48 shows percent carbon loss in the fly ash versus percent theoretical air to the fuel firing zone. The carbon heat loss results are very similar to the CO results. There is a general trend of increasing carbon heat loss with

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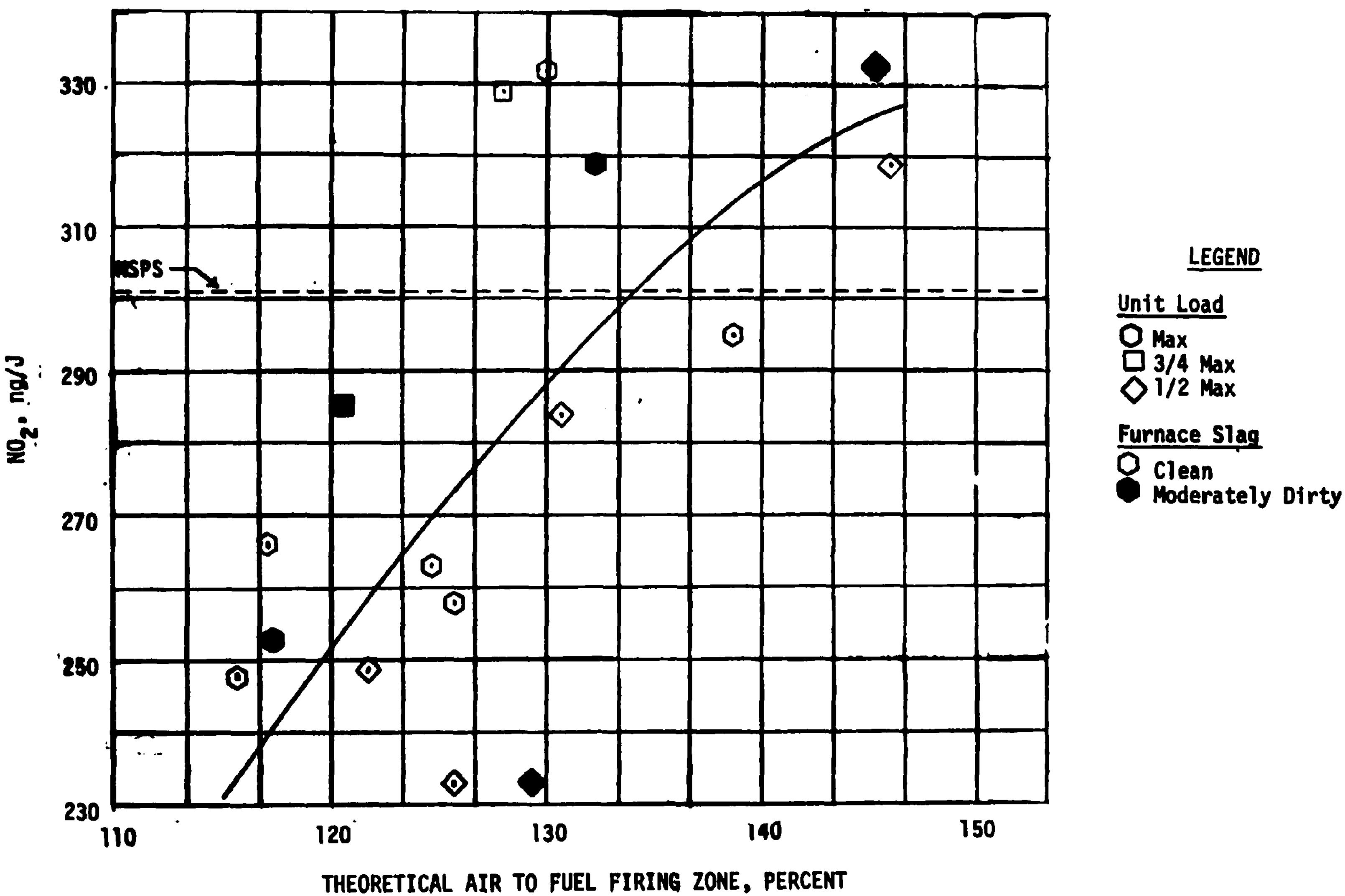


Figure 46: $NO_2$ vs. theoretical air to fuel firing zone, baseline study

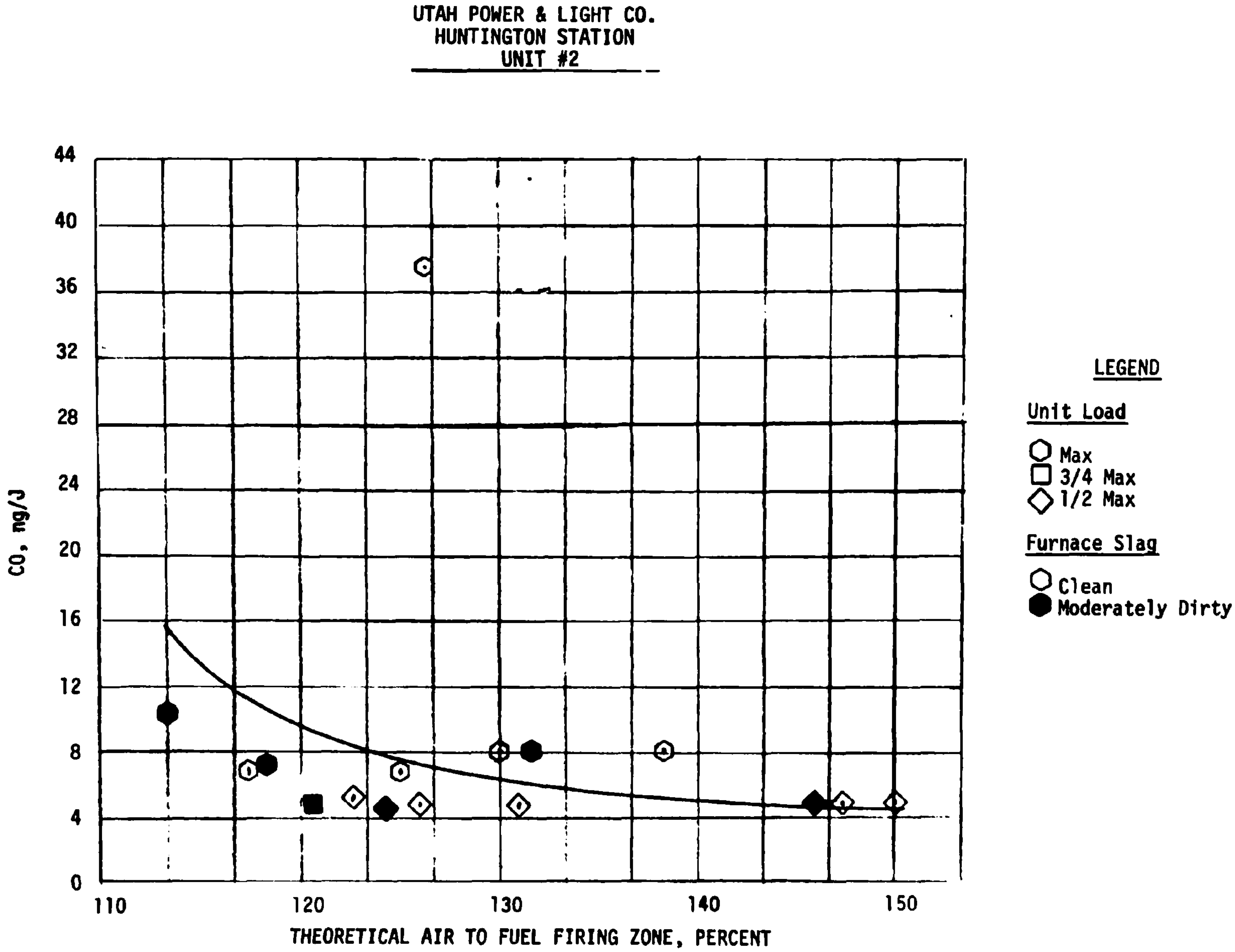


Figure 47: CO vs. theoretical air to fuel firing zone, baseline study

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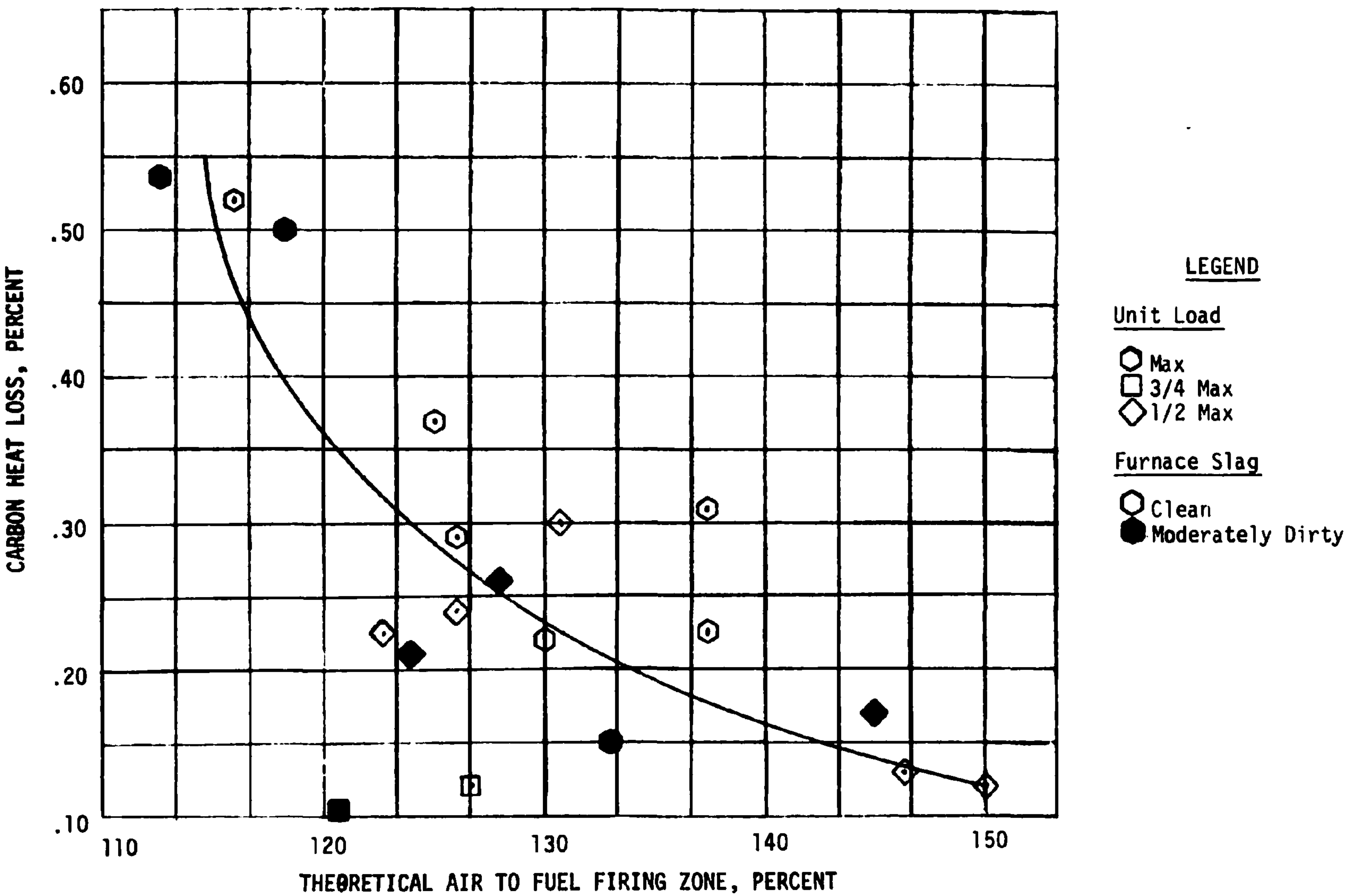


Figure 48: Carbon heat loss vs. theoretical air, baseline study

decreasing TA. No distinct variation of carbon heat loss with unit loading is evident with the exception that carbon heat losses for the half load tests are lower than the carbon heat losses for full load tests. As with the CO results, this variation may be related to the fact that the half load tests were run with higher excess air levels than full load tests. The higher excess air levels would promote better carbon burnout. Based on the data as plotted in Figure 48, carbon heat losses appear to be unaffected by variations in furnace waterwall deposits.

Figure 49 shows unit efficiency versus percent excess air at the economizer outlet. When viewed without regard to unit load, the scatter in the data as plotted in Figure 49 overshadows any obvious trend. However, when full load and half load tests are examined separately a decrease in unit efficiency is found with increasing excess air at the economizer outlet.

No effect on unit efficiency was obvious for changes in furnace waterwall deposits for the baseline operation tests.

$SO_2$ emission levels were monitored for each test and are reported on Sheets B-1 and B-2. No correlation was evident between $SO_2$ emission levels and excess air, unit loading or furnace waterwall deposits. It was not possible to control the $SO_2$ emission level as it is more a function of the sulfur content of the fuel rather than the mode of boiler operation.

Unburned hydrocarbon emission levels were monitored and were found to be at such low levels as to be unmeasurable.

A thirty (30) day waterwall corrosion coupon test was conducted in April and May of 1975. The boiler was operated normally with full load being maintained as much as possible. The waterwall corrosion coupon test is discussed in the section "Waterwall Corrosion Coupon Evaluation."

## TASK V - BIASED FIRING OPERATION STUDY

### Fuel Elevations Out of Service Variation

Tests 1 through 16 were conducted to determine the effect on $NO_2$ emission levels, when taking various fuel elevations out of service (biased firing) at three different unit loadings and two excess air levels. The test program called for half load tests being performed with two adjacent fuel firing elevations out of service. However, Utah Power and Light Co. would not permit this mode of operation. As a result, the half load tests were performed with only the top fuel firing elevation of the two adjacent elevations out of service.

As can be seen in the following table, maximum $NO_2$ emissions control was obtained with the top elevation of fuel nozzles out of service (Tests 1, 4, 7, 9 and 12).

No thirty (30) day waterwall corrosion coupon evaluation was performed following the biased firing operation study.

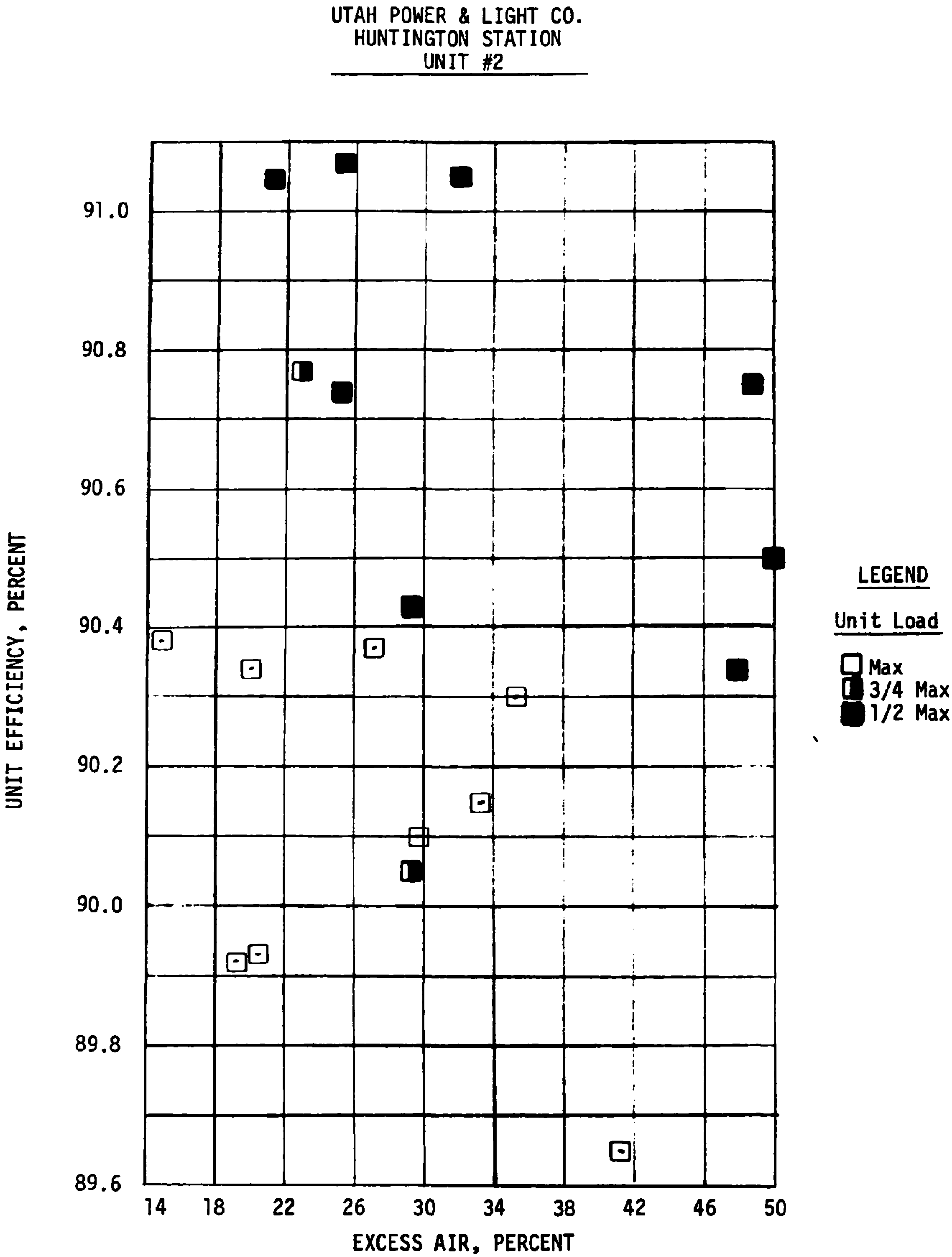


Figure 49: Unit efficiency vs. excess air, baseline study

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air to Firing Zone-% | Unit Effic. % | Fuel Nozzle Elevation Out of Service |
|---|---|---|---|---|---|---|---|
| 1 | 375 | 168.4 | 16.7 | 19.8 | 107.1 | 89.91 | Top |
| 2 | 371 | 223.7 | 4.8 | 21.5 | 118.9 | 90.40 | Center |
| 3 | 368 | 243.1 | 9.2 | 20.9 | 117.8 | 89.97 | Bottom |
| 4 | 297 | 191.5 | 6.3 | 16.8 | 98.5 | 90.14 | Top |
| 5 | 295 | 203.6 | 4.4 | 19.9 | 119.3 | 90.23 | Top Center |
| 6 | 299 | 263.4 | 4.8 | 20.8 | 119.8 | 90.97 | Bottom Center |
| 7 | 218 | 178.4 | 4.8 | 22.6 | 106.5 | 90.99 | Top |
| 8 | 214 | 263.3 | 4.1 | 24.4 | 122.8 | 90.84 | Center |
| 9 | 375 | 208.1 | 5.0 | 26.3 | 107.6 | 89.80 | Top |
| 10 | 370 | 227.3 | 5.0 | 27.4 | 125.3 | 89.97 | Top Center |
| 11 | 369 | 255.9 | 5.2 | 29.3 | 126.8 | 90.13 | Bottom Center |
| 12 | 295 | 214.2 | 5.2 | 29.3 | 109.1 | 90.21 | Top |
| 13 | 299 | 283.8 | 5.7 | 28.0 | 127.0 | 89.97 | Center |
| 14 | 299 | 248.4 | 6.4 | 31.7 | 131.0 | 90.04 | Bottom |
| 15 | 203 | 187.2 | 4.5 | 25.1 | 124.4 | 90.77 | Top Center |
| 16 | 210 | 224.3 | 4.6 | 24.7 | 124.0 | 90.58 | Bottom Center |

## Analysis of Results

Figure 50 is a plot of $NO_2$ emission levels versus theoretical air to the fuel firing zone. As with the baseline study tests, this figure shows that increasing TA results in increasing $NO_2$ emission levels. As evidenced by the scatter in the data, unit loading does not appear to have any distinct effect on $NO_2$ emission levels.

Most of the biased firing tests were performed during the time period when the coal being fired was a blend of two or three coals. Furnace waterwall slagging conditions for the biased firing tests ranged from light to moderately dirty furnace waterwalls. As a result of the small variation in furnace waterwall deposits, no effect on $NO_2$ emission levels was evident. Therefore, furnace slagging conditions have not been indicated on the biased firing graphs.

Figure 51 is a plot of fuel firing elevation out of service versus $NO_2$ emissions level. As this figure shows, the lowest $NO_2$ levels were obtained when the top fuel firing elevation was removed from service. This method of unit operation most closely simulates overfire air operation. The highest $NO_2$ emission levels were obtained when the center fuel firing elevation was removed from service. Removal of the bottom fuel firing elevation from service showed a reduction in $NO_2$ levels from the highest levels obtained when the center fuel elevation was removed from service. These lower $NO_2$ levels may possibly be attributed to the flow of air under the fuel firing zone causing a lowering in bulk flame temperature.

CO emission levels versus theoretical air to the fuel firing zone are plotted in Figure 52. No variation in CO emission levels with unit loading or furnace waterwall deposits is evident. The variation in CO emission levels with TA is not as expected. Test #1 has an unusually high CO emission level. This can be partially attributed to the fact that the dampers for the top fuel firing elevation were only 10 percent open as opposed to the 100 percent open desired.

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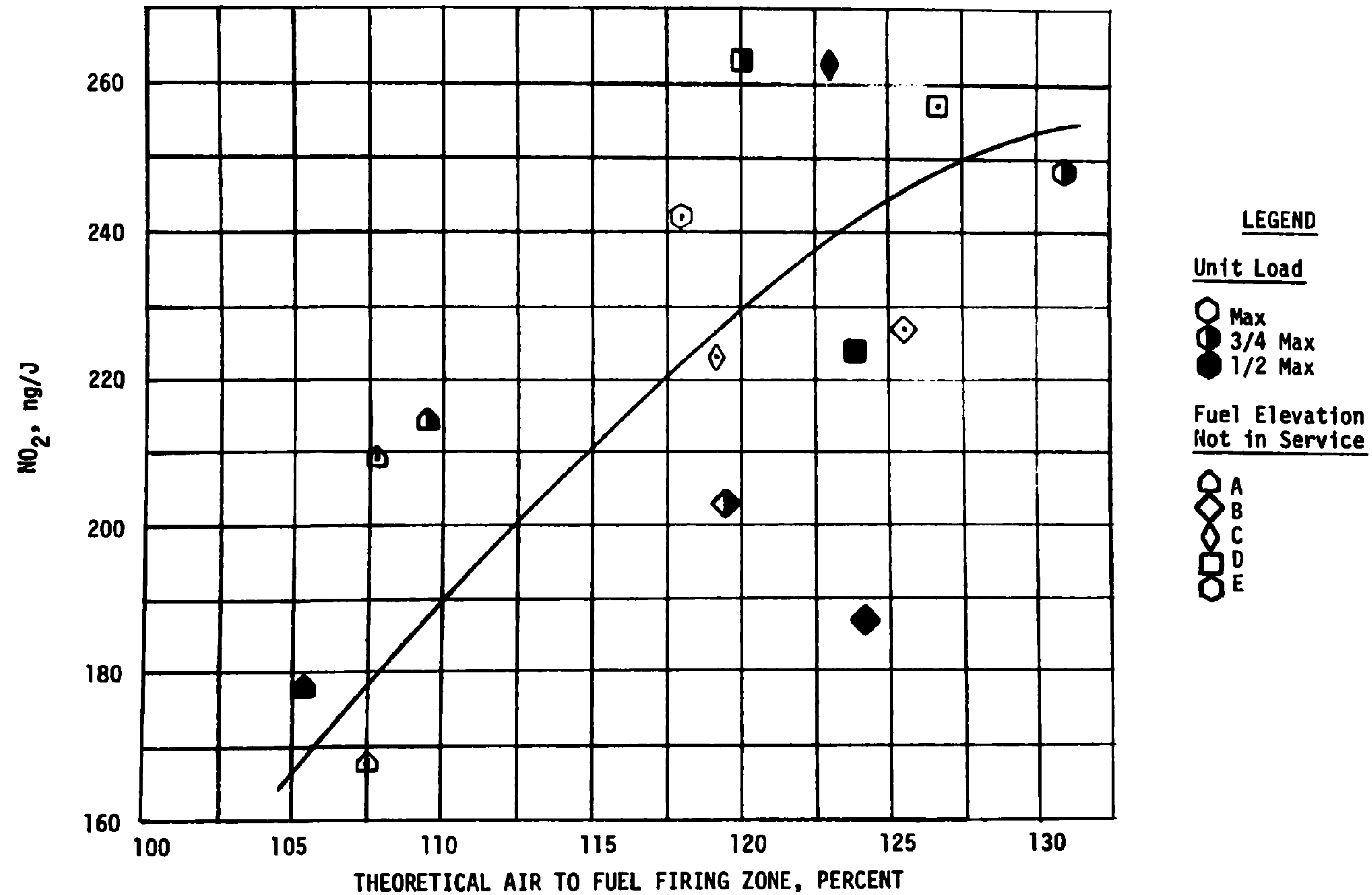


Figure 50: $NO_2$ vs. theoretical air to fuel firing zone, biased firing study

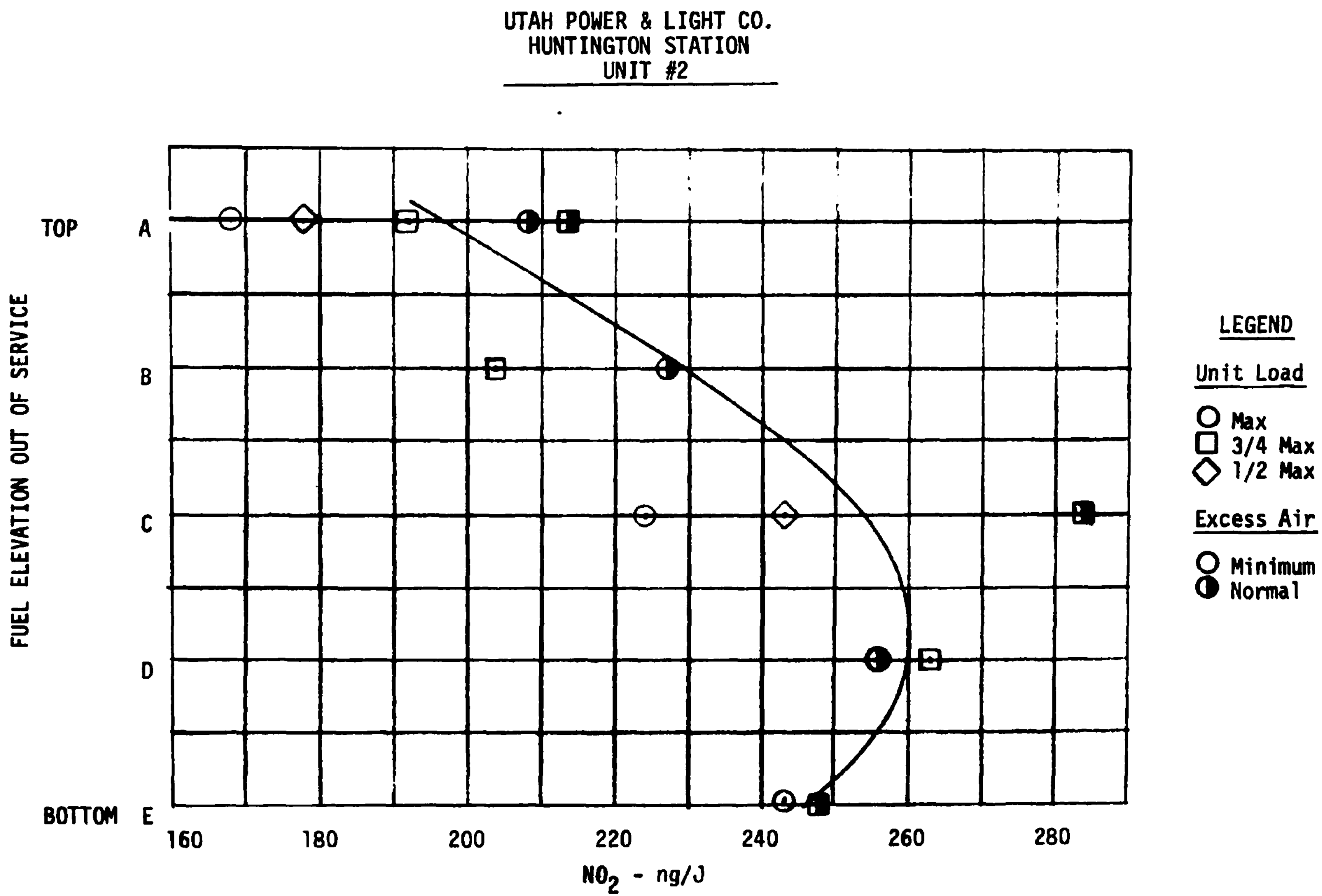


Figure 51: Fuel elevation out of service vs. $NO_2$, biased firing study

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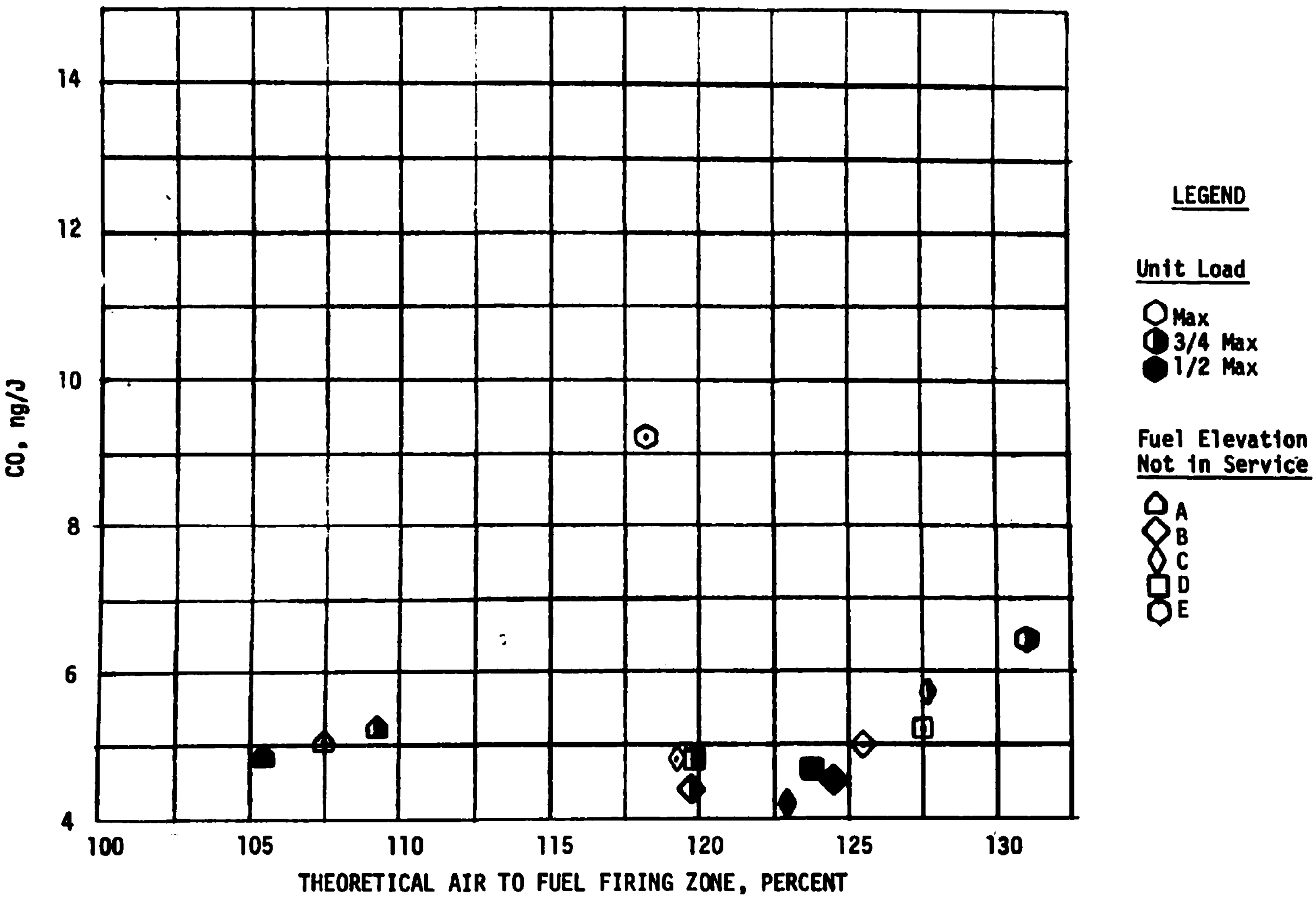


Figure 52: CO vs. theoretical air, biased firing study

This fact coupled with the low excess air operation may have contributed to the high CO level. While there is a rise in CO level for TA's below 120 percent, the variation is not pronounced. Also, Tests #13 and #14 have slightly higher CO emission levels while operating at the highest TA.

Figure 53 shows that some of those tests (Nos. 3, 4 and 14) with high CO emission levels also have some of the highest carbon heat loss values regardless of unit load or TA. Figure 53 indicates that increasing carbon heat loss is possible with decreasing TA. This trend is not completely supported by the data as plotted. Tests 3, 13 and 14 have higher carbon heat loss values than expected for the excess air levels at which the unit was operating. It should be noted that these tests were run with the center and bottom fuel elevations out of service. Plotting of the fuel elevation out of service versus the CO emission levels did not provide any useful information; therefore, it is not included in this report.

Figure 54 shows unit efficiency versus percent excess air at the economizer outlet. This plot reveals no useful information regarding the effect of excess air level on unit efficiency.

$SO_2$ emission levels were again monitored for each test and are reported on Data Sheets B-3 and B-4.

Unburned hydrocarbon emission levels monitored were at such low levels as to be unmeasurable.

## TASK VI - OVERFIRE AIR OPERATION STUDY

### Excess Air and Overfire Air Rate Variation

Tests 1 through 11 were conducted to determine the effect of varying the overfire air rate and excess air level on the $NO_2$ emission levels and Unit Performance. For these tests the overfire air registers were held at horizontal while the fuel nozzle tilts were allowed to vary from a -14 degrees to a +17 degrees. For each group of tests in this series, the variation in tilt was held to the minimum allowed while maintaining acceptable superheat and reheat outlet temperatures. Furnace waterwall deposits were not controlled for these tests and ranged from light to heavy slagging conditions on the waterwalls. The overfire air tests were performed during that time period when the coal being fired was a blend of two to three coals. There was also some problems at this time with soot blowers being out of operation.

As shown by the following table, $NO_2$ emission levels are found to increase with increasing theoretical air to the fuel firing zone. This correlation is evident regardless of the total excess air level the unit is operating at. Although Tests 1 through 5 were conducted at normal excess air levels, averaging 26.5 percent at the economizer outlet, the $NO_2$ emission levels were lower than for Tests 6 through 8 at minimum excess air levels, averaging 19 percent at the economizer outlet. This variation was not as expected.

One possible explanation to this unexpected variation is that the tilts for tests 6 through 8 were at a plus ten (+10) degrees while those tilts for tests 1 through 5 ranged from a plus six (+6) to a minus fourteen (-14) degrees. While the plus tilts in tests 6 through 8 reduced the residence time of the hot

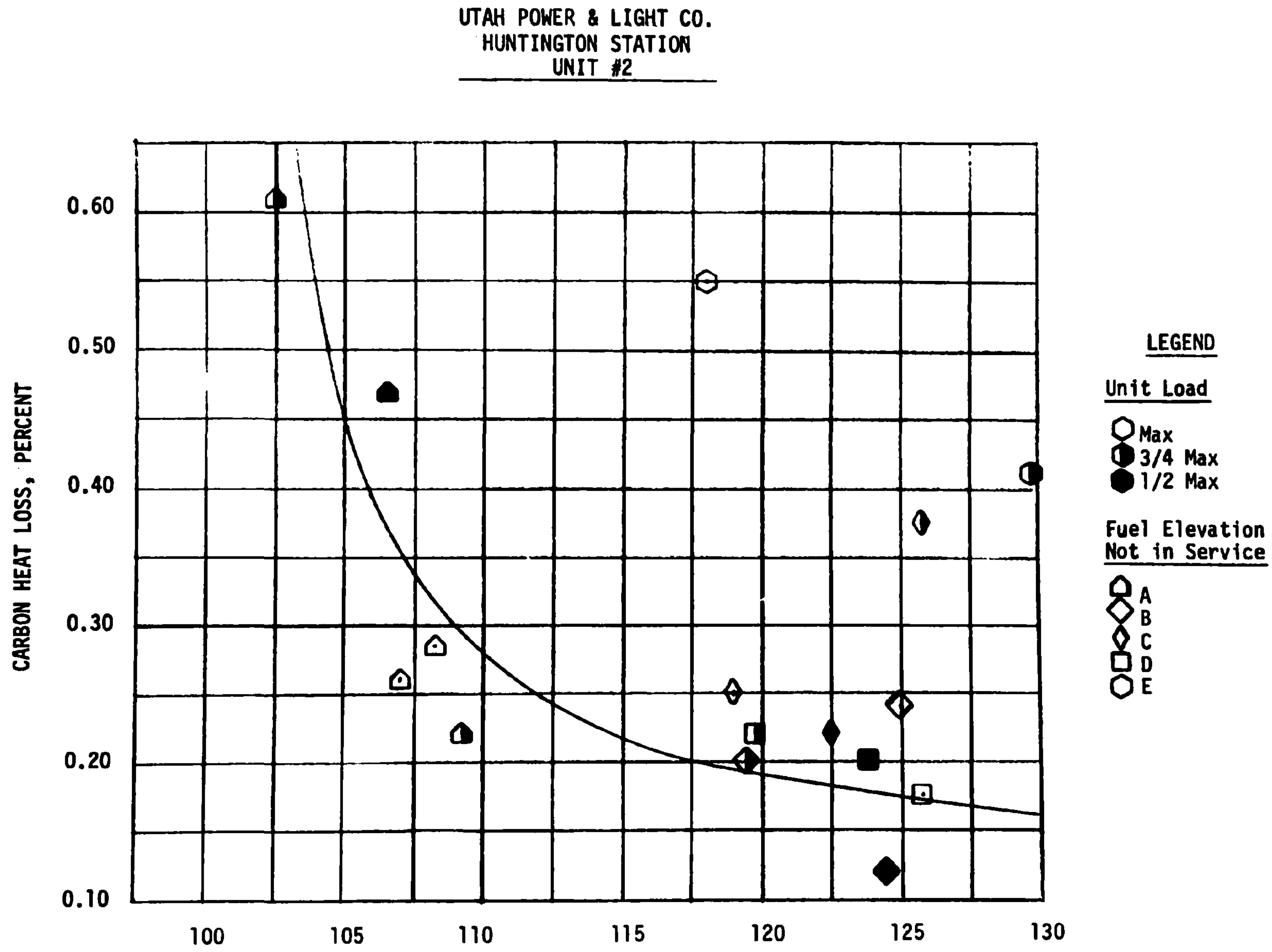


Figure 53: Carbon heat loss vs. theoretical air, biased firing study

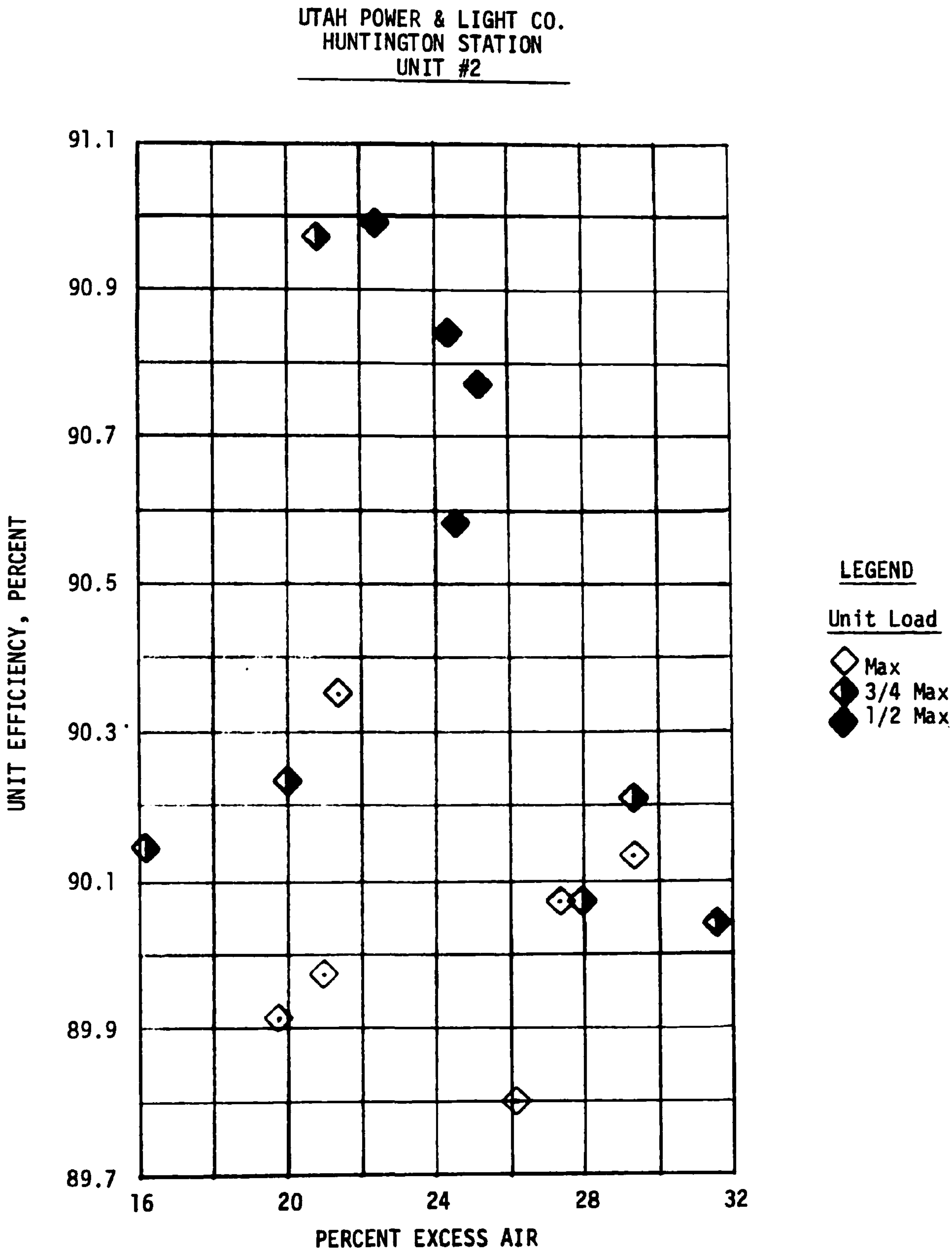


**Figure 54:** Unit efficiency vs. excess air, biased firing study

gases in the furnace they also exposed the fire to less furnace waterwall surface. The decrease in furnace waterwall surface cooling area seen by the fire can result in increased flame temperatures with a corresponding increase in thermal $NO_x$ formation. Previous experience has shown minimum total excess air gives the minimum $NO_2$ emission levels for any given coal. One possible explanation to this difference in $NO_2$ emission levels is that the coal being burned at this time was a blend of American-Church Mine, Peabody-Wilberg Mine and Peabody-Deer Creek Mine coals. The percentages of each coal burned on a daily basis was an unknown factor. The Church Mine or Wilberg Mine coals were never used exclusively. Although these coals are of similar individual analysis, increased slagging conditions were experienced when firing a blend of these coals. The testing at this time was further aggravated by the necessity from that which had been required when burning design coal. Wall deposits were greater at this time, with running slag being experienced where previously only dry slag had existed.

Although those tests conducted at the normal excess air operating level resulted in the lowest $NO_x$ values, normal excess air operation was not considered optimum for $NO_x$ control. Based on the above facts, the optimum excess air operating level was considered to be the minimum, approximately 20 percent at the economizer outlet. The optimum overfire air rate based on the $NO_2$ emission level results for Tests 1 through 11 is with the overfire air dampers 100 percent open. This allows approximately 15 to 20 percent of the total combustion air to be introduced above the top level of fuel nozzles.

With the exception of Tests 7 and 8, CO emission levels are not found to vary significantly with changes in TA. Tests 7 and 8 have the lowest TA of Tests 1 through 11. This could contribute to the high CO levels monitored.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | OFA Dampers % Open |
|---|---|---|---|---|---|---|---|
| 1 | 369 | 273.7 | 4.7 | 27.0 | 125.2 | 89.51 | 0 |
| 2 | 372 | 251.1 | 4.6 | 28.2 | 120.2 | 90.13 | 25 |
| 3 | 372 | 229.4 | 4.6 | 26.2 | 111.6 | 89.92 | 50 |
| 4 | 370 | 213.0 | 4.6 | 25.5 | 107.1 | 89.99 | 75 |
| 5 | 370 | 205.3 | 4.5 | 25.2 | 105.4 | 90.05 | 100 |
| 6 | 372 | 300.1 | 4.7 | 18.5 | 116.7 | 90.09 | 0 |
| 7 | 372 | 247.3 | 36.3 | 19.2 | 102.9 | 89.70 | 50 |
| 8 | 370 | 221.6 | 49.0 | 19.2 | 96.6 | 90.46 | 100 |
| 9 | 369 | 353.2 | 4.8 | 32.1 | 123.2 | 89.44 | 25 |
| 10 | 368 | 334.0 | 4.4 | 33.8 | 113.8 | 89.18 | 75 |
| 11 | 370 | 332.3 | 4.8 | 33.8 | 112.5 | 89.48 | 100 |

## Overfire Air Tilt Variation

Tests 12 through 18 were conducted to determine the effect of fuel nozzle and overfire air register tilt on $NO_2$ emission levels and unit performance. These tests were conducted at the optimum overfire air rate (dampers 100 percent open) and excess air level (approximately 20 percent excess air at the economizer outlet) established in Tests 1 through 11. The fuel nozzles were varied from a -20 degrees to a +25 degrees, while the overfire air registers were varied from a

-30 to a +30 degrees. This variation of the fuel nozzle and overfire air register tilt angles moves the fuel firing zone both in the furnace and in its effective position relative to the overfire air registers. Movement of the fuel nozzles and overfire air registers away from each other accentuates the effect of staged combustion. Movement of the fuel nozzles and overfire air registers toward each other minimizes the effect of staged combustion because the air is being forced down into the firing zone. For these tests the furnace slagging conditions were allowed to vary, and ranged from light to moderate waterwall deposits.

As shown in the following table, minimum $NO_2$ levels were obtained when the fuel nozzles and overfire air registers were separated by 20 to 30 degrees (Tests 14 and 17). Parallel operation of the fuel nozzles and overfire air registers was nearly as effective, when both the fuel nozzle and overfire air registers were in a horizontal position (Test 15) or when both were tilted downward to their respective limits (Test 12). $NO_2$ emission levels were highest when the nozzles were moved toward each other. Therefore, the optimum condition was at a tilt differential of 20 to 30 degrees away from each other (Tests 14 and 17). For ease of boiler operation the tilt conditions for Test 17 were utilized in Tests 19 through 24.

With the exception of Tests 12 and 18, CO emission levels appear to be relatively unaffected by variations in fuel nozzle and overfire air register tilts. It should be noted that for Tests 12 and 18 the TA was less than 100 percent and that the fuel nozzles and overfire air registers were essentially operating in parallel. Test 12 was conducted with the fuel and overfire air nozzles at maximum minus tilt, while test 18 was conducted with the fuel and overfire air nozzles at maximum plus tilt. Operation of the boiler with the tilts at the maximum plus will reduce the residence time of the gases in the furnace and may result in higher CO levels due to insufficient burnout of the CO.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Fuel Nozzle Tilt-° | OFA Register Tilt-° |
|---|---|---|---|---|---|---|---|---|
| 12 | 370 | 223.3 | 10.4 | 23.1 | 99.6 | 90.11 | -20 | -30 |
| 13 | 364 | 263.4 | 4.5 | 25.1 | 101.1 | 89.83 | 0 | -30 |
| 14 | 370 | 179.8 | 4.8 | 22.0 | 99.2 | 90.32 | -20 | 0 |
| 15 | 370 | 212.1 | 4.6 | 25.1 | 101.1 | 89.82 | 0 | 0 |
| 16 | 372 | 283.5 | 4.4 | 21.3 | 98.4 | 89.90 | +25 | 0 |
| 17 | 377 | 186.1 | 4.9 | 23.5 | 99.8 | 90.01 | 0 | +30 |
| 18 | 367 | 252.1 | 15.8 | 21.7 | 98.6 | 89.51 | +25 | +30 |

Load and Furnace Waterwall Deposit Variation at Optimum Conditions

Tests 19 through 24 were conducted at the optimized conditions of excess air level, overfire air rate and fuel nozzle and overfire air register tilt as determined in Tests 1 through 18. These tests were run to determine the effect on $NO_x$ emission levels and unit performance at optimum conditions, while varying unit load and furnace wall deposits. These tests were conducted at an average excess air level of 21 percent, overfire air register dampers 75 to 100 percent open and with the overfire air registers tilted to +30 degrees while the fuel nozzles were held at horizontal.

As shown in the following table, $NO_2$ emission levels are affected by unit load, with higher $NO_2$ levels for higher loads. Furnace waterwall deposits have a greater effect on $NO_2$ levels at lower loads. A distinct effect on $NO_2$ emission level is evident at half (1/2) load (Test Nos. 23 and 24), while this distinction is considerably less for three-quarter (3/4) load (Tests 21 and 22) and is reversed for full load (Tests 19 and 20). This suggests a possible relationship between furnace waterwall deposits, unit load and $NO_2$ levels.

Except for Test 23, CO emission levels are unaffected by unit load or furnace waterwall deposits. The CO level and the carbon heat loss for Test 23 are high when considering the conditions at which the boiler was operating.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Furnace Condition |
|---|---|---|---|---|---|---|---|
| 19 | 374 | 196.5 | 5.8 | 18.5 | 95.8 | 89.79 | Clean |
| 20 | 377 | 190.2 | 5.8 | 19.6 | 97.1 | 89.85 | Moderate |
| 21 | 299 | 161.3 | 5.7 | 19.3 | 98.1 | 90.41 | Clean |
| 22 | 299 | 167.8 | 6.3 | 21.5 | 95.0 | 90.65 | Moderate |
| 23 | 218 | 132.0 | 19.0 | 22.8 | 97.3 | 90.79 | Clean |
| 24 | 217 | 155.3 | 4.5 | 23.9 | 99.7 | 90.76 | Moderate |

Analysis of Results

The changes in $NO_2$, CO and carbon heat loss versus changes in theoretical air to the fuel firing zone are shown in Figures 55, 56 and 57, respectively.

Figure 55 shows that there is a definite trend in $NO_2$ emission levels with changes in TA. Increasing TA results in increasing $NO_2$ emission levels. Furnace waterwall deposits and unit load are also indicated on Figure 55. No correlation between furnace waterwall deposit variation and $NO_2$ emission level is evident from the data as plotted. The effect of unit load on $NO_2$ levels shows lower $NO_2$ levels for lower loads. As these low load tests (Tests 21, 22, 23 and 24) also have some of the lowest TA's, these should be compared with full load tests at similar TA's to find the effect of unit load. A comparison of Tests 21 and 24 with Tests 14 and 17 or of Tests 22 and 23 with Tests 19 and 20 shows that lower loads resulted in lower $NO_2$ levels.

CO emission level versus theoretical air to the fuel firing zone is plotted in Figure 56. Figure 56 indicates rise in CO emission levels below TA levels of 104 percent. Previous studies at Alabama Power Company's, Barry #2 [2] have shown that CO levels tend to rise rapidly in those TA regions where $NO_2$ levels are falling rapidly.

As is evident in Figure 57, decreasing theoretical air to the fuel firing zone results in increasing carbon heat loss levels. This trend, while being similar, is much more apparent than with the CO emission levels, with carbon heat losses rising rapidly below 104 percent TA. This trend was also observed at Alabama Power Company, Barry Station, Unit #2 [2].

Figure 58 shows the effect that variation of fuel nozzle and overfire air register tilts has on $NO_2$ emission levels.

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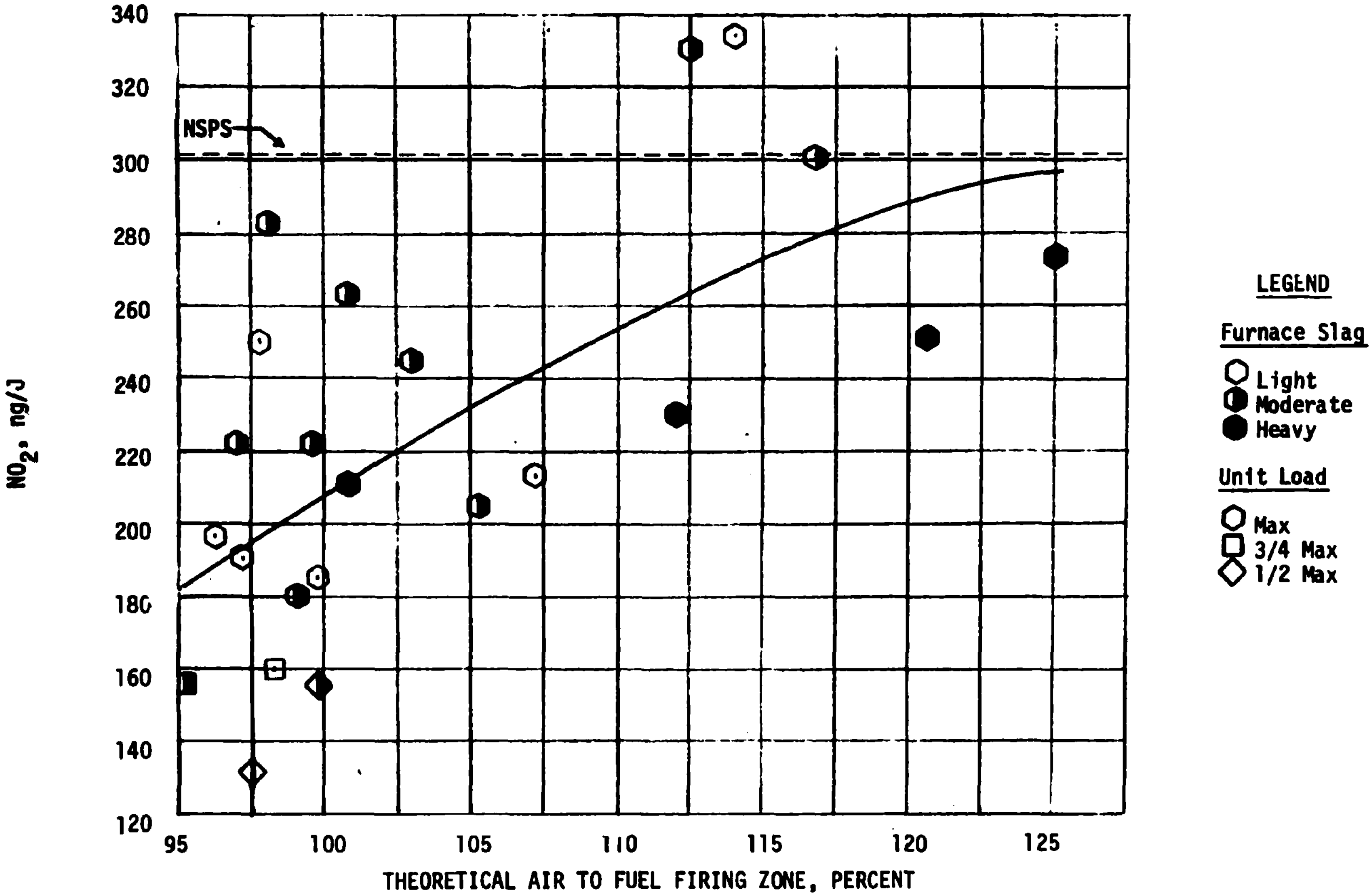


Figure 55: $NO_2$ vs. theoretical air to fuel firing zone, overfire air study

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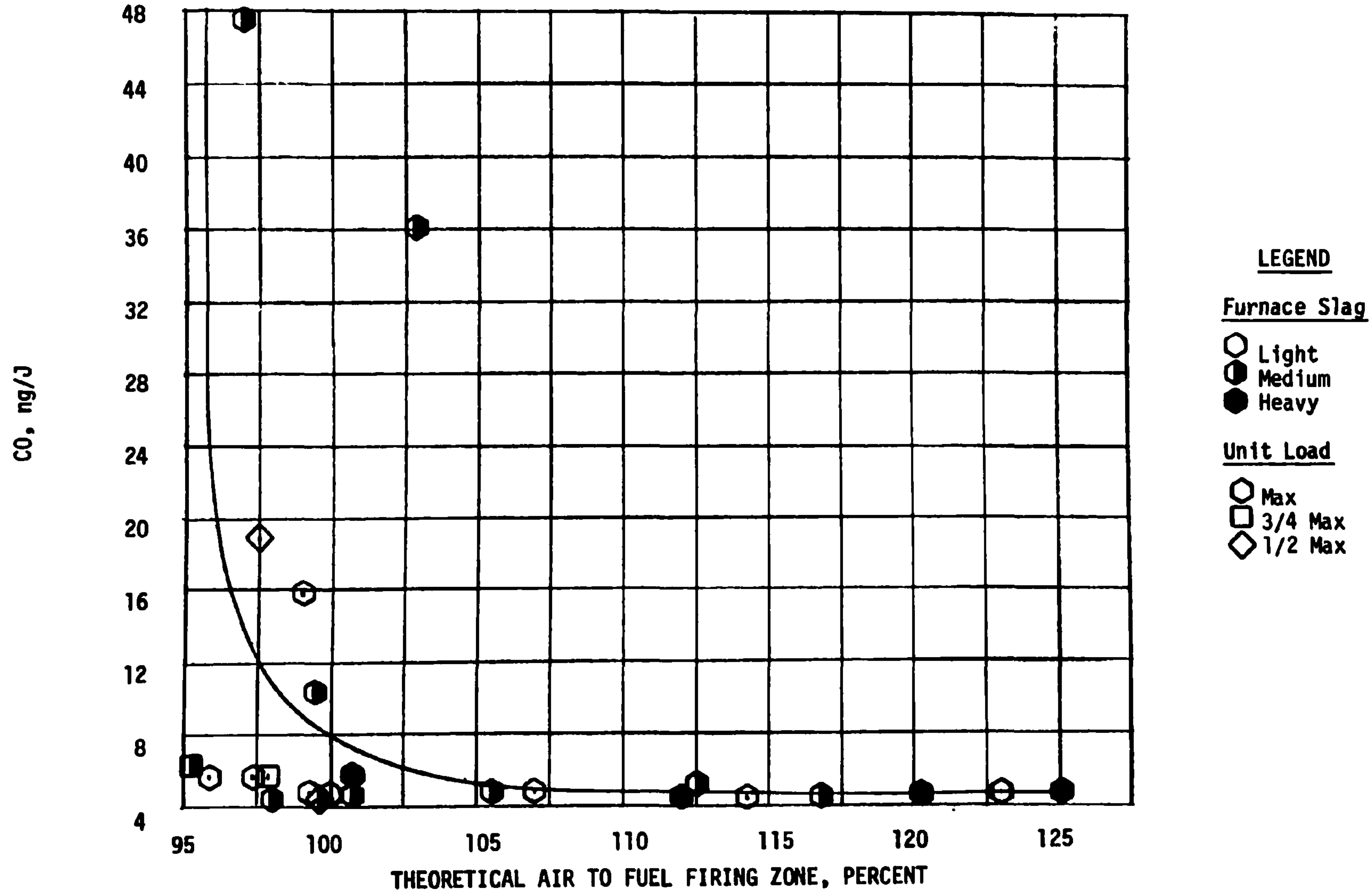


Figure 56: CO vs. theoretical air to fuel firing zone, overfire air study

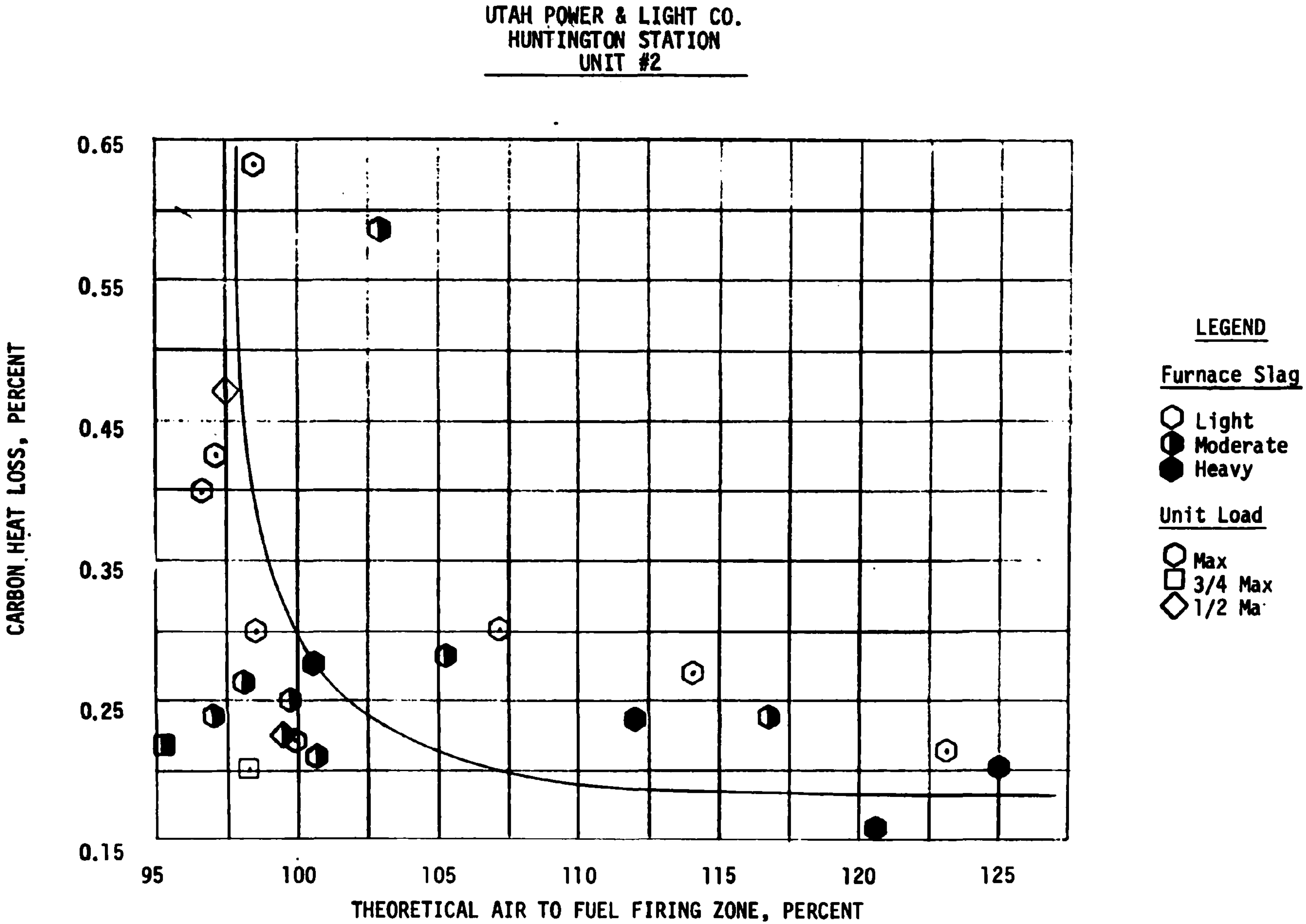


Figure 57: Carbon heat loss vs. theoretical air, overfire air study

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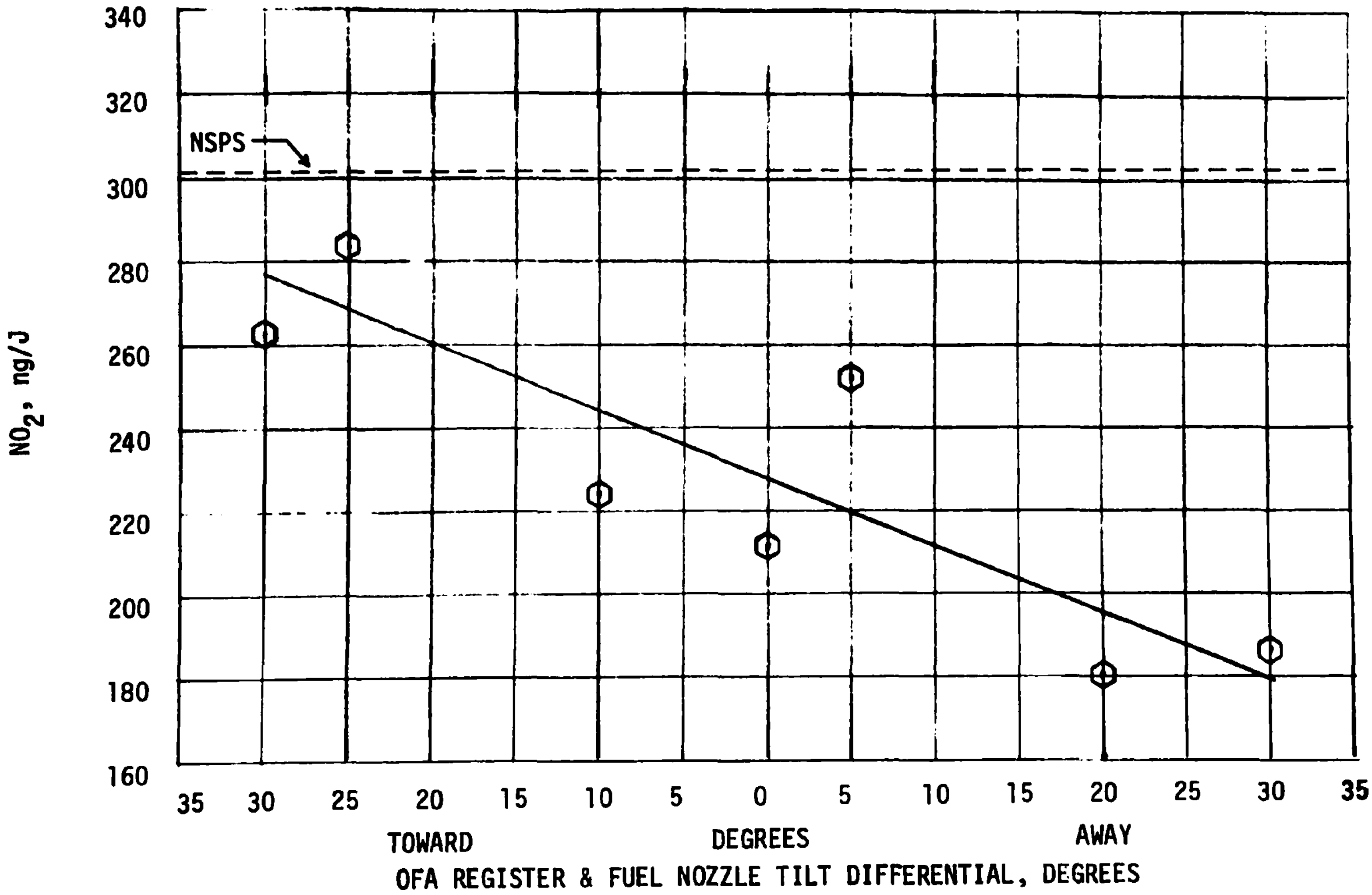


Figure 58: $NO_2$ vs. tilt differential, overfire air study

Figure 58 shows that as the fuel nozzles and overfire air registers are angled toward each other, $NO_2$ emission levels rise. Conversely as the nozzles are moved away from each other, the effect of staged combustion becomes more pronounced, until at 30 degrees away from each other the $NO_2$ emission level is 186 ng/J for full load unit operation.

Prior experience at Alabama Power Company's, Barry Station, Unit #2 has shown that flame stability can be a limiting factor as the fuel nozzles and overfire air registers move substantially away from each other. Tests, similar to Tests 12 through 18, at the Barry Station, Unit #2 indicated a probable maximum differential of 50 degrees between the fuel nozzles and overfire air registers [2]. Flame instability was not apparent during tilt variation tests at Utah Power and Light Company's Huntington Canyon Station, Unit #2. The maximum differential of the fuel nozzles and overfire air registers away from each other for these tests was only 30 degrees compared to 50 degrees for the Barry tests.

Figure 59 shows unit efficiency versus excess air at the economizer outlet. A decrease in unit efficiency is evident with increasing excess air at the economizer outlet. This trend is in agreement with the baseline and biased firing tests at Huntington Canyon Station, Unit #2 and previous tests at Barry Station, Unit #2.

$SO_2$ emission levels were monitored and are reported on Sheets B-5 and B-6. As with the other tests there is no apparent correlation between $SO_2$ emission levels and excess air, unit load or furnace waterwall deposits.

Unburned hydrocarbons were monitored for all overfire air tests and were at such low levels as to be unmeasurable.

A thirty (30) day waterwall corrosion coupon test was conducted in November, 1975. The boiler operated with the overfire dampers 100% open and with full load being maintained as much as possible. The overfire air corrosion coupon test is discussed in the following section, Waterwall Corrosion Coupon Evaluation.

## WATERWALL CORROSION COUPON EVALUATION

Following completion of the steady state phases of the baseline and overfire air test programs, thirty (30) day waterwall corrosion coupon evaluations were performed. The purpose of these evaluations was to determine whether any measurable changes in coupon weight losses could be obtained for the modes of firing under study.

The individual probes were exposed at five locations on the furnace front wall as shown on Figure 60. The coupon temperatures were maintained at the same levels for each 30 day run and a typical tract of the control temperature range for each of the twenty coupons is shown on Figure 61.

The individual coupon weights were determined before and after each thirty day test and the individual coupon and average probe weight losses are shown on Sheets B45 and B46. The weight losses are calculated as $mg/cm^2$ of coupon surface area.

Figures 62 and 63 show the unit load schedules for each of the 30 day test

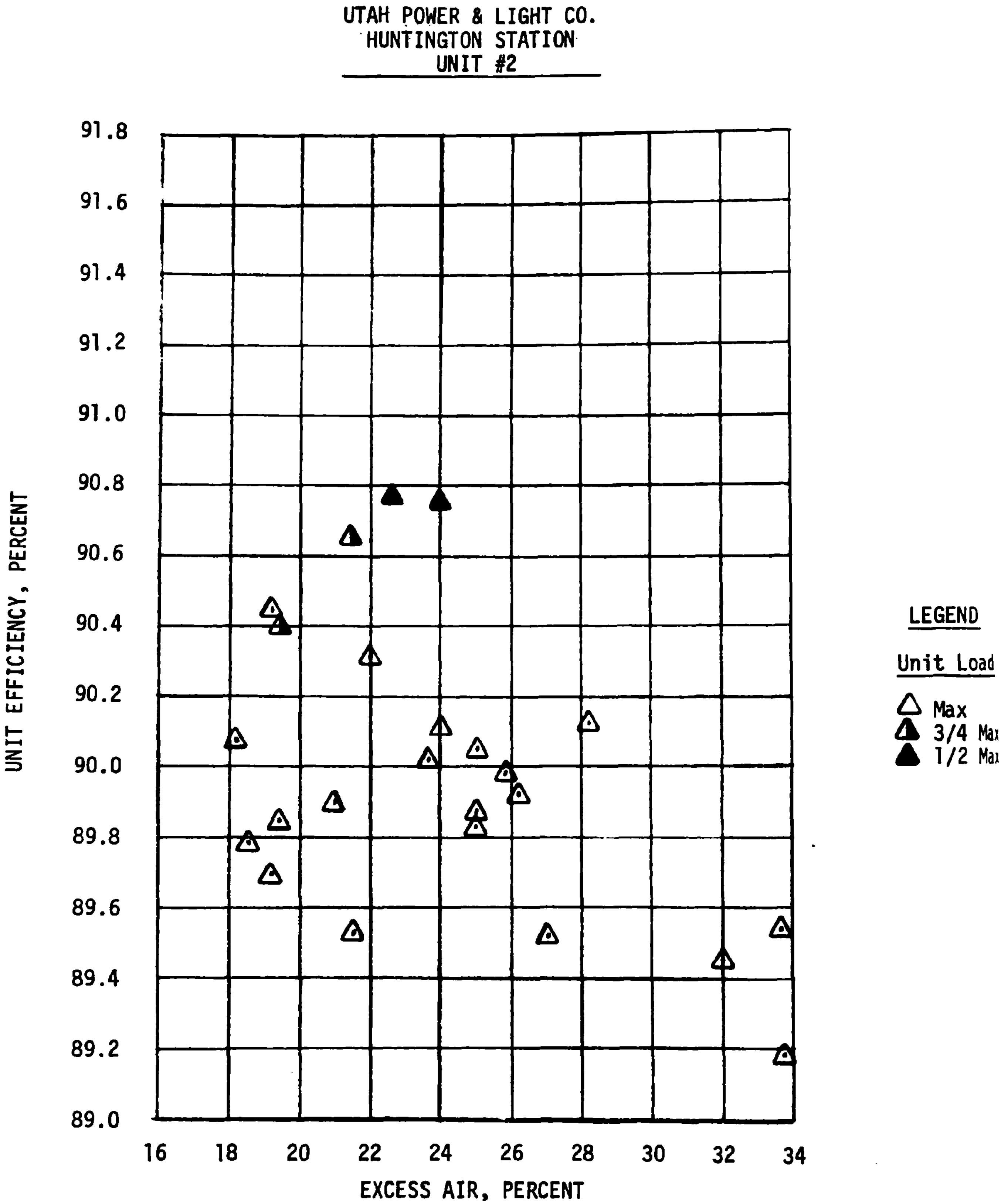


Figure 59: Unit efficiency vs. excess air, overfire air study

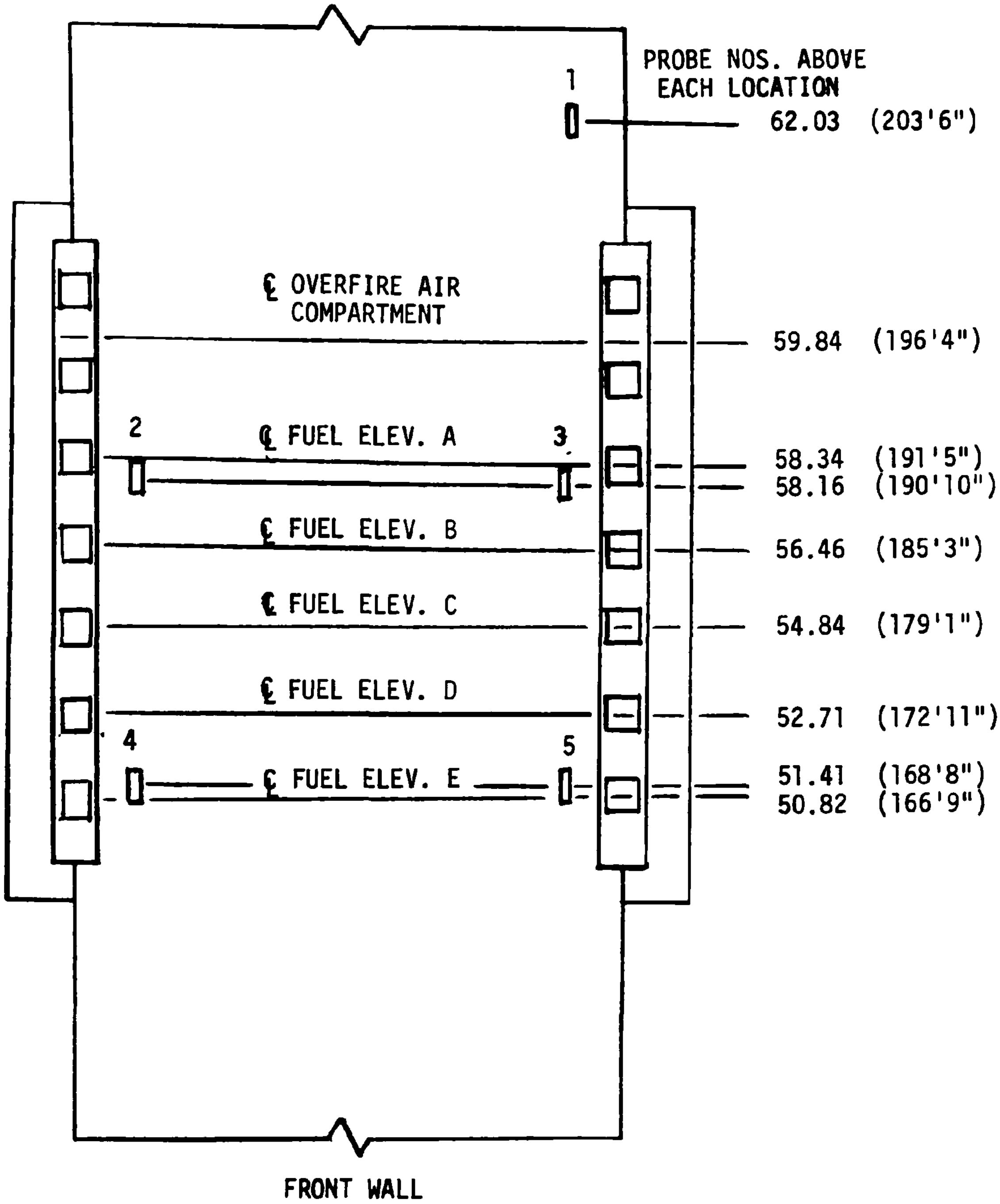


Figure 60. Waterwall corrosion probe locations, Huntington Station No. 2

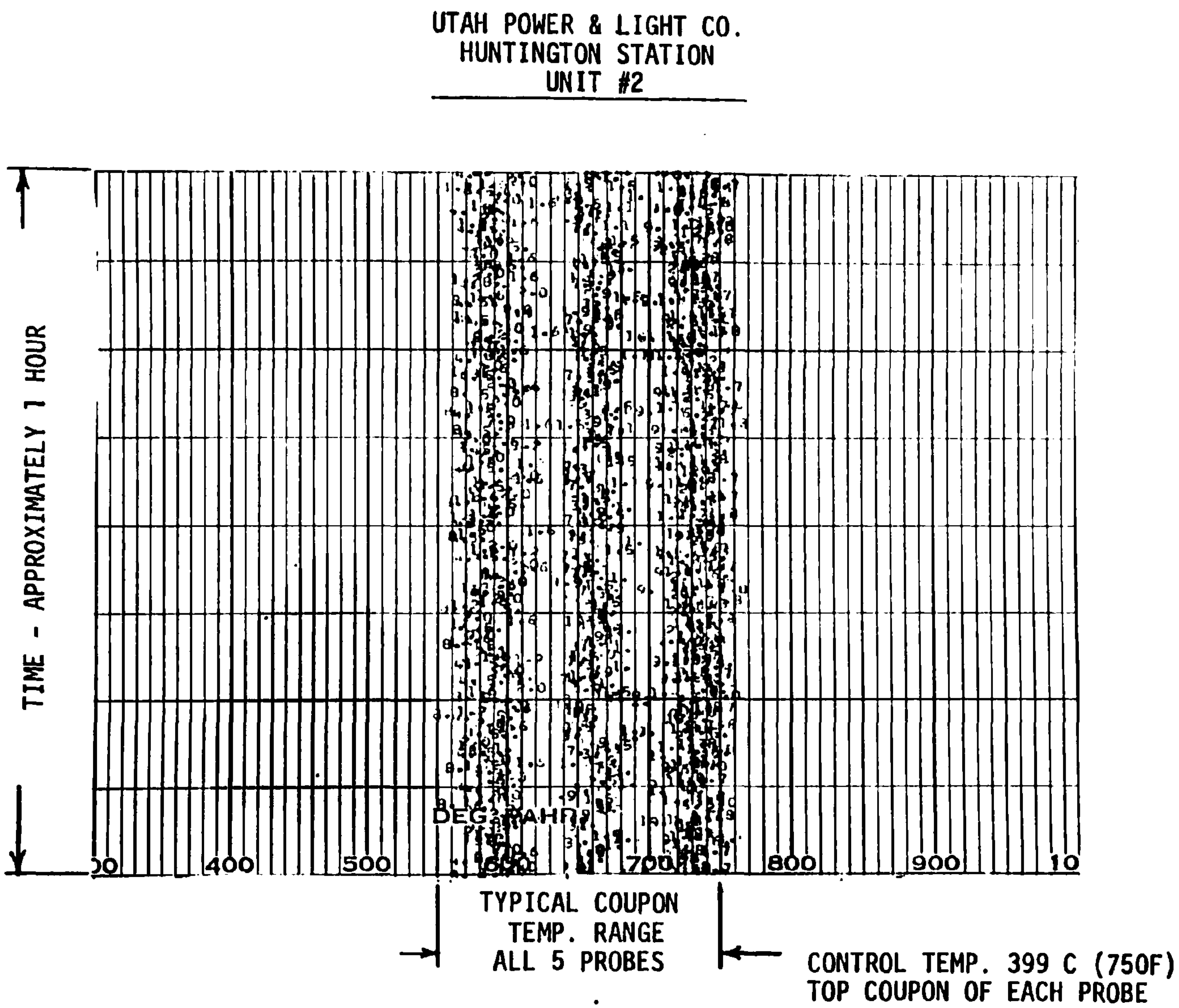


Figure 61. Typical corrosion probe temperature ranges, Huntington Station No. 2

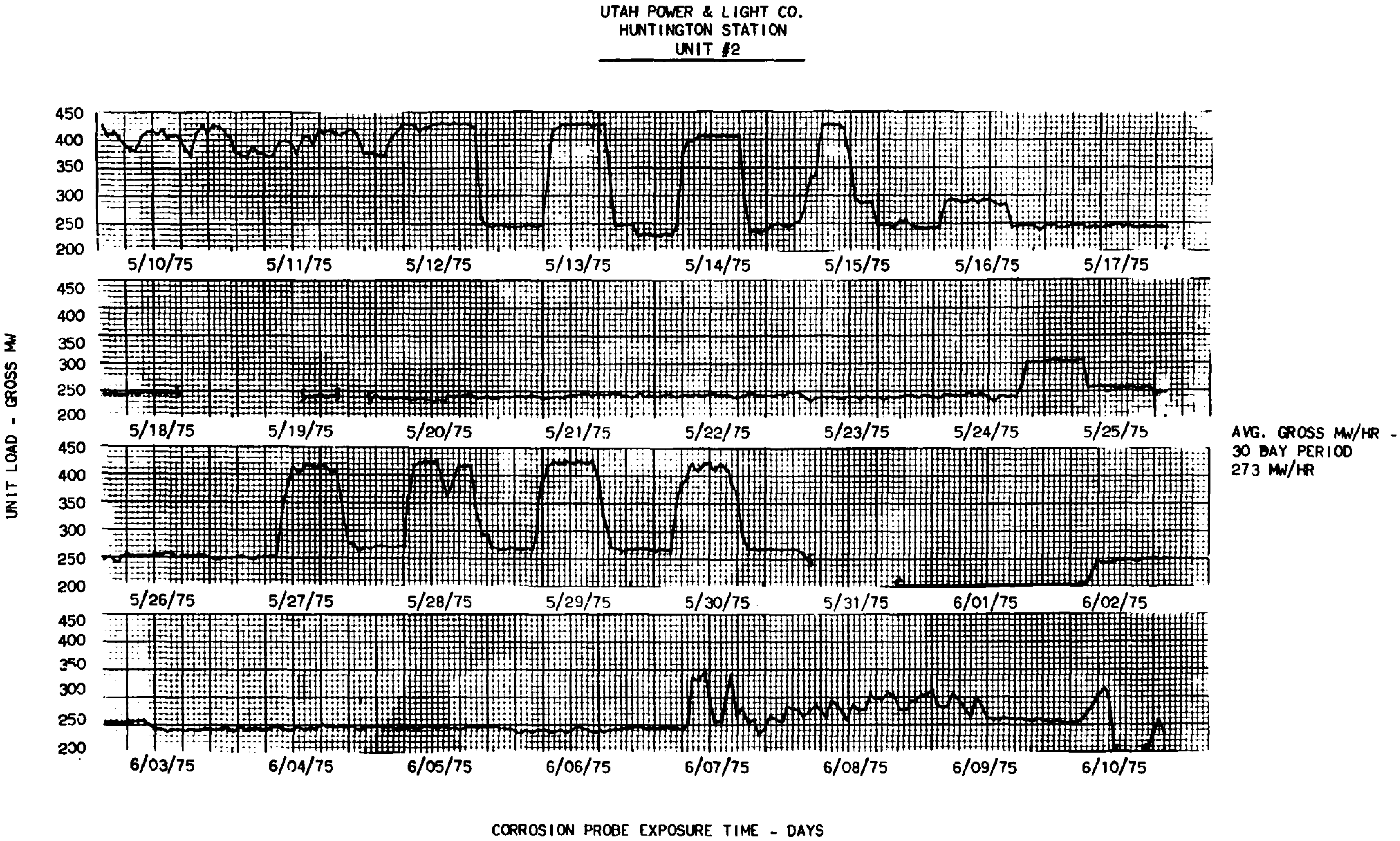


FIGURE 62: GROSS MW LOADING VS. TIME - BASELINE CORROSION PROBE STUDY

UTAH POWER & LIGHT CO.
HUNTINGTON STATION
UNIT #2

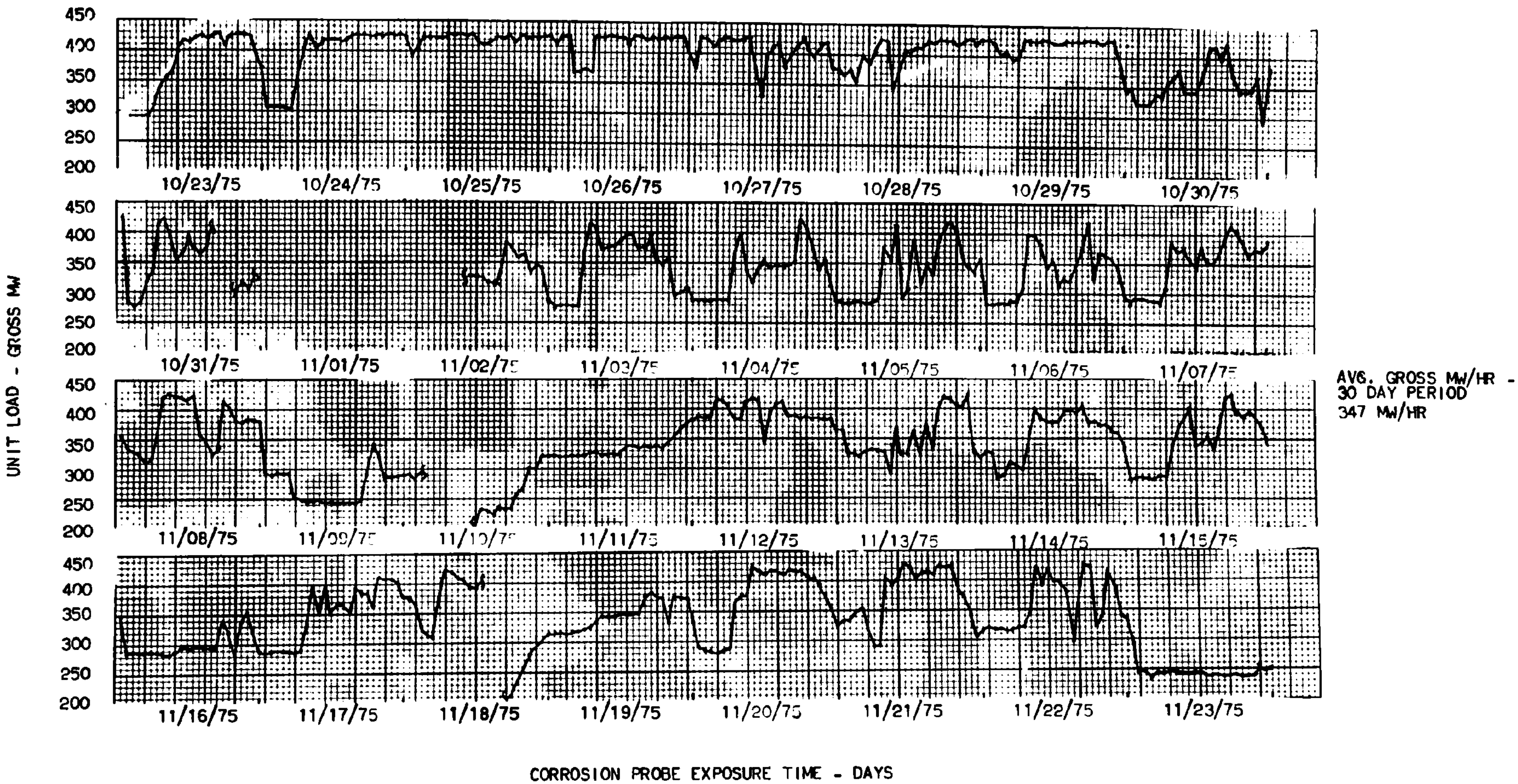


FIGURE 63: GROSS MW LOADING VS. TIME - OVERFIRE AIR CORROSION PROBE STUDY

periods.

The overfire air portion of the study was conducted using the "optimum" operating conditions determined during the overfire air steady state tests.

Throughout the overfire air study the overfire air dampers were maintained at the full open configuration over the range of unit loading shown on Figure 63 with the following exceptions. On November 2, 1975 the overfire air were closed during unit start-up. Between November 5 and November 7, 1975 one compartment was closed when required to maintain proper windbox pressure. November 15 to November 16, 1975 one compartment was closed at reduced unit loading and on November 22 and November 23, 1975 one or both dampers were closed during low load operation.

The percent oxygen was monitored daily during each thirty day study at each probe location and was found to range between 7 and 19 percent $O_2$ during both the baseline and overfire air studies.

The weight losses calculated for the baseline portion of the test program were found to be greater than those for the overfire air tests. The average weight losses for all five probes were as follows:

| Baseline | Overfire Air |
|---|---|
| 3.4266 $mg/cm^2$ | 2.6357 $mg/cm^2$ |

These values are within the range of losses which would be expected for oxidation of carbon steel for a 30 day period. This premise is verified by control studies conducted in C-E's Kreisinger Development Laboratory using probes exposed during the biased firing study conducted at Alabama Power Co., Barry #2. These probes were cleaned and prepared in an identical manner to those used for furnace exposure and placed in a muffle furnace for 30 and 60 day exposures at 399°C with a fresh air exchange. The test results were as follows:

| Probe | Wt. Loss $mg/cm^2$ - 30 Days |
|---|---|
| M (30 day) | 4.7999 |
| Q (30 day) | 4.7741 |
| R (60 day) | 5.1571/2 = 2.5785 |
| B (60 day) | 8.3493/2 = 4.1746 |

These results indicate that the test coupons oxidized more rapidly during the first 30 days exposure with average weight losses decreasing in the second thirty days. Based on these results, it appears that the differences in weight losses observed during the test program are within the ranges to be expected from oxidation alone.

Chemical analysis of coupon deposits taken during the test program indicate an enrichment in iron as compared with the "as fired" coal ash analysis with the greater enrichment occurring during the baseline study. Also the degree of iron enrichment during the overfire air study was not as consistent as was noted in the baseline study. There is some question as to whether the ash deposits accurately represent inner and outer layers of deposit in some probes. Despite the uncertainty there was nothing about the compositions or fusibility temperatures which would indicate a change in slagging condition between the baseline and overfire air studies. The as-fired ash and coupon deposit analyses are given on Figures 64 and 65.

# WATERWALL CORROSION COUPON DATA SUMMARY

## AS FIRED ASH AND COUPON DEPOSIT ANALYSIS

## BASELINE STUDY

| Sample Location | Mill Exhauster | Probe #1 | Probe #2 | Probe #3 | Probe #4 | Probe #5 |
|---|---|---|---|---|---|---|
| Ash Fusibility-$^{o}$F | | | | | | |
| Initial Deformation Temp. | 2050 | 1980 | I.S. | 1980 | I.S. | 1910 |
| Softening Temp. | 2160 | 2040 | | 2160 | | I.S. |
| Fluid Temp. | 2440 | 2210 | | 2270 | | 2050 |
| Ash Composition-%by Weight | | | | | | |
| $SiO_2$ | 49.0 | 21.0 | 18.4 | 21.0 | 18.5 | I.S. |
| $Al_2O_3$ | 15.5 | 4.5 | 6.0 | 4.8 | 7.9 | |
| $Fe_2O_3$ | 7.2 | 54.6 | 47.9 | 54.8 | 45.6 | |
| CaO | 9.0 | 9.0 | 6.5 | 8.0 | 8.3 | |
| MgO | 2.0 | 2.1 | 1.1 | 1.7 | 1.3 | |
| $Na_2O$ | 4.8 | 2.0 | 3.2 | 1.9 | 3.3 | |
| $K_2O$ | 1.0 | 0.5 | 0.9 | 0.6 | 0.6 | |
| $TiO_2$ | 1.0 | 0.3 | 0.6 | 0.4 | 0.3 | |
| $SO_3$ | 7.6 | 6.0 | 15.4 | 6.8 | 14.1 | |
| Total | 97.1 | 100.0 | 100.0 | 100.0 | 99.9 | |

I.S. - Insufficient Sample

Figure 64: As-fired ash & coupon deposit analysis, baseline study

# WATERWALL CORROSION COUPON DATA SUMMARY

## AS FIRED ASH AND COUPON DEPOSIT ANALYSIS

## OVERFIRE AIR STUDY

| Sample Location | Mill Exhauster | Probe #1 | Probe #2 | Probe #3 | Probe #4 | Probe #5 |
|---|---|---|---|---|---|---|
| Ash Fusibility-°F | | | | | | |
| Initial Deformation Temp. | 2130 | 2200 | 1890 | 2120 | 1940 | I.S. |
| Softening Temp. | 2200 | 2250 | 1920 | 2210 | 1970 | |
| Fluid Temp. | 2450 | 2530 | 2020 | 2440 | 2140 | |
| Ash Composition-%by Weight | | | | | | |
| $SiO_2$ | 51.5 | 56.9 | 28.7 | 55.6 | 29.3 | 23.9 |
| $Al_2O_3$ | 17.0 | 19.2 | 11.3 | 18.3 | 26.8 | 9.2 |
| $Fe_2O_3$ | 4.7 | 4.4 | 32.8 | 5.4 | 25.5 | 39.9 |
| CaO | 8.9 | 9.6 | 13.9 | 9.1 | 9.3 | 11.9 |
| MgO | 1.1 | 1.1 | 2.6 | 1.0 | 1.6 | 2.3 |
| $Na_2O$ | 5.2 | 4.6 | 2.5 | 4.4 | 2.2 | 2.0 |
| $K_2O$ | 0.6 | 0.6 | 0.4 | 0.6 | 0.3 | 0.3 |
| $TiO_2$ | 1.0 | 0.6 | 0.4 | 0.6 | 0.9 | 0.5 |
| $SO_3$ | 6.6 | $<0.1$ | 4.7 | 0.3 | 3.8 | 5.5 |
| Total | 96.6 | 97.0 | 97.1 | 95.3 | 99.9 | 95.5 |

I.S. - Insufficient Sample

Figure 65: As-fired ash & coupon deposit analysis, overfire air study

## SECTION III - EPA CONTRACT 68-02-1367

## ALABAMA POWER COMPANY, BARRY STATION, UNIT #2

## INTRODUCTION

This program encompassed the work to be performed under the second phase of a two phase program to identify, develop and recommend the most promising combustion modification techniques for the reduction of $NO_x$ emissions from tangentially coal fired utility boilers with a minimum impact on unit performance.

Phase I (performed under EPA Contract 68-02-0264) consisted of selecting a suitable utility field boiler to be modified for experimental studies to evaluate $NO_x$ emission control. Phase I also included the preparation of preliminary drawings, a detailed preliminary test program, a cost estimate and detailed schedule of the program phases and a preliminary application economic study indicating the cost range of a variety of combustion modification techniques applicable to existing and new boilers [1].

Phase II consisted of modifying and testing the utility boiler selected in Phase I to evaluate overfire air and biased firing as methods for $NO_x$ control. This phase also included the completion of detailed fabrication and erection drawings, installation of analytical test equipment, updating of the preliminary test program, analysis and reporting of test results and the development of control technology application guidelines for existing and new tangentially coal fired utility boilers.

This program was conducted at the Barry Steam Station, Unit No. 2 of the Alabama Power Company. This unit is a natural circulation, balanced draft design, firing coal through four elevations of tilting tangential fuel nozzles. Unit capacity at maximum continuous rating (MCR) is 113 kg/s main steam flow with a superheat outlet temperature and pressure of 538°C and 12.9 MPa. Superheat and reheat temperatures are controlled by fuel nozzle tilt and spray desuperheating A side elevation of the unit prior to modification is shown on Figure 66.

Throughout this report $NO_x$ emission levels are expressed as ng/J $NO_2$.

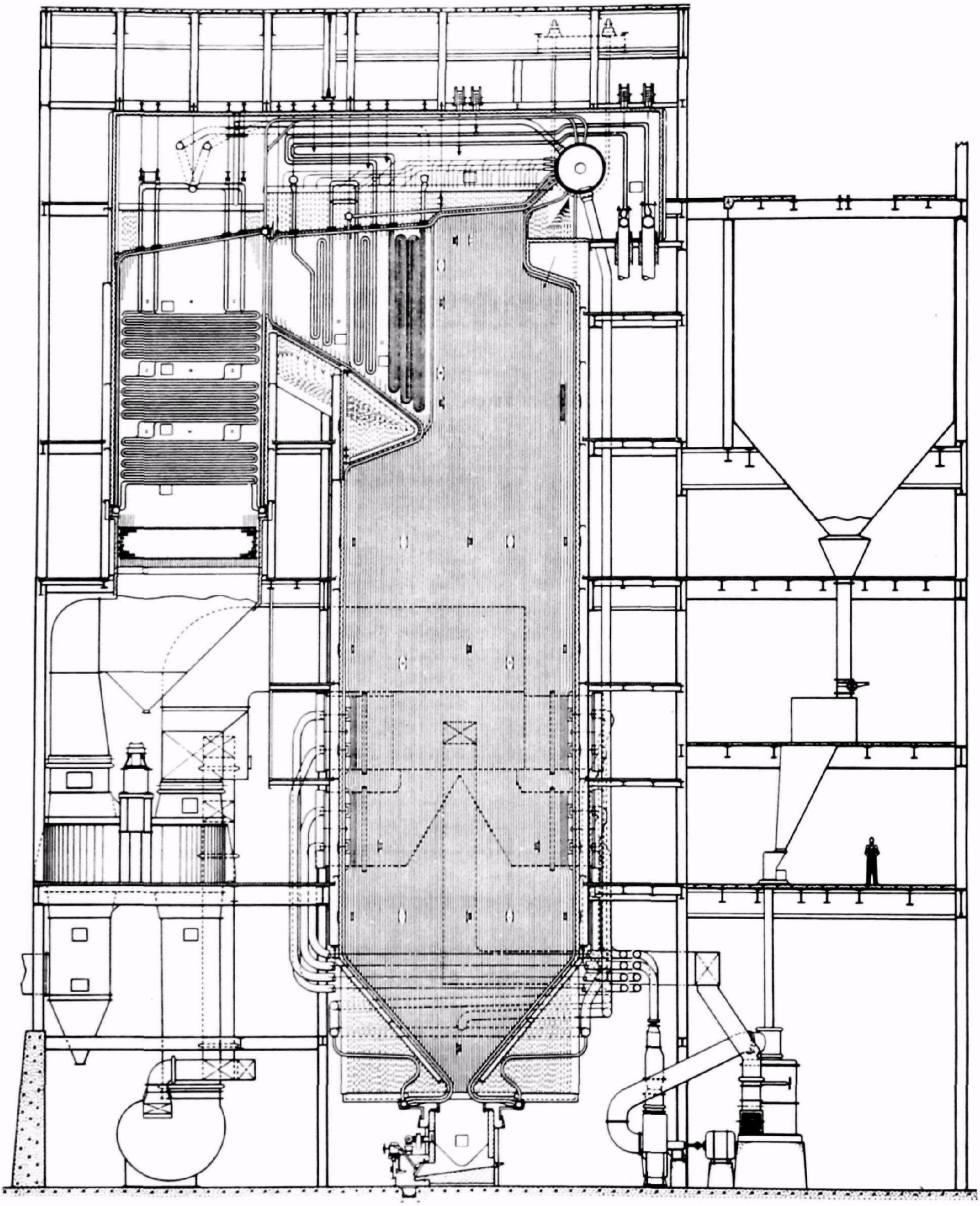

Figure 66. Unit side elevation, Alabama Power Company, Barry Station No. 2

## CONCLUSIONS

### NORMAL OPERATION

1. Under normal unit operation, without overfire air, excess air variation was found to have the greatest single effect on $NO_x$ emission levels, increasing $NO_x$ with increasing excess air. An average increase of 3.34 ng/J for each 1% change in excess air was observed over the normal operating range.

2. Unit loading and variation in furnace slag conditions were found to have the least effect on $NO_x$ and CO emission levels and the percent carbon in the fly ash.

3. Under normal unit operation, the percent carbon loss in the fly ash and CO emission levels increased with decreasing excess air with the increases becoming greater below a level of approximately 20 to 25 percent excess air. CO levels in excess of 23.9 ng/J were considered unacceptable for the purposes of this program.

### OVERFIRE AIR OPERATION

1. $NO_x$ reductions of 20 to 30% were obtained with 15 to 20 percent overfire air when operating at a total unit excess air of approximately 15 percent as measured at the economizer outlet. This condition would provide an <u>average</u> fuel firing zone stoichiometry of 95 to 100 percent of theoretical air. Stoichiometries below this level did not result in large enough decreases in $NO_x$ levels to justify their use. Biased firing, while potentially as effective, necessitates a reduction in unit loading and is therefore less desirable as a method of $NO_x$ control.

2. When using overfire air as a means of decreasing the theoretical air (TA)* to the fuel firing zone the percent carbon in the fly ash and CO emission levels were less affected than when operating with low excess air. This is due to the ability to maintain acceptable total excess air levels during overfire air operation.

3. Furnace performance as indicated by waterwall slag accumulations, visual observations and absorption rates were not significantly affected by overfire air operation.

4. On the test unit, where the overfire air port could not be installed as a windbox extension, test results indicated that the centerline of the overfire air port should be kept within 3 meters of the centerline of the top fuel elevation. Distances greater than 3 meters did not result in decreased $NO_x$ levels. Changes in distance less than 3 meters did affect $NO_x$ levels to

* See Appendix D.

a limited extent with the $NO_x$ level increasing with decreasing distance.

5. Optimum overfire air operation was obtained with the test unit when the overfire air nozzles were tilted with the fuel nozzles. From a standpoint of $NO_x$ control, emission levels increased when the nozzles were directed toward each other, and flame stability decreased when they were directed away from each other by more than 20-25°. With the overfire air tilts fixed in a horizontal position, acceptable unit operation was obtained, however, $NO_x$ levels varied with fuel nozzle position.

6. The results of the 30 day baseline, biased firing and overfire air corrosion coupon runs indicate that the overfire air operation for low $NO_x$ optimization did not result in significant increases in corrosion coupon degradation. Additional studies will be required to verify these observations over long-term operation.

7. Variables normally used to control normal boiler operation should not be considered as $NO_x$ controls with coal firing. These variables include unit load, nozzle tilt, pulverizer fineness, windbox dampers and total excess air.

8. Overall unit efficiency was not significantly affected by overfire air operation.

## OBJECTIVES

The objective of program Phase II was to complete the design of the overfire air system, modify the Barry #2 unit accordingly, perform baseline, biased firing and optimization tests and based on the results of this program, prepare an application guideline for the $NO_x$ control technology generated.

Specifically these objectives are defined as follows:

TASK I

Prepare the design, detailed fabrication and erection drawings necessary for modification of Barry No. 2 to incorporate an overfire air system. The system design provides for:

a. Introducing a maximum of 20% of the total combustion air above the fuel admission nozzles.

b. Overfire air introduction through the top two existing windbox compartments (thereby prohibiting the use of one elevation of fuel nozzles).

c. Introduction of hot overfire air only with consideration for air preheat control.

An updated schedule for Tasks II and IV were also prepared under Task I.

TASK II

Complete the purchasing and fabrication of all equipment necessary for modification of the Barry No. 2 unit.

TASK III

Install all necessary instrumentation required to measure flue gas constituents and characterize the effects of combustion modifications on unit performance. Specifically the following determinations were made:

a. Flue gas constituents: $NO_x$, $SO_x$, CO, HC, $O_2$

b. Unit Performance Effects:

Fireside Corrosion
Furnace Heat Absorption
Sensible Heat Leaving Furnace
Superheater, Reheater and Air Heater Performance

TASK IV

Conduct a baseline test program to establish the effect of unit load, wall slagging and excess air variation on baseline emission levels, thermal performance and operating ranges. A baseline corrosion coupon test of 30 day duration was also conducted.

TASK V

Conduct a biased firing baseline test program to establish the effect on unit emission levels while operating with various fuel elevations out of service. These tests were performed specifically to evaluate the maximum emission control at full load and throughout the normal load range. In addition, the degree of control required to meet and maintain emission standards throughout the normal control range was also evaluated. A biased firing corrosion coupon test of 30 days duration was also conducted.

TASK VI

Install all equipment required for modification of the test unit and functionally check equipment to determine that proper operation is obtained. (See Figure 67).

TASK VII

Complete final preparations for conducting the overfire air test program to be conducted in Task VIII including the following:

a. Finish installation of the furnace waterwall thermocouples.

b. Check out all necessary test instrumentation for proper installation and operation.

c. Review test program with EPA project officer and utility company.*

d. Perform a final inspection of the test unit to assure proper operation.

TASK VIII

Conduct the overfire air test program, analyze the data generated and compare this data with that obtained during Task V. The program investigated the effect of overfire air location and rate at various unit loadings and evaluated operating conditions considered as optimum from the standpoint of $NO_x$ control and unit operation. The final report was also generated under this Task.

TASK IX

Prepare a program outlining the application of the technology developed under this study to existing and new design tangentially coal fired utility boilers. These application guidelines will be submitted as a separate final report.

* The test program for this study was originated during the Phase I study, Contract 68-02-0264 and was included as part of the Phase I report.

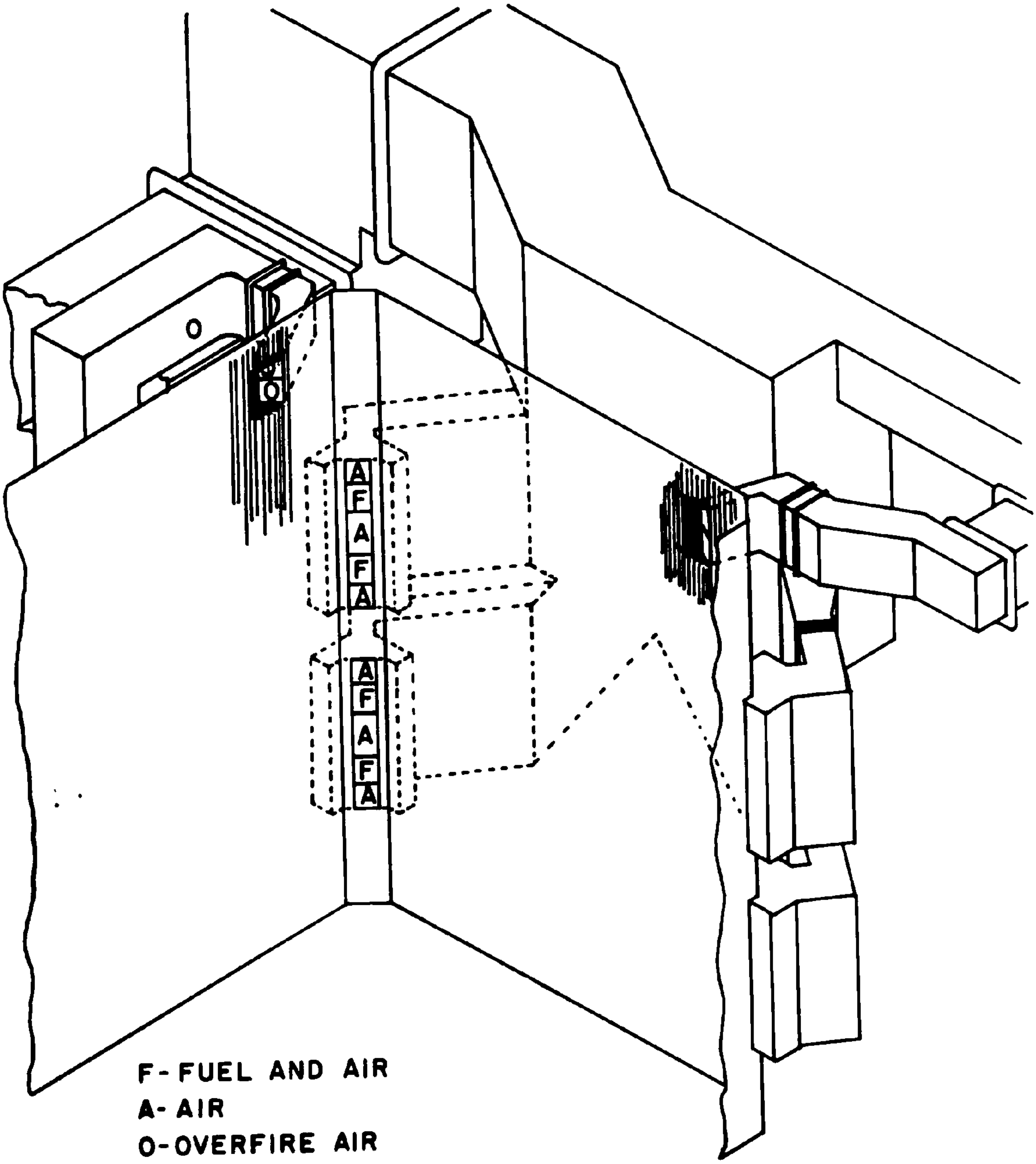


Figure 67. Schematic overfire air system, Barry Station No. 2

## DISCUSSION

Tasks 1, 2 and 3 were completed essentially as stated in the program Phase II Objectives.

### TASK IV & V - BASELINE AND BIASED FIRING TEST PROGRAMS

#### Test Data Acquisition and Analysis

The flue gas samples for determination of $NO_x$, $O_2$, CO, $SO_2$ and HC emission levels were obtained at each of the two economizer outlet ducts. The emissions monitoring system is shown in Figure 68.

The flue gas samples were drawn from a twenty-four (24) point grid arranged on centroids of equal area in each duct with the exception of the $SO_2$ sample which was drawn from a single average point using a heated sample line. Fly ash samples for carbon loss analysis and dust loading were obtained at a single point in each duct.

The percent $O_2$ leaving the air preheaters was also determined using a twenty-four (24) point grid arranged in centroids of equal area for the determination of air preheater leakage and unit efficiency.

The following instrumentation was used in determining the emission concentrations:

1. $NO_x$: Chemiluminescence Analyzer
2. $O_2$ : Paramagnetic Analyzer
3. CO : Nondispersive Infrared Analyzer
4. HC : Flame Ionization Analyzer
5. $SO_2$: Wet Chemistry
6. Carbon Loss & Dust Loading: ASME Particulate Sampling Train

A summary of the $NO_x$ emission test data is tabulated on Data Sheets C1, C2, C3, C4 and C5.

Unit steam and gas side performance was monitored using calibrated thermocouples, pressure gauges, transducers and manometers as required.

Coal samples were obtained during each test for later analysis. The samples were obtained from each feeder and blended to form a composite sample. Fuel analyses, unit steam flow rates, absorption rates, gas and air weights and

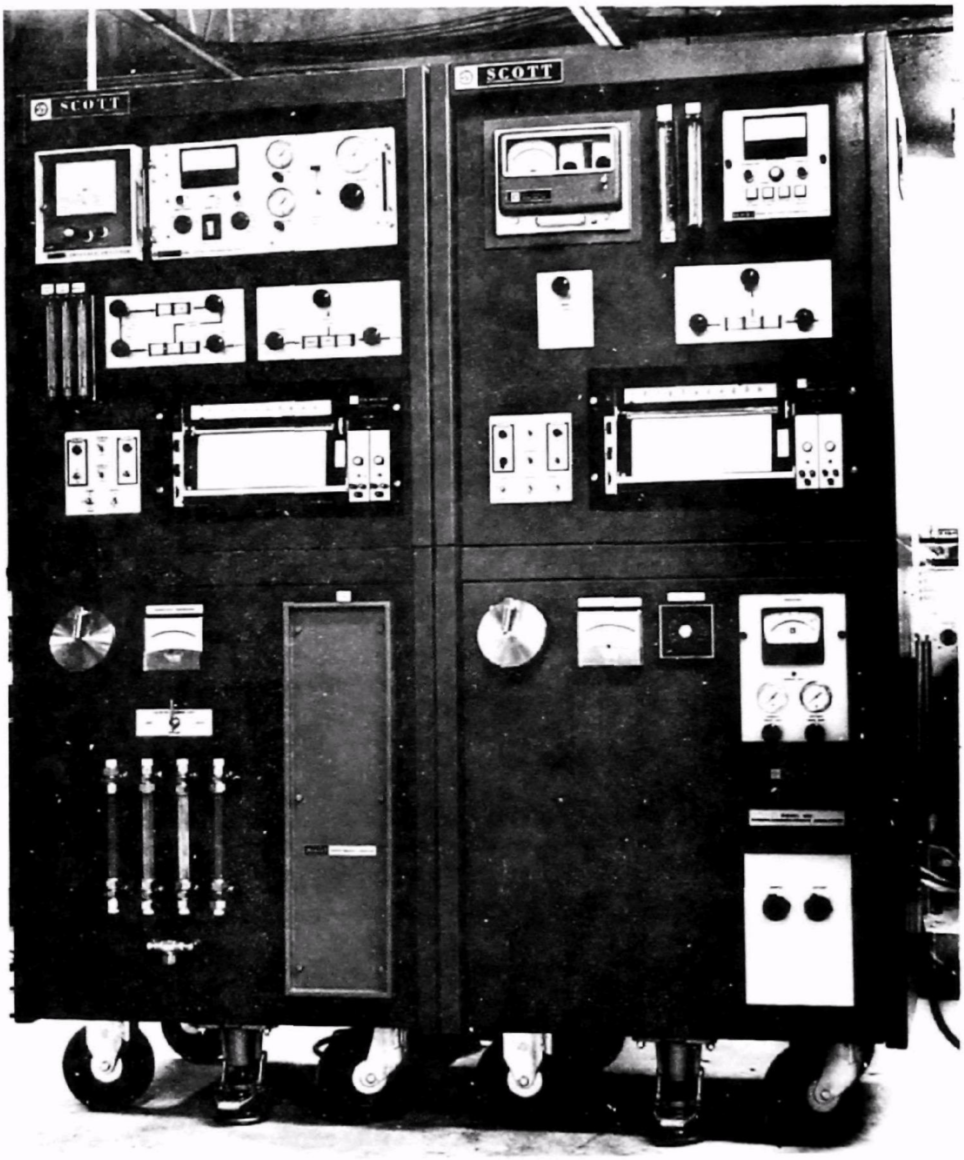


Figure 68. Gaseous emissions test system

efficiencies were calculated for each test run. Unit efficiency was determined using the heat losses method (based on ASME Power Test Code 4.1-1964). The 30 day waterwall corrosion coupon evaluation was conducted using a specially designed probe consisting of four individual coupons. Individual probes were exposed at five locations on the front furnace wall as shown on Figure 69. A typical trace of the control temperature range for each of the twenty coupons is shown on Figure 70. The control temperature ranges were the same for the baseline, biased firing and overfire air studies.

TASK IV - BASELINE TEST STUDY

Load and Excess Air Variation

Tests 1 through 7 were conducted to determine the effect of varying excess air at three unit loads on unit emission levels and performance. These tests were conducted with clean furnace conditions.

As shown in the following table, $NO_x$ emission levels increased with increased excess air but did not change significantly with changes in unit loading. An average increase of 3.34 ng/J was noted for each 1% change in excess air over the normal unit operating range.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Eff. % | WW Slag |
|---|---|---|---|---|---|---|---|
| 1 | 61 | 319.3 | 7.5 | 35.5 | 130.6 | 88.3 | Clean |
| 2 | 62 | 246.0 | 43.5 | 17.5 | 117.1 | 88.2 | Clean |
| 3 | 59 | 362.8 | 2.5 | 58.9 | 151.3 | 87.6 | Clean |
| 4 | 88 | 215.0 | 11.9 | 12.6 | 109.2 | 89.3 | Clean |
| 5 | 112 | 248.6 | 9.5 | 22.7 | 117.9 | 89.0 | Clean |
| 6 | 113 | 181.8 | 47.3 | 11.7 | 107.2 | 89.1 | Clean |
| 7 | 112 | 335.1 | 10.1 | 30.8 | 125.3 | 89.5 | Clean |

A maximum excess air limit of 30.8 and 58.9 percent was obtained at full and half load conditions respectively due to ID fan capacities.

Minimum excess air limits of 20 to 25 percent were determined as those at which acceptable CO emission levels could be maintained. Reduction of $NO_2$ emission levels using excess air reduction was therefore limited to approximately 248.6 ng/J as obtained during Test 5.

The changes in $NO_2$, CO, percent carbon loss in the fly ash and unit efficiency versus theoretical air to the fuel firing zone are shown on Figures 71, 72, 73 and 74, respectively. The theoretical air (TA) to the firing zone is used in this case as it accounts for variations in position and leakage in the compartment dampers above the top active fuel compartment and thereby presents a more accurate determination of the actual air available for combustion in the fuel firing zone than does the total excess air. As seen on Figure 71 for clean furnace conditions the $NO_2$ correlates well with TA with little variation due to unit load. As shown on Figures 72 and 73 carbon loss in the fly ash and CO emission levels increased with decreased TA levels. Unit load does not appear to have a discernable effect. Figure 74 is a plot of unit efficiency versus

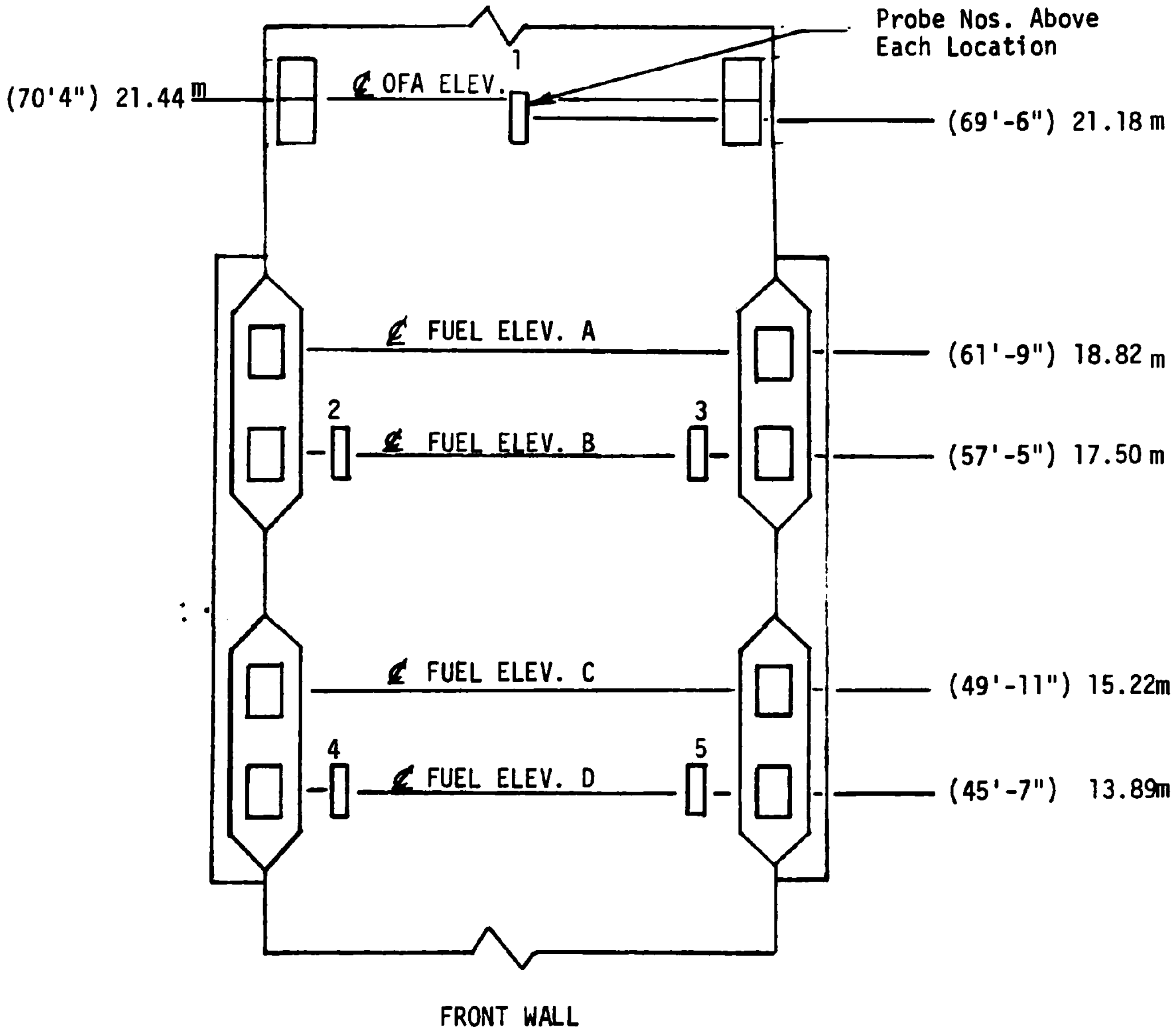


Figure 69. Waterwall corrosion probe locations, Alabama Power Company Barry Station No. 2

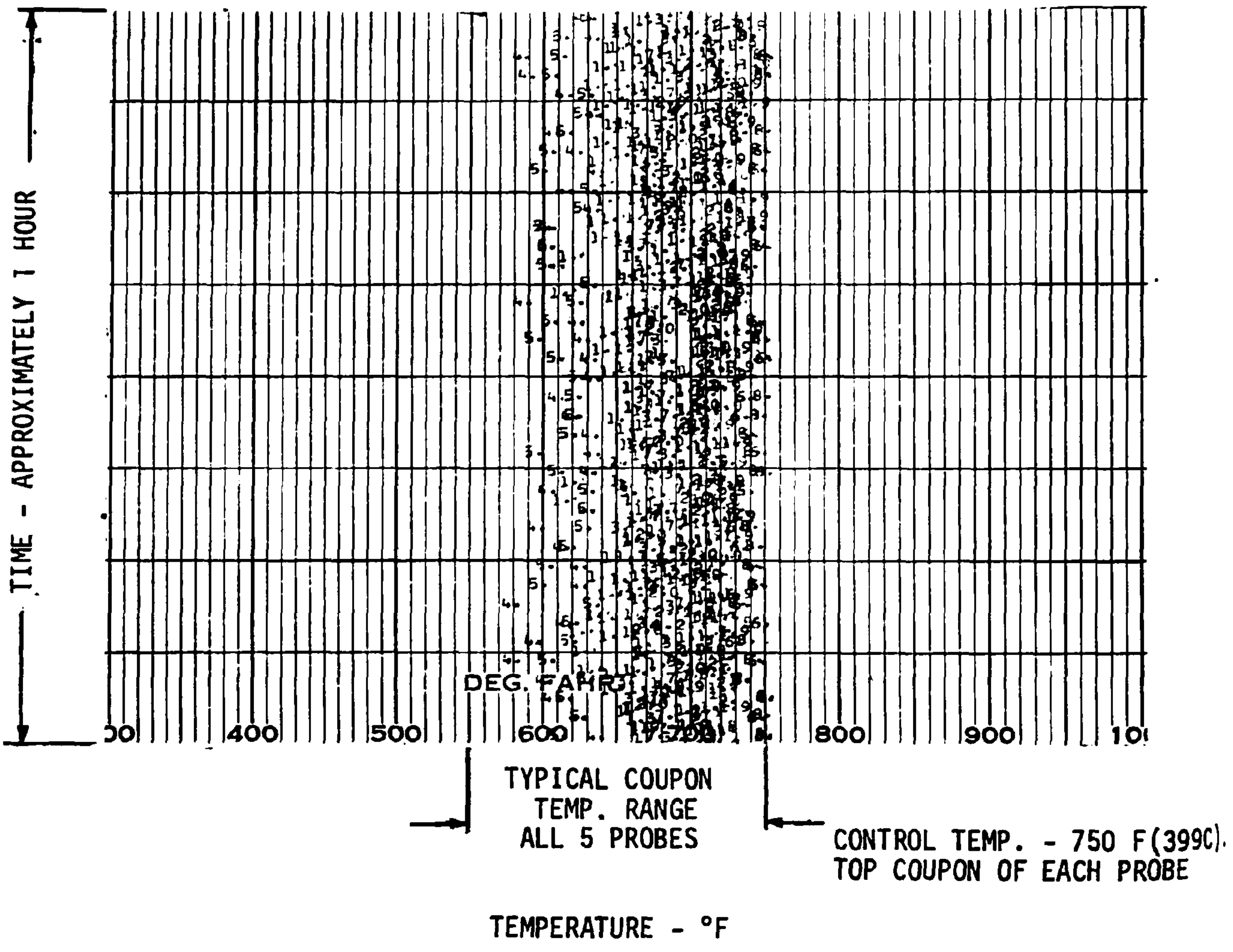


Figure 70: Typical corrosion probe temperature range, Barry Station No. 2

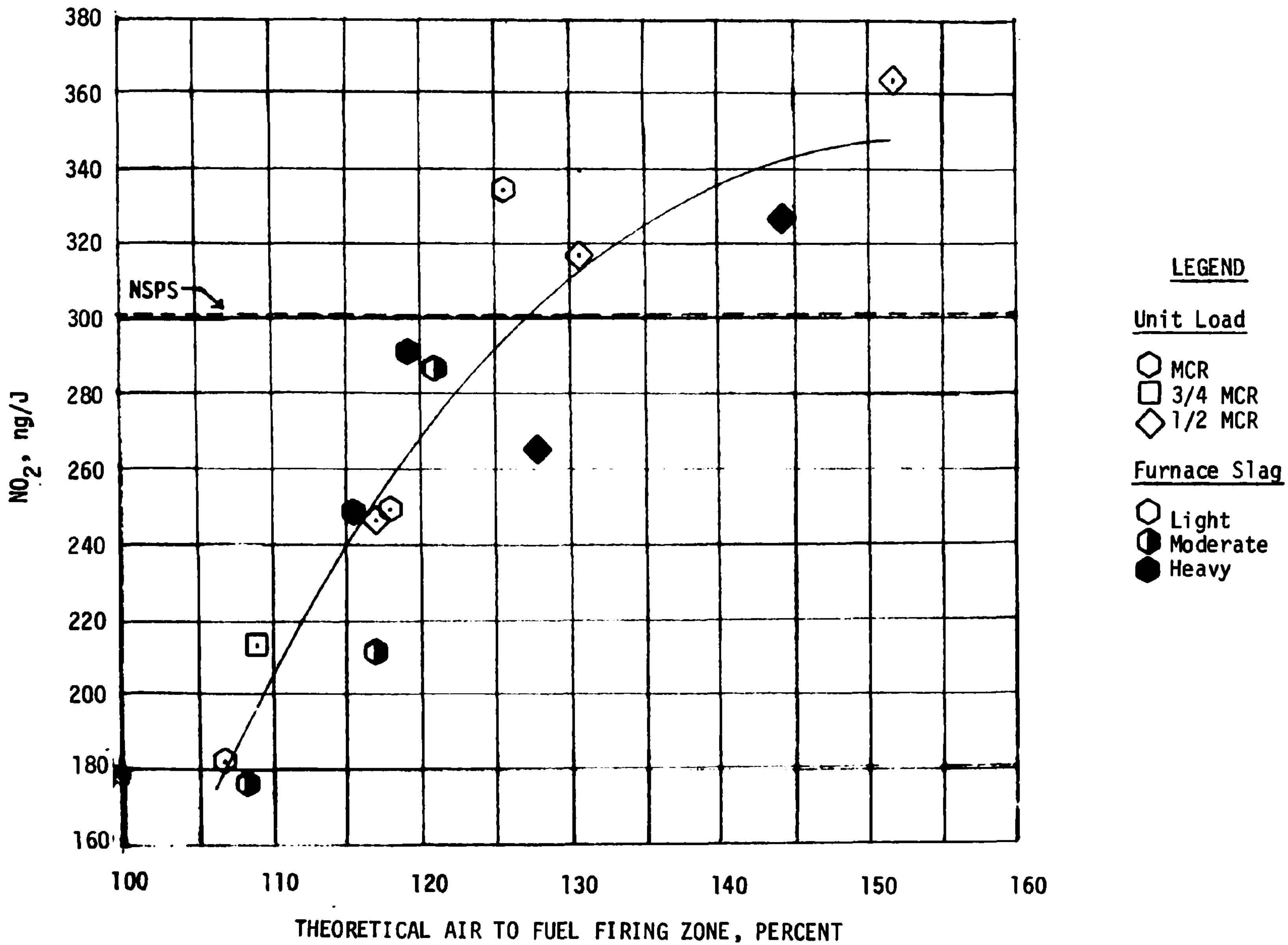


Figure 71: $NO_2$ vs. theoretical air to fuel firing zone, baseline study, Tests 1-14

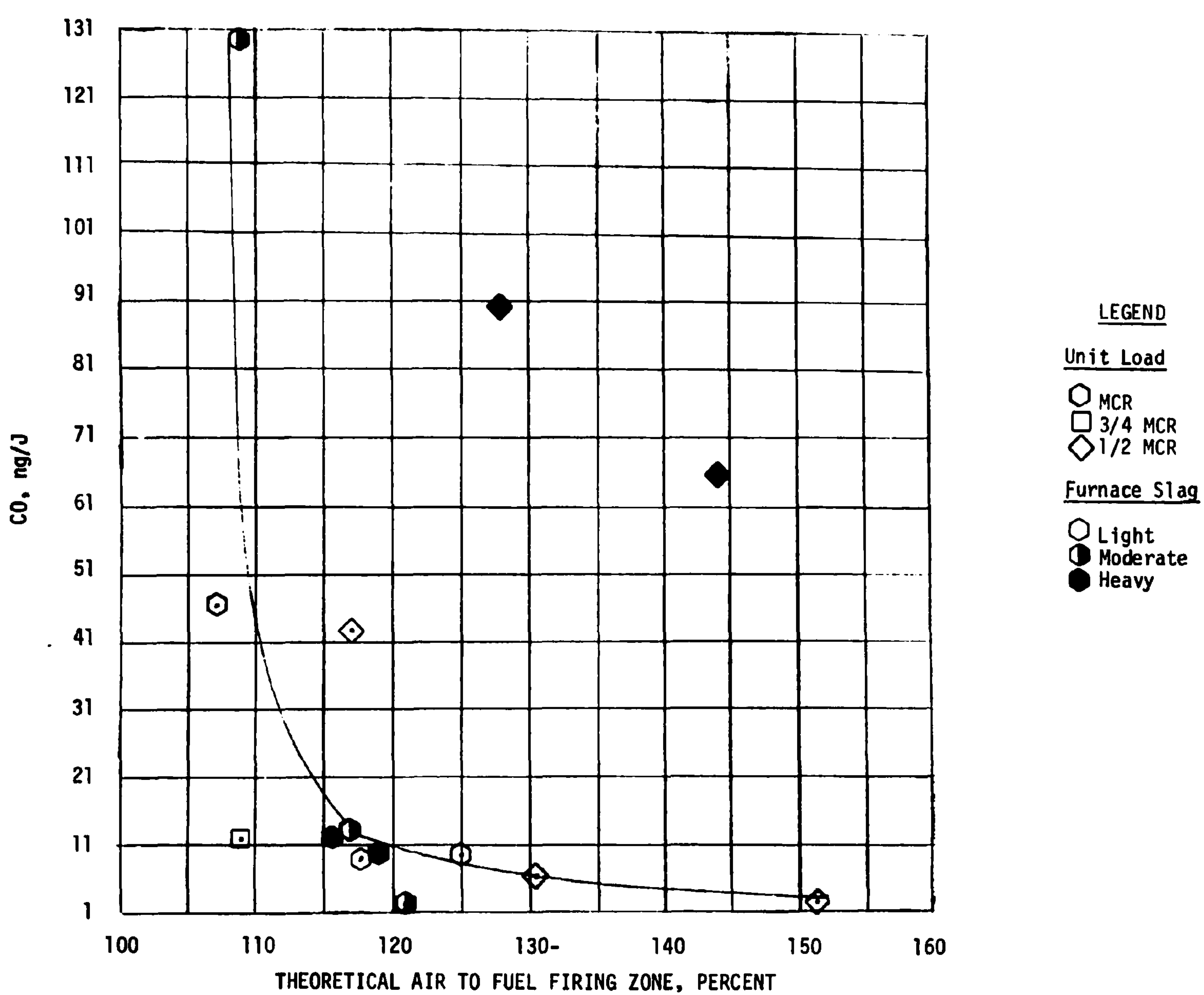


Figure 72: CO vs. theoretical air to fuel firing zone, baseline study, Tests 1-14

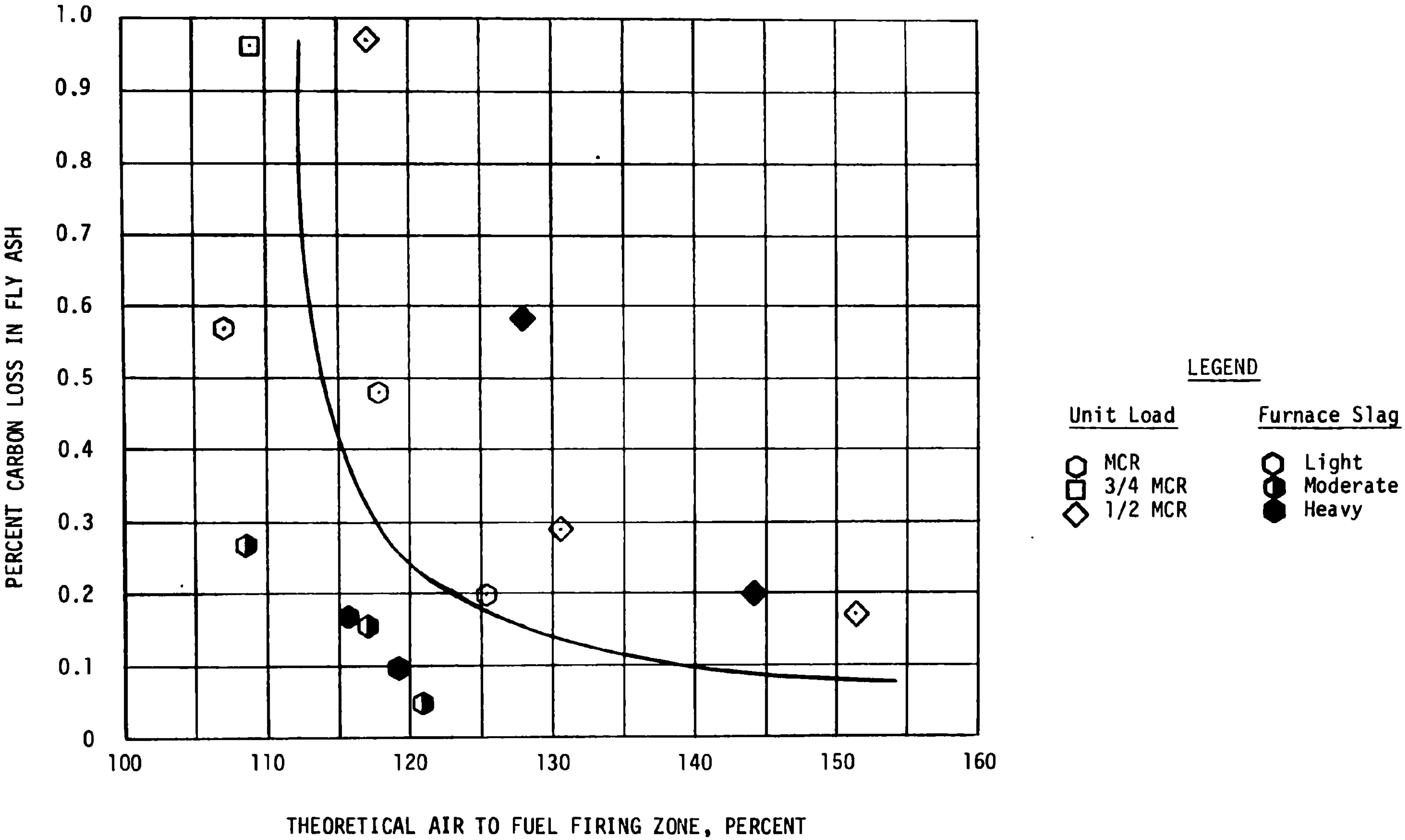


Figure 73: Percent carbon loss vs. theoretical air to fuel firing zone, baseline study, Tests 1-14

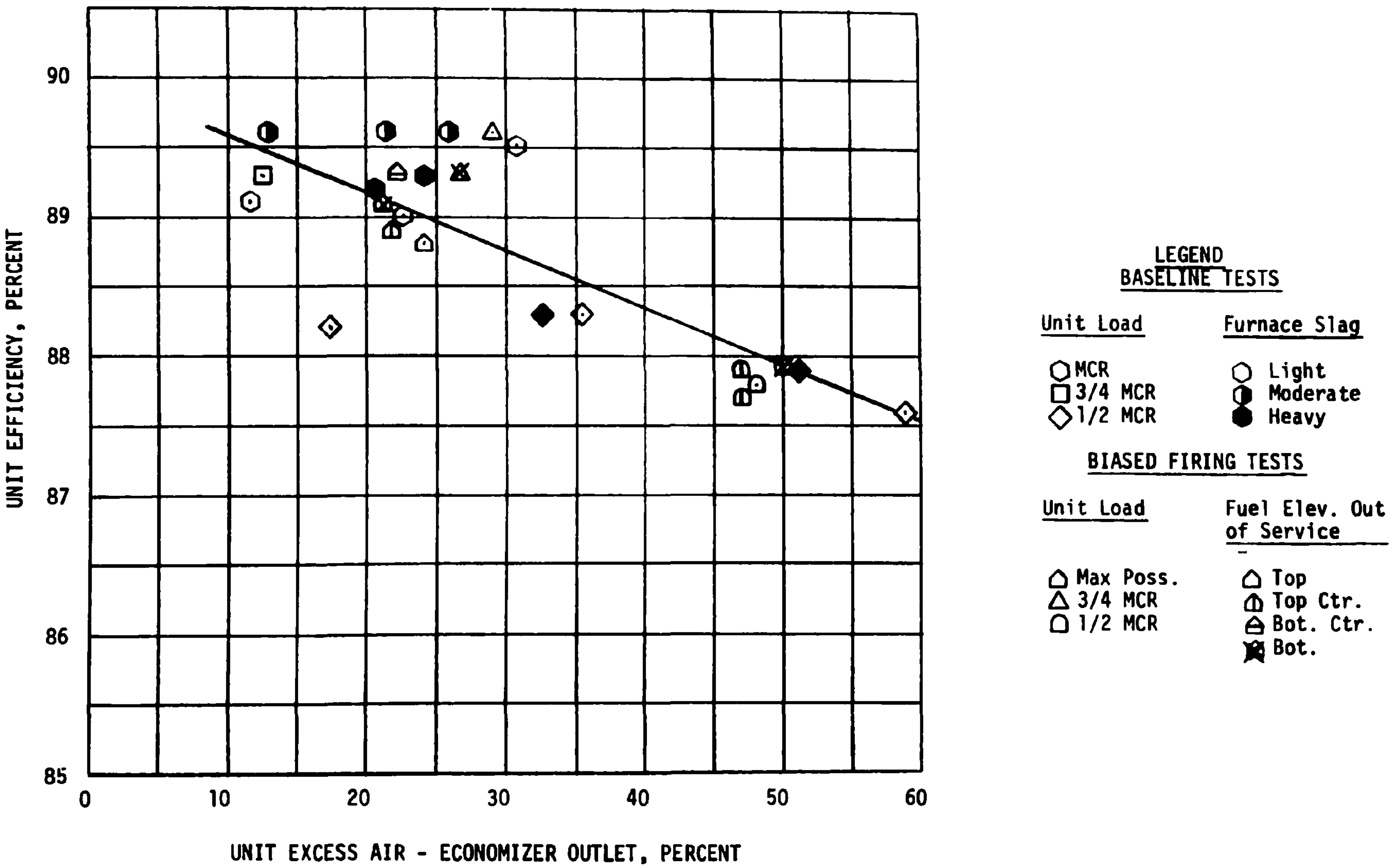


Figure 74: Unit efficiency vs. unit excess air

unit excess air measured at the economizer outlet.

During this portion of the test program total hydrocarbon levels (HC) were monitored and were found to be present in only trace quantities as shown on Data Sheets C1 and C2. The $SO_2$ levels measured are also shown on Data Sheets C1 and C2.

Furnace Wall Deposit Variation

Tests 8 through 14 were conducted to determine the effect on unit performance and emission levels of varying furnace waterwall deposits from a clean condition to the maximum possible slagging condition obtainable. The maximum slagging condition was obtained after operation in excess of twenty-four hours without operating any wall blowers. During this time period slag deposits of up to 102 mm in thickness could be obtained in and above the fuel firing zone.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Eff. % | WW Slag |
|---|---|---|---|---|---|---|---|
| 8 | 114 | 213.5 | 14.1 | 21.5 | 116.9 | 89.6 | 1/2 Max Dep |
| 9 | 112 | 178.7 | 130.2 | 13.0 | 108.5 | 89.6 | 1/2 Max Dep |
| 10 | 112 | 286.1 | 1.6 | 26.0 | 120.8 | 89.6 | 1/2 Max Dep |
| 11 | 59 | 267.0 | 90.3 | 32.7 | 128.0 | 88.3 | Max Dep |
| 12 | 57 | 327.2 | 66.9 | 51.2 | 144.1 | 87.9 | Max Dep |
| 13 | 114 | 247.7 | 12.4 | 20.7 | 115.7 | 89.2 | Max Dep |
| 14 | 113 | 292.6 | 10.3 | 24.3 | 119.2 | 89.3 | Max Dep |

As can be seen from Figure 71, furnace slagging did not exhibit a discernable effect on $NO_x$ emission levels. As shown in Figures 72 and 73, this condition was also found to be true for carbon loss in the fly ash and CO emission levels with the exception of the half load Tests 11 and 12 where CO levels higher than those obtained with clean furnace conditions were observed. The high CO levels may have been due to slag buildup at or near the fuel and air nozzles which could have contributed to poor combustion. The higher CO levels were not observed under full load with heavy slag operation. Figure 74 indicates that furnace cleanliness did not exhibit any discernable effect on unit efficiency.

Slag patterns taken during clean, moderate and heavy slagging conditions at full load operation are shown on Figures 75, 76 and 77.

TASK V - BIASED FIRING STUDY

Fuel Elevations Out of Service Variation

Tests 15 through 24 were conducted to determine the effect on $NO_x$ emission levels of taking various fuel elevations out of service (biased firing) at various unit loadings. As shown on the following table the maximum $NO_x$ emissions control was obtained with the top elevation of fuel nozzles out of service at maximum and 75 percent maximum loading (Tests 20 and 21). At 50 percent maximum loading (Test 23) the high excess air levels required to maintain unit steam temperatures appeared to negate any $NO_x$ reductions obtained by biasing the top

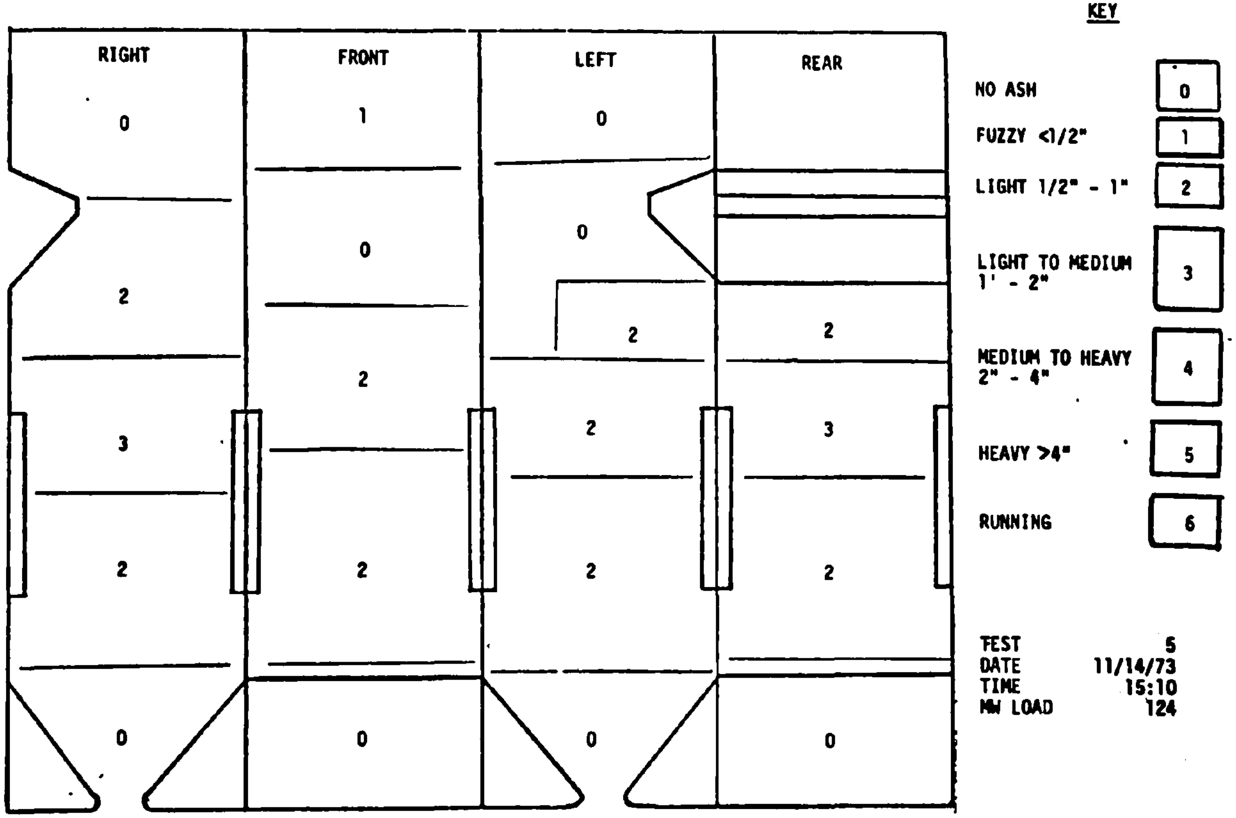


Figure 75: Furnace slag pattern, clean furnace

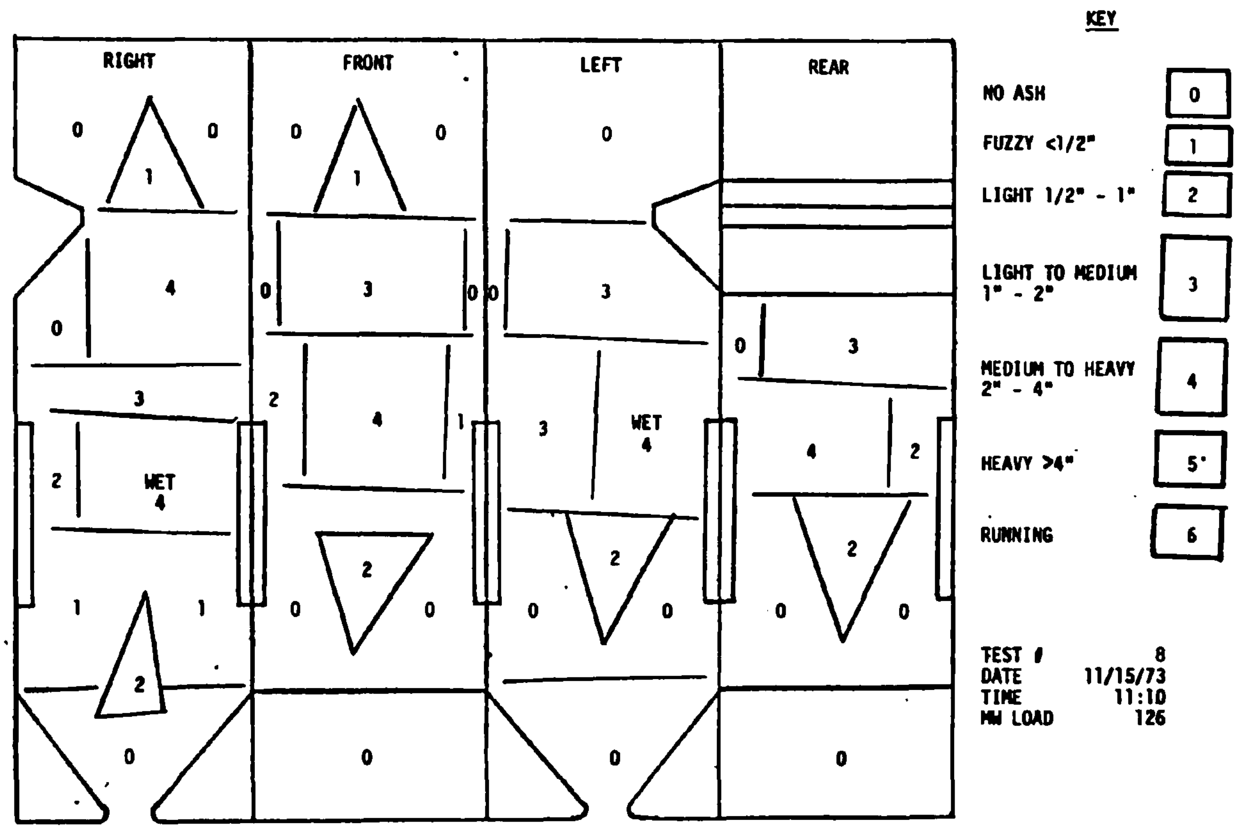


Figure 76: Furnace slag pattern, moderate slag furnace

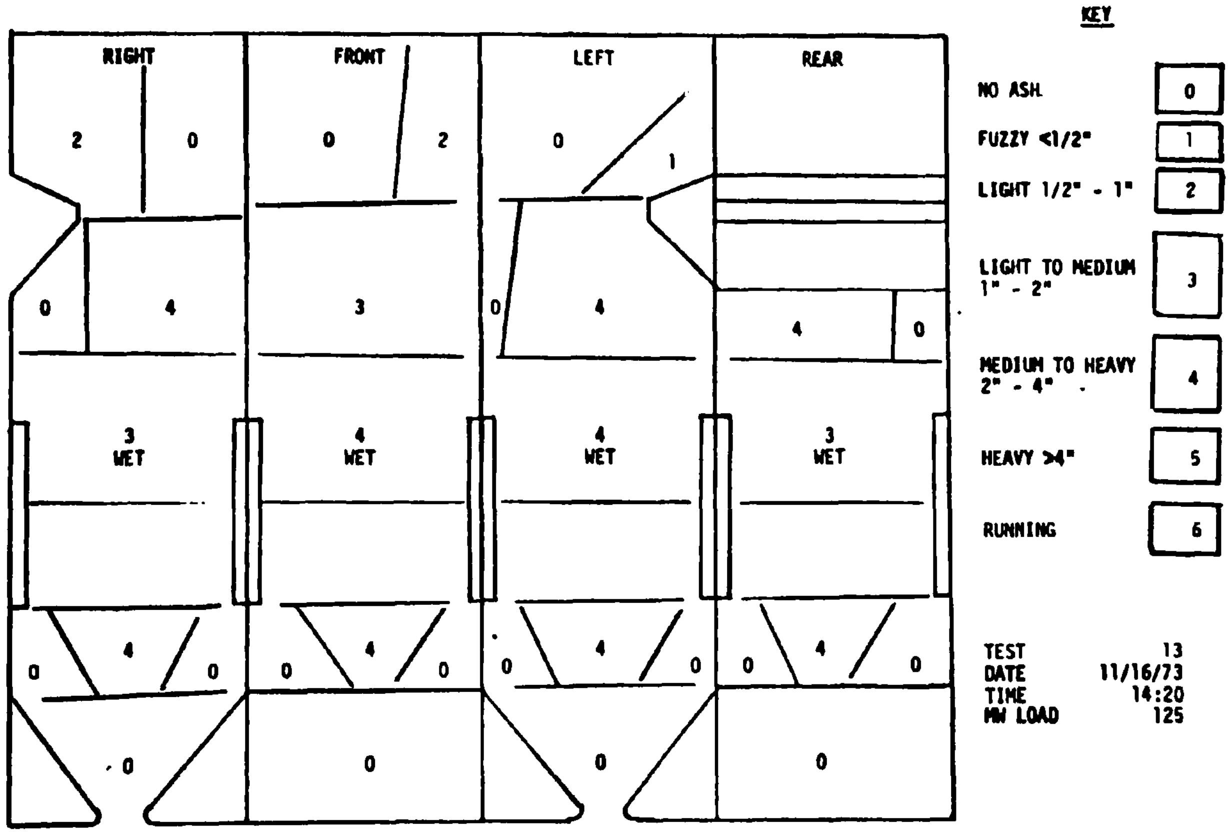


Figure 77: Furnace slag pattern, heavy slag furnace

fuel nozzle elevation, however, the emissions level obtained was below the current EPA limit for coal fired units of 301 ng/J.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Eff. % | Fuel Nozzle Elevation Out of Service |
|---|---|---|---|---|---|---|---|
| 15 | 55 | 288.0 | 9.8 | 50.1 | 105.8 | 87.9 | Bottom |
| 16 | 82 | 272.8 | 8.9 | 26.7 | 121.7 | 89.3 | Bottom |
| 17 | 87 | 200.6 | 14.0 | 21.1 | 116.5 | 89.1 | Bottom |
| 18 | 89 | 189.2 | 11.9 | 22.2 | 117.5 | 89.3 | Bottom Center |
| 19 | 89 | 189.9 | 10.6 | 21.8 | 117.2 | 88.9 | Top Center |
| 20 | 87 | 143.1 | 8.1 | 24.2 | 94.7 | 88.8 | Top |
| 21 | 86 | 166.2 | 9.5 | 29.0 | 97.3 | 89.6 | Top |
| 22 | 58 | 268.5 | 9.1 | 48.0 | 112.5 | 87.8 | Top |
| 23 | 59 | 249.1 | 7.0 | 47.0 | 141.4 | 87.9 | Top Center |
| 24 | 56 | 306.2 | 8.4 | 47.0 | 141.3 | 87.7 | Bottom Center |

As can be seen from Figure 78, biasing the center two and bottom fuel elevations did not have a discernable effect on $NO_x$ emission levels although the emission level tended to be higher at reduced unit loadings for given TA levels.

Figures 79 and 80 indicate that with biased firing, low TA levels to the fuel firing zone were obtained without increasing either CO emission levels or the carbon loss in the fly ash. Figure 74 shows that biased firing operation did not significantly affect unit efficiency. This condition is due to the ability to maintain acceptable total unit excess air levels during biased firing operation.

TASK VIII - UNIT OPTIMIZATION STUDY

Load and Excess Air Variation (After Modification)

Tests 1 through 7 were performed with unit conditions closely approximating those of Baseline Tests 1-7 under Program Task IV. A clean furnace was maintained as the excess air was varied at three unit loads.

The effect of these operating conditions emission levels and performance can be seen in the Table below.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | WW Slag |
|---|---|---|---|---|---|---|---|
| 1 | 61 | 221.9 | 8.4 | 33.5 | 127.1 | 88.4 | Clean |
| 2 | 59 | 167.4 | 114.4 | 16.0 | 113.4 | 88.8 | Clean |
| 3 | 60 | 319.8 | 10.6 | 64.7 | 155.4 | 87.4 | Clean |
| 4 | 87 | 162.4 | 33.4 | 15.5 | 111.0 | 89.8 | Clean |
| 5 | 125 | 202.1 | 8.0 | 21.0 | 115.3 | 89.4 | Clean |
| 6 | 122 | 165.3 | 38.8 | 12.4 | 107.1 | 89.2 | Clean |
| 7 | 117 | 238.8 | 6.6 | 25.4 | 119.5 | 89.5 | Clean |

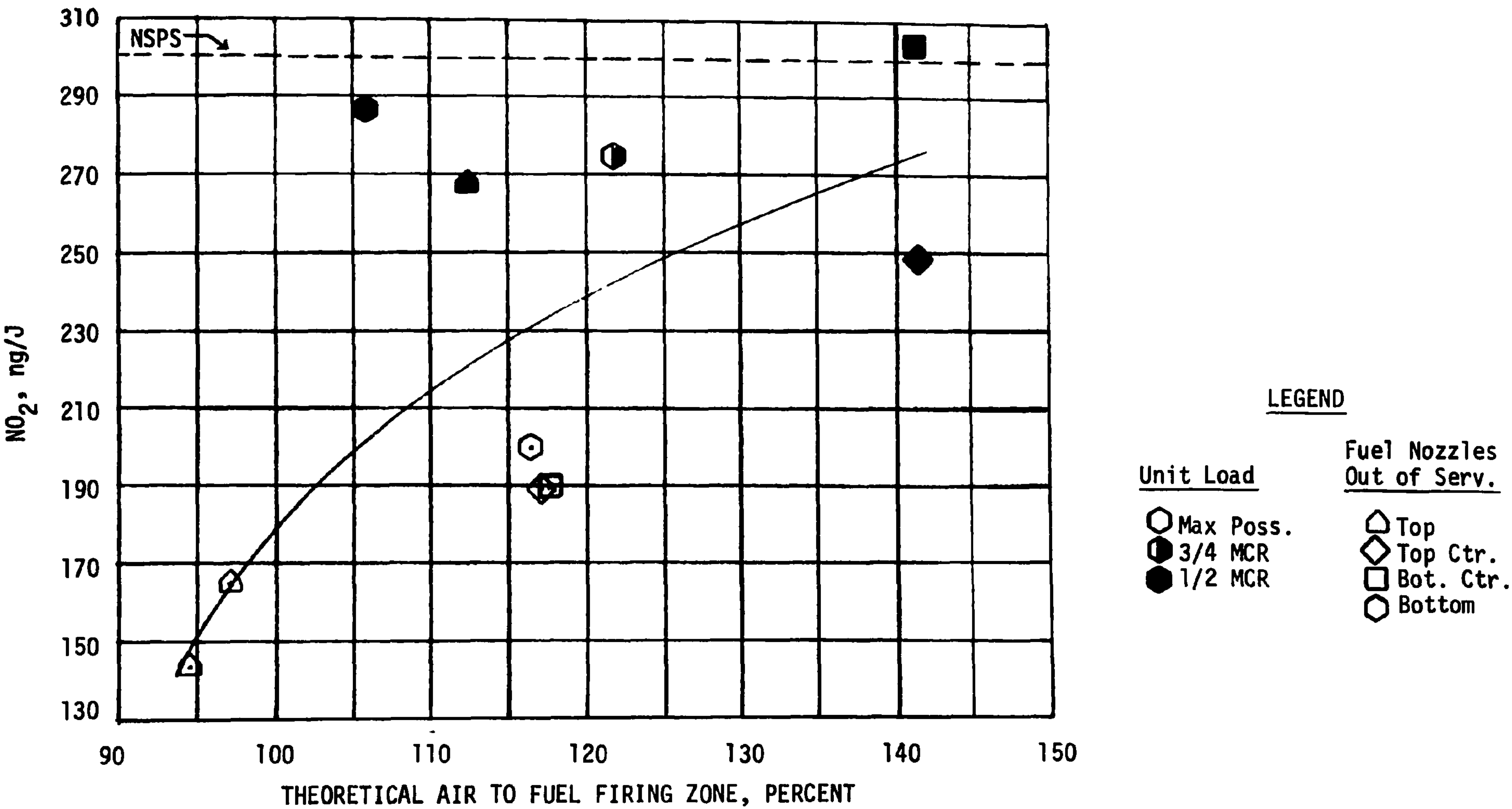


Figure 78: $NO_2$ vs. theoretical air to fuel firing zone, biased firing study, Tests 15-24

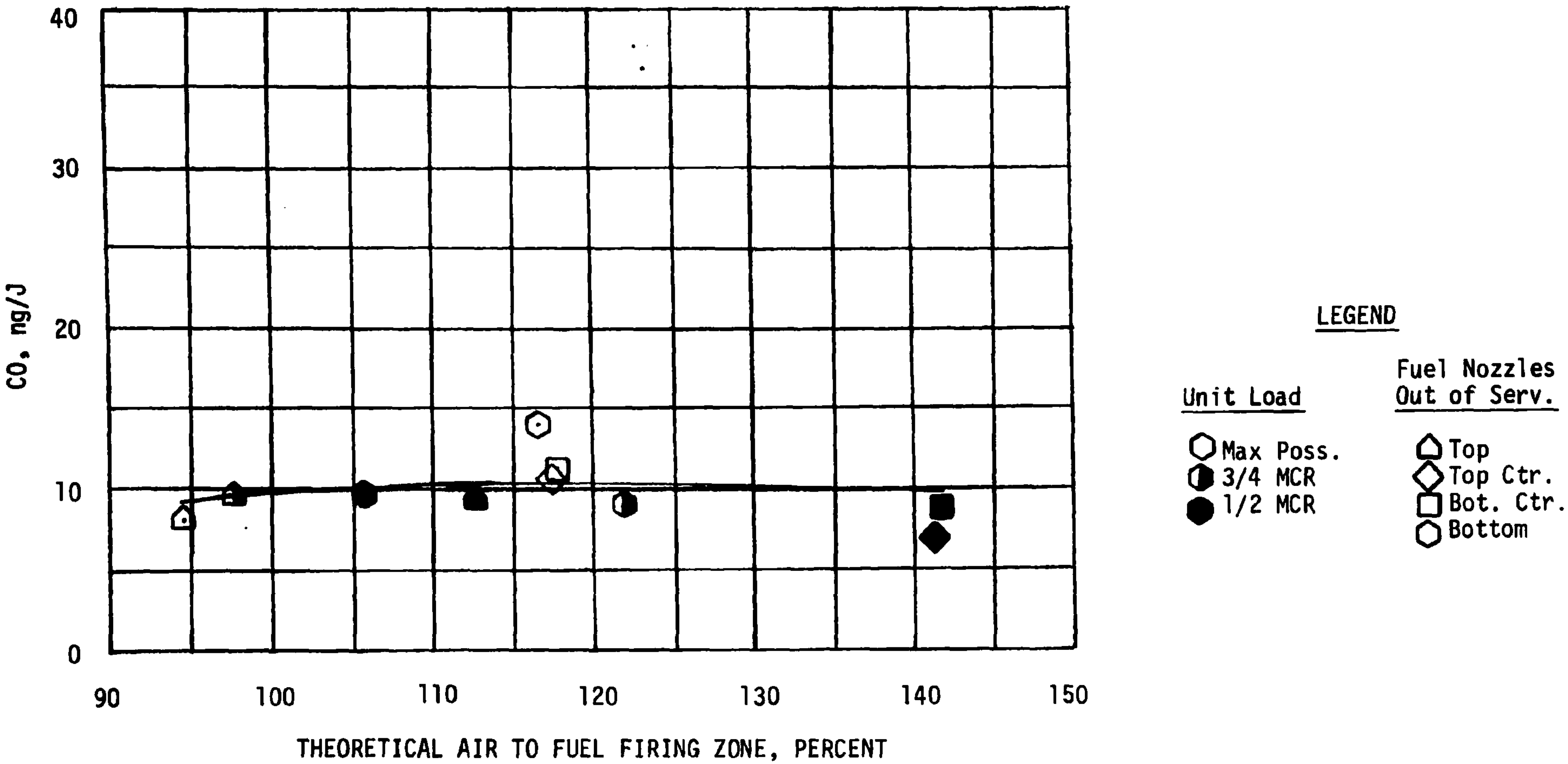


Figure 79: CO vs. theoretical air to fuel firing zone, biased firing study, Tests 15-24

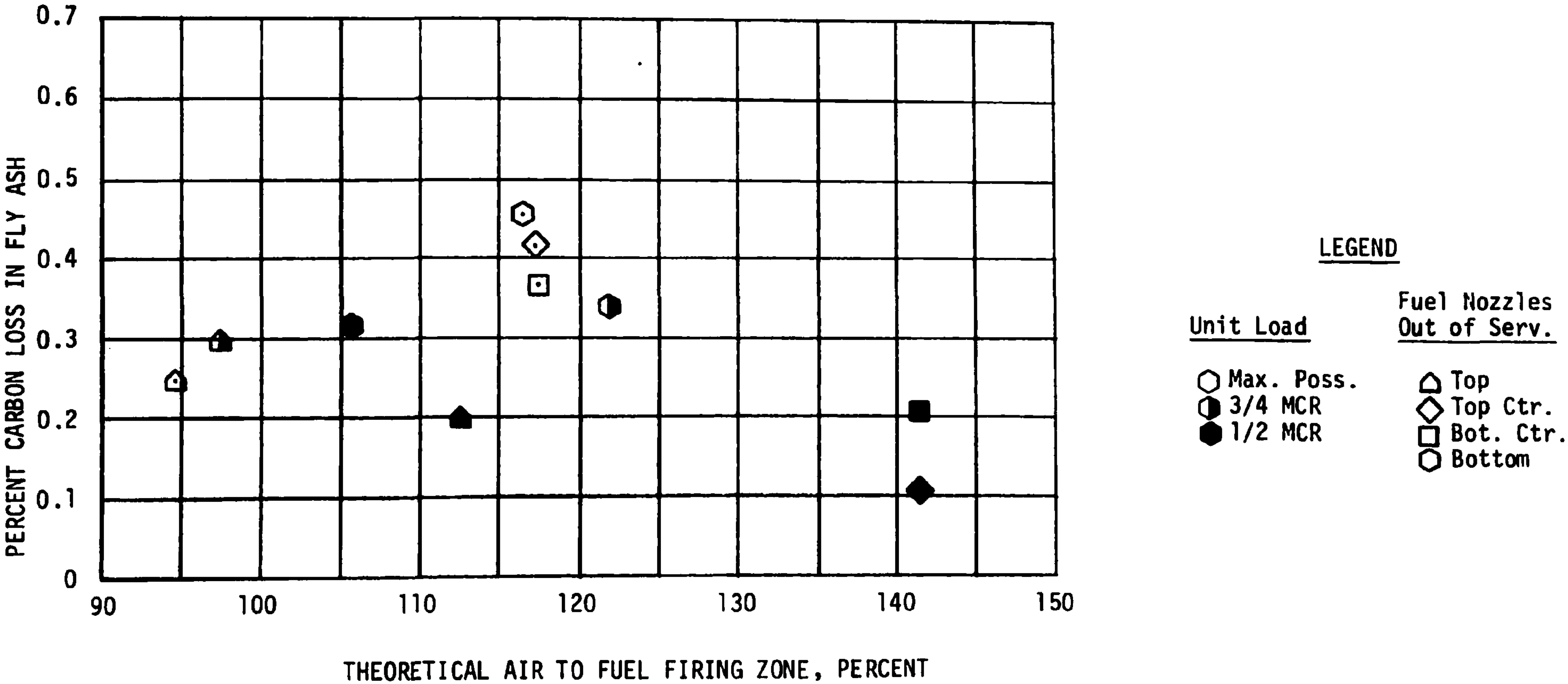


Figure 80: Percent carbon loss vs. theoretical air to fuel firing zone, biased firing study, Tests 15-24

As witnessed in the previous baseline tests, $NO_x$ emission levels increased with increased excess air.*

ID fan capacities limited excess air to a maximum of 64.7 and 33.5 percent at half and full load conditions respectively. Acceptable minimum excess air limits were established at 20-25 percent to control CO emission levels. Thus, $NO_x$ emission levels could only be reduced to approximately 215 ng/J through excess air reduction. The effect of theoretical air to the firing zone on $NO_x$, CO, and percent carbon loss in the fly ash (% CL) can be seen in Figures 81, 82 and 83. Consistent with the original baseline tests, theoretical air to the firing zone (TA) was used for comparison in place of total excess air (EA). TA is determined by location and means of admission as well as quantity, and consequently better defines that air actually available for initial combustion.

Figure 81 indicates a definite increase in $NO_x$ emission levels with increasing TA for clean furnace conditions. CO emission levels and percent carbon loss in the fly ash can be seen to increase with decreased TA without overfire air. Reasonable control of CO and % CL can only be maintained at TA levels above 120%. No definite relationship can be observed between unit load and CO emission levels. Percent CL can be seen to be greater at higher unit loads for given TA levels.

Changes in steam generator efficiency versus excess air at the economizer outlet are presented in Figure 84. Overall, unit efficiency decreases as the excess air increases.

Hydrocarbon emission levels appeared only in trace quantities for this portion of the test program. HC and $SO_2$ levels are presented on Data Sheet C3.

Furnace Wall Deposit Variation (After Modification)

The effect of furnace waterwall deposits on unit performance and emission levels was studied in Tests 8 through 14 (Clean Condition - Maximum Slagging Conditions). The results are shown in the table below. Dirty conditions were established after a minimum of 24 hours of not operating the wall blowers. Deposits of up to 102 millimeters in thickness could subsequently be found in and above the fuel firing zone.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | WW Slag |
|---|---|---|---|---|---|---|---|
| 8 | 122 | 235.3 | 7.4 | 17.8 | 112.3 | 89.0 | 1/2 Max |
| 9 | 124 | 166.9 | 9.6 | 12.1 | 106.9 | 88.9 | 1/2 Max |
| 10 | 119 | 215.4 | 9.2 | 26.6 | 120.5 | 89.5 | 1/2 Max |

* In general, $NO_2$ values were slightly lower after modification for the same test conditions. This resulted from an upgraded firing system installed between the sets of tests along with an average percent nitrogen in fuel decrease of 0.15 percent (1.21 to 1.06 percent). Also, fuel higher heating values and furnace outlet temperatures tended to be lower for Tests 1-7 after modification.

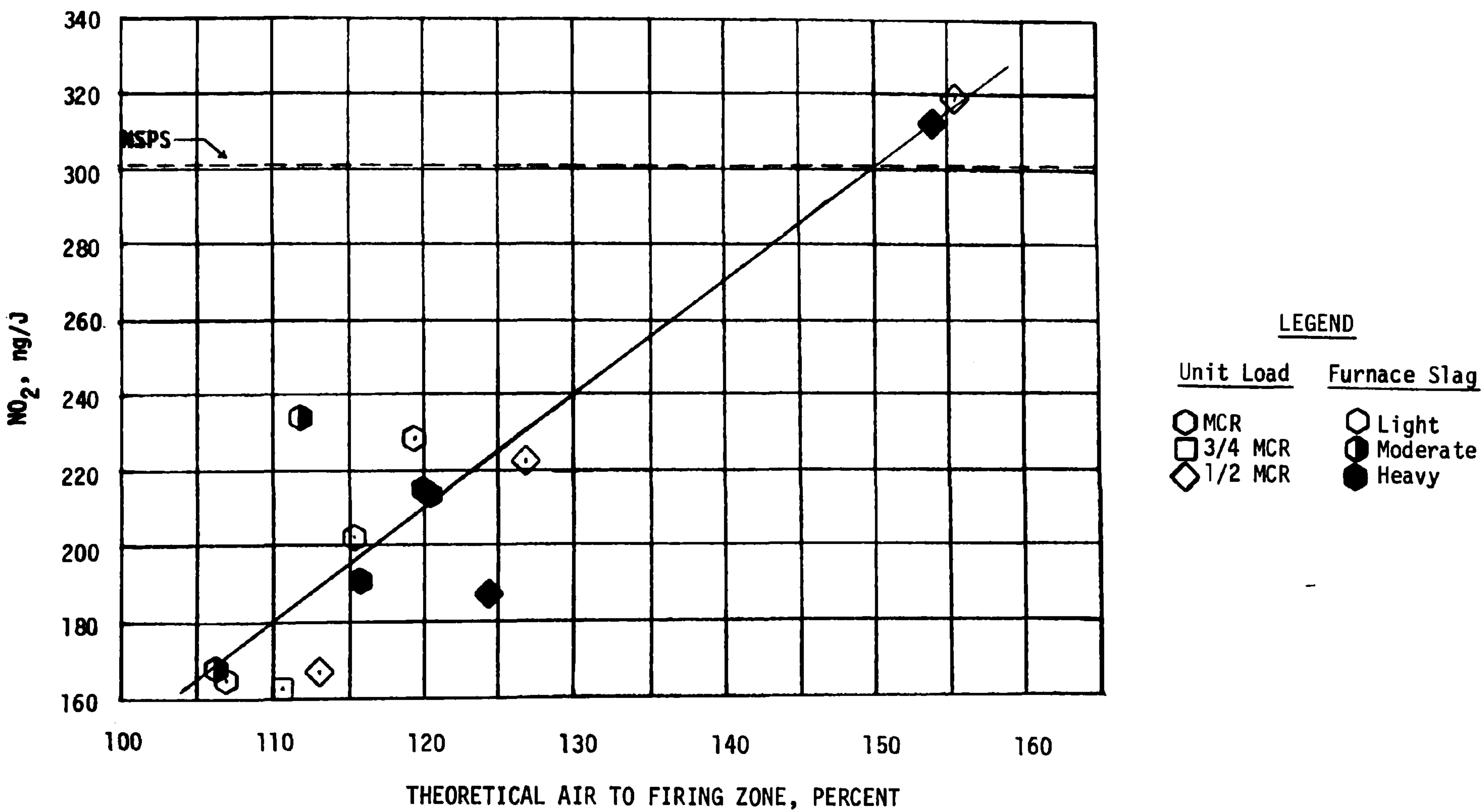


Figure 81: $NO_2$ vs. theoretical air to firing zone, overfire air study, load and excess air variation, Tests 1-14

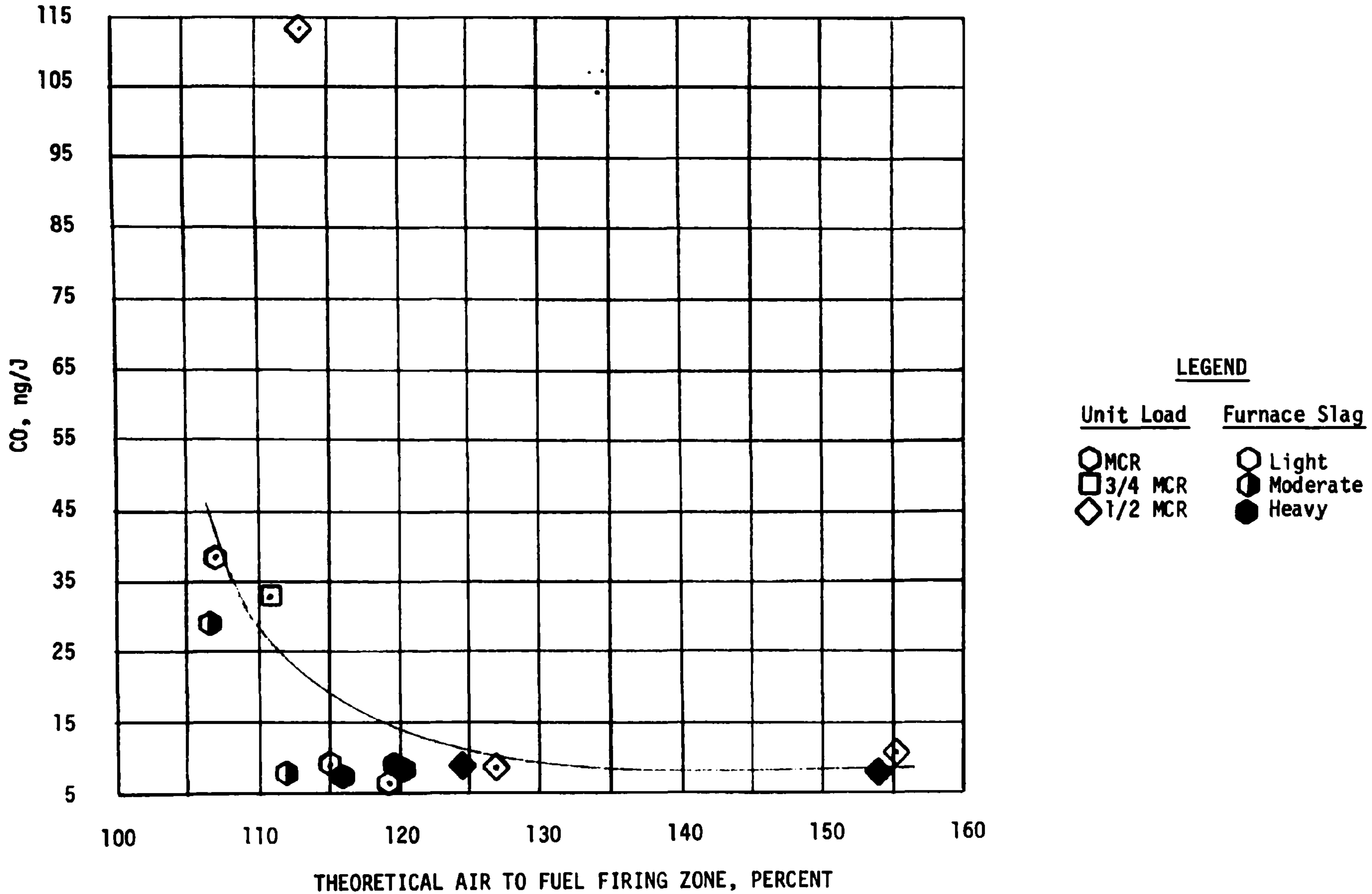


Figure 82: CO vs. theoretical air to firing zone, overfire air study, load and excess air variation, Tests 1-14

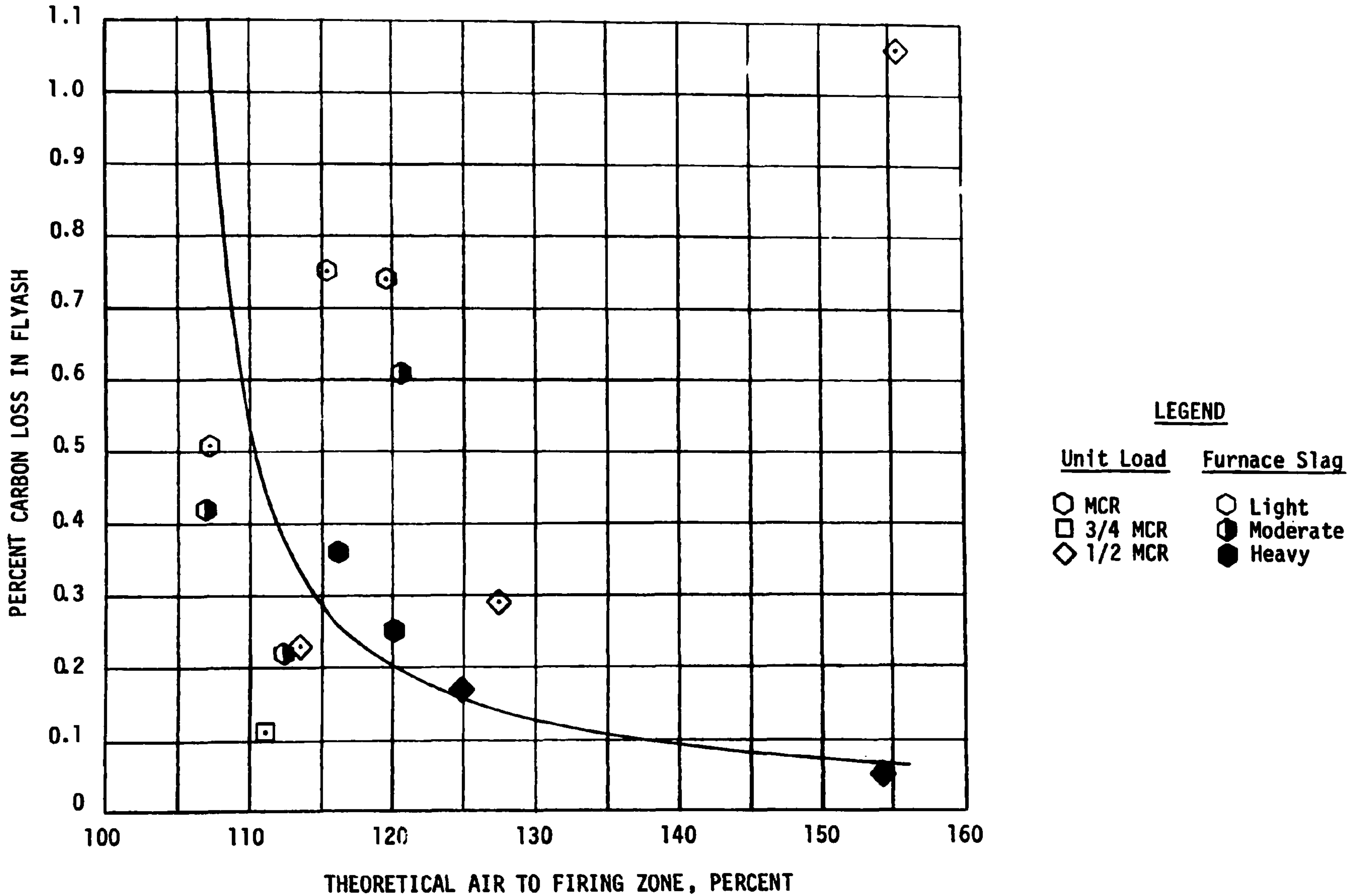


Figure 83: Percent carbon loss vs. theoretical air to firing zone, overfire air study load and excess air variation, Tests 1-14

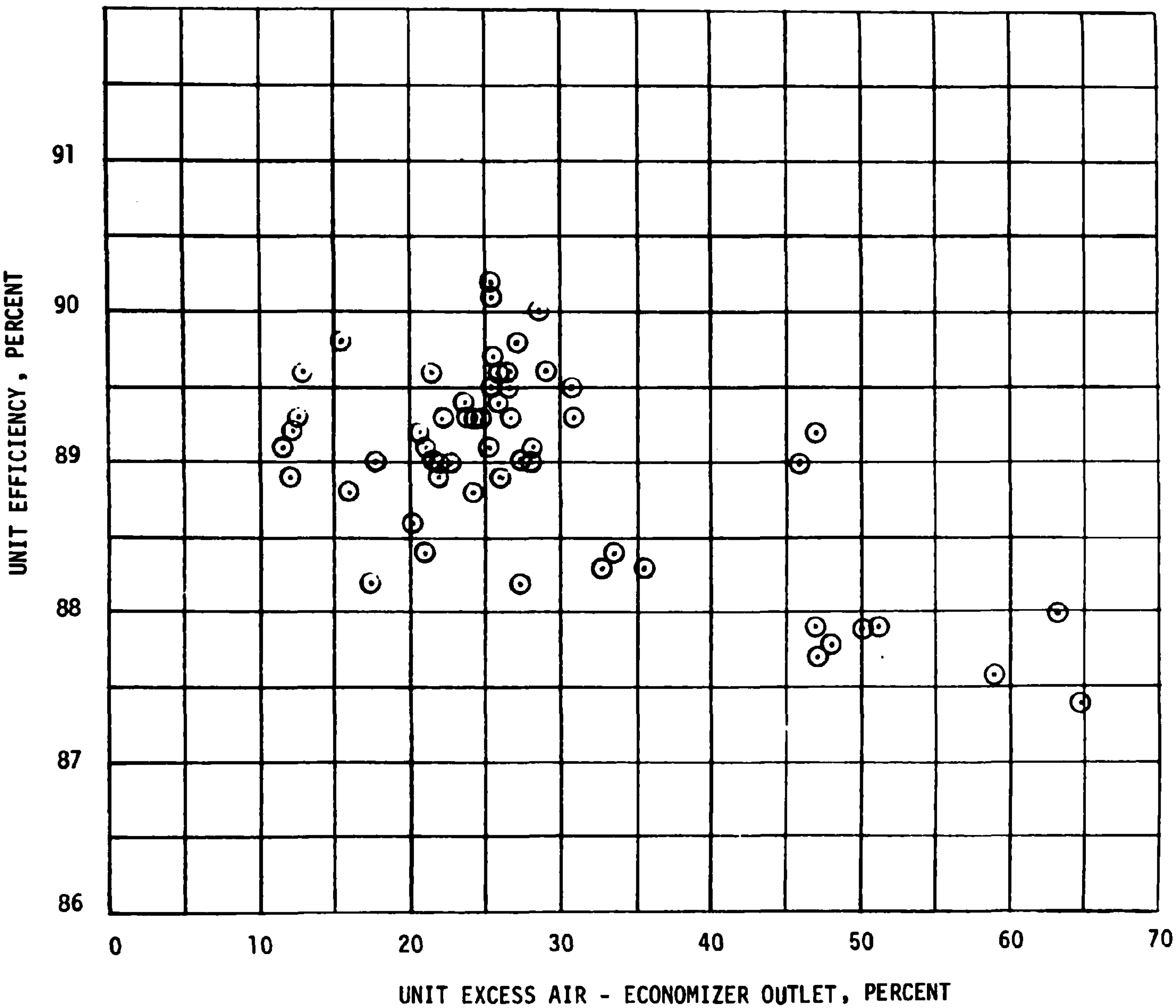


Figure 84: Unit efficiency vs. excess air - economizer outlet, all tests (before & after modification)

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | WW Slag |
|---|---|---|---|---|---|---|---|
| 11 | 68 | 186.8 | 8.0 | 30.9 | 124.6 | 89.3 | Max |
| 12 | 61 | 312.9 | 7.3 | 63.1 | 154.0 | 88.0 | Max |
| 13 | 120 | 195.6 | 7.1 | 22.0 | 116.2 | 89.0 | Max |
| 14 | 118 | 215.4 | 7.0 | 25.9 | 119.9 | 89.4 | Max |

Figures 81, 82 and 83 reveal no observable effect of furnace cleanliness on $NO_x$ or CO emission levels along with percent carbon loss in the fly ash. Again, $NO_x$ values were generally slightly lower after modification. Nitrogen in fuel decreased an average of 0.19 percent from 1.23 percent. Furnace outlet temperatures were somewhat lower for Tests 8 through 14 after modification although fuel higher heating values showed no definite change.

Slag patterns taken during full load operation for clean, moderate and heavy slagging furnace conditions are shown in Figures 85, 86 and 87.

This set of tests also confirms the results found in Tests 1 through 7, i.e., $NO_x$ emission levels increase with increased excess air. $NO_x$ cannot be decreased through excess air reductions below 20 percent excess air while maintaining an acceptable CO emission level without overfire air.

OFA Location, Rate and Velocity Variation

Tests 15 through 23 were performed to establish the effect of overfire air admission on $NO_x$ emission levels. The unit load and excess air remained constant for moderately dirty furnace conditions. Location of air admission to the furnace was varied.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | Theo. Air To Firing Zone - % | Unit Eff. % | Mills In Serv. | Adm. Pts.* | Adm. Rate |
|---|---|---|---|---|---|---|---|---|
| 15 | 93 | 178.7 | 8.6 | 114.5 | 90.0 | BCD | 0-1 | 0 |
| 16 | 94 | 127.3 | 9.1 | 96.7 | 89.8 | BCD | 0-1 | Max |
| 17 | 94 | 127.3 | 9.9 | 95.8 | 89.7 | BCD | 0-2 | Max |
| 18 | 96 | 114.4 | 14.6 | 84.8 | 89.6 | BCD | 0-1,0-2 | Max |
| 19 | 94 | 116.1 | 11.9 | 89.3 | 89.3 | BCD | 0-1,0-2 | 1/2 Max |
| 20 | 96 | 161.7 | 8.8 | 100.5 | 90.2 | BCD | 0-3 | Max |
| 21 | 95 | 241.7 | 7.7 | 117.4 | 90.1 | ABC | 0-1 | 0 |
| 22 | 95 | 164.6 | 7.8 | 90.4 | 89.0 | ABC | 0-1,0-2 | Max |
| 23 | 96 | 168.1 | 7.7 | 96.9 | 89.1 | ABC | 0-1,0-2 | 1/2 Max |

* OFA Admission Points:

0-1: Top overfire air compartment
0-2: Bottom overfire air compartment.
0-3: Top fuel elevation out of service.

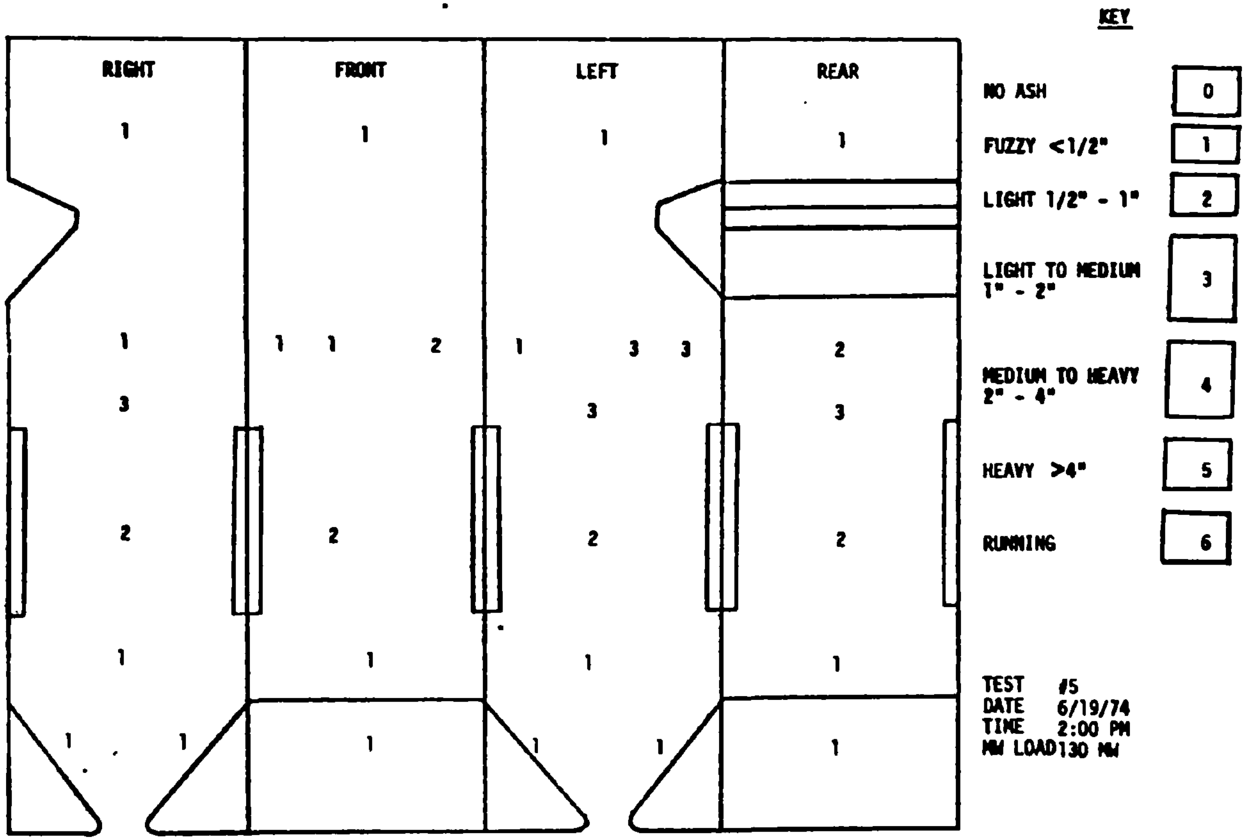


Figure 85: Furnace slag pattern, clean furnace

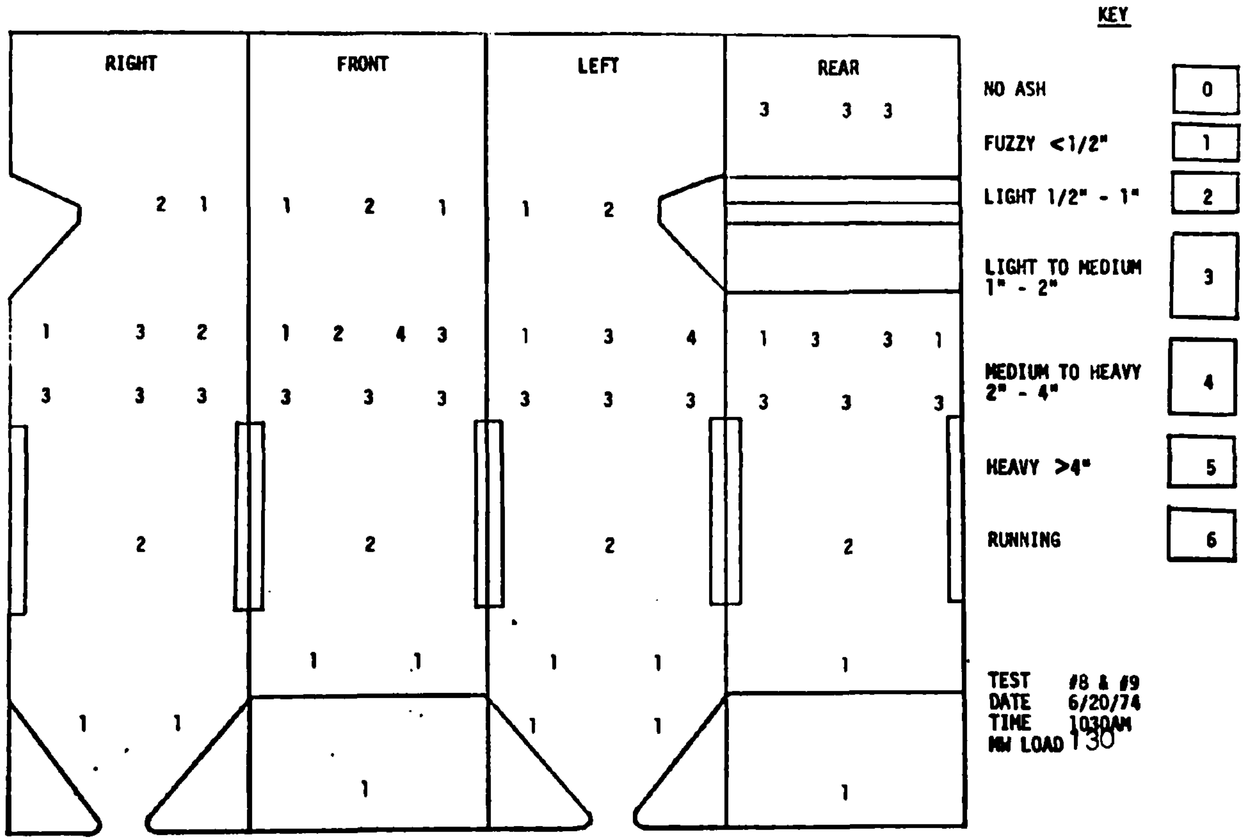


Figure 86: Furnace slag pattern, moderate slag furnace

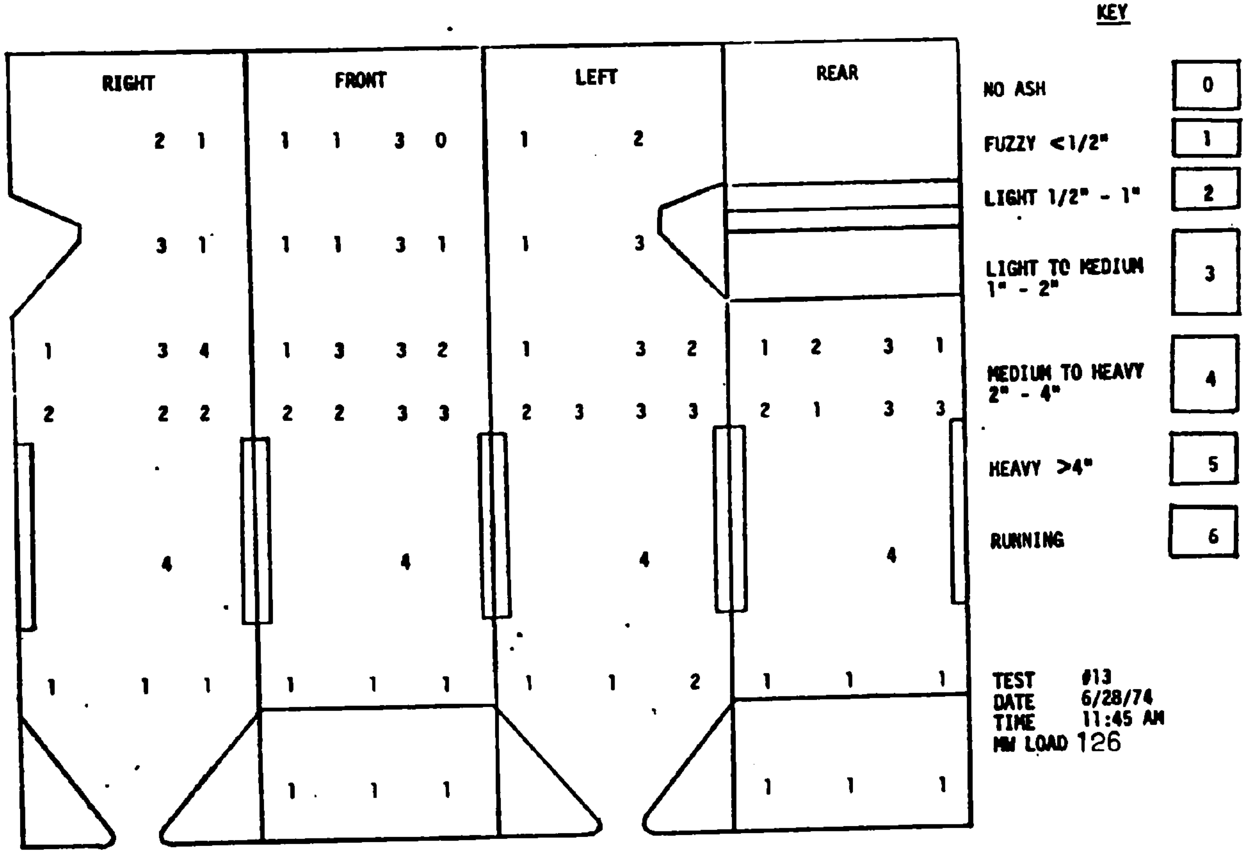


Figure 87: Furnace slag pattern, heavy slag furnace

As shown in Figure 88, this set of tests shows a tendency of $NO_x$ emission levels to decrease with decreased theoretical air to the firing zone. $NO_x$ levels are generally higher with ABC mills (top 3 elevations) in service than with BCD mills (bottom 3 elevations). Both operating conditions support the premise of reducing $NO_x$ emission levels by reducing the air input to the fuel firing zone and admitting the balance of combustion air downstream of that point. The fire is thereby spread out over more of the furnace reducing its intensity. The above factors are limited by flame stability which became very lazy in Test 18. By using the bottom 3 elevations in place of the top 3 elevations, the distance between the overfire air and the firing zone was increased. (The mean firing elevation is also slightly decreased.) Comparison of Tests 18 and 19 with Tests 22 and 23 reveals lower $NO_x$ levels obtained with increased distance between the overfire air and the firing zone. Operation at TA levels below 95% did not result in significant reductions in $NO_x$ emission levels.

CO emission levels remained acceptable for the entire set of tests where the total excess air was approximately 27 percent as shown on Figure 89.

OFA admission location or rate variation exhibited no significant change in percent carbon loss in the fly ash as shown on Figure 90.

Unit efficiencies were not significantly affected by fuel elevations in service, or by overfire air location and rate variation. This is explained by the fact that essentially constant total excess air levels were maintained during this study.

OFA Tilt Variation

Tests 24 through 30, and 33, were conducted at full unit load with excess air and theoretical air levels to the firing zone of approximately 24 percent and 92 percent, respectively. With moderate slagging conditions on the waterwalls the fuel nozzle tilts and OFA tilts were varied. This essentially moves the firing zone both in the furnace and in its relative position to the overfire air. Fuel nozzle tilts that are maximum minus combined with OFA tilts of maximum plus increase the distance between the overfire air and the firing zone. As with previous methods of increasing this distance, the $NO_x$ emission levels are decreased. Figure 91 shows that as the tilts are moved toward one another (fuel nozzle tilts up; OFA tilts down), the OFA-firing zone separation is decreased and the $NO_x$ levels are increased.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | Fuel Nozzle Tilt-° | OFA Tilts-° |
|---|---|---|---|---|---|---|---|---|
| 24 | 113 | 169.6 | 7.7 | 25.9 | 94.2 | 89.6 | -5 | 0 |
| 25 | 116 | 145.4 | 8.3 | 23.7 | 92.4 | 89.3 | -23 | 0 |
| 26 | 114 | 183.9 | 9.7 | 25.1 | 93.2 | 88.9 | +19 | 0 |
| 27 | 113 | 172.2 | 6.7 | 22.3 | 91.5 | 89.3 | -5 | -30 |
| 28 | 115 | 202.1 | 8.6 | 20.2 | 89.6 | 88.6 | +22 | -30 |
| 29 | 116 | 142.3 | 15.0 | 23.7 | 92.6 | 89.4 | -21 | +30 |
| 30 | 116 | 169.6 | 7.9 | 21.6 | 90.7 | 89.0 | -4 | 0 |
| 33 | 114 | 166.5 | 7.5 | 27.4 | 94.6 | 89.0 | -22 | -22 |

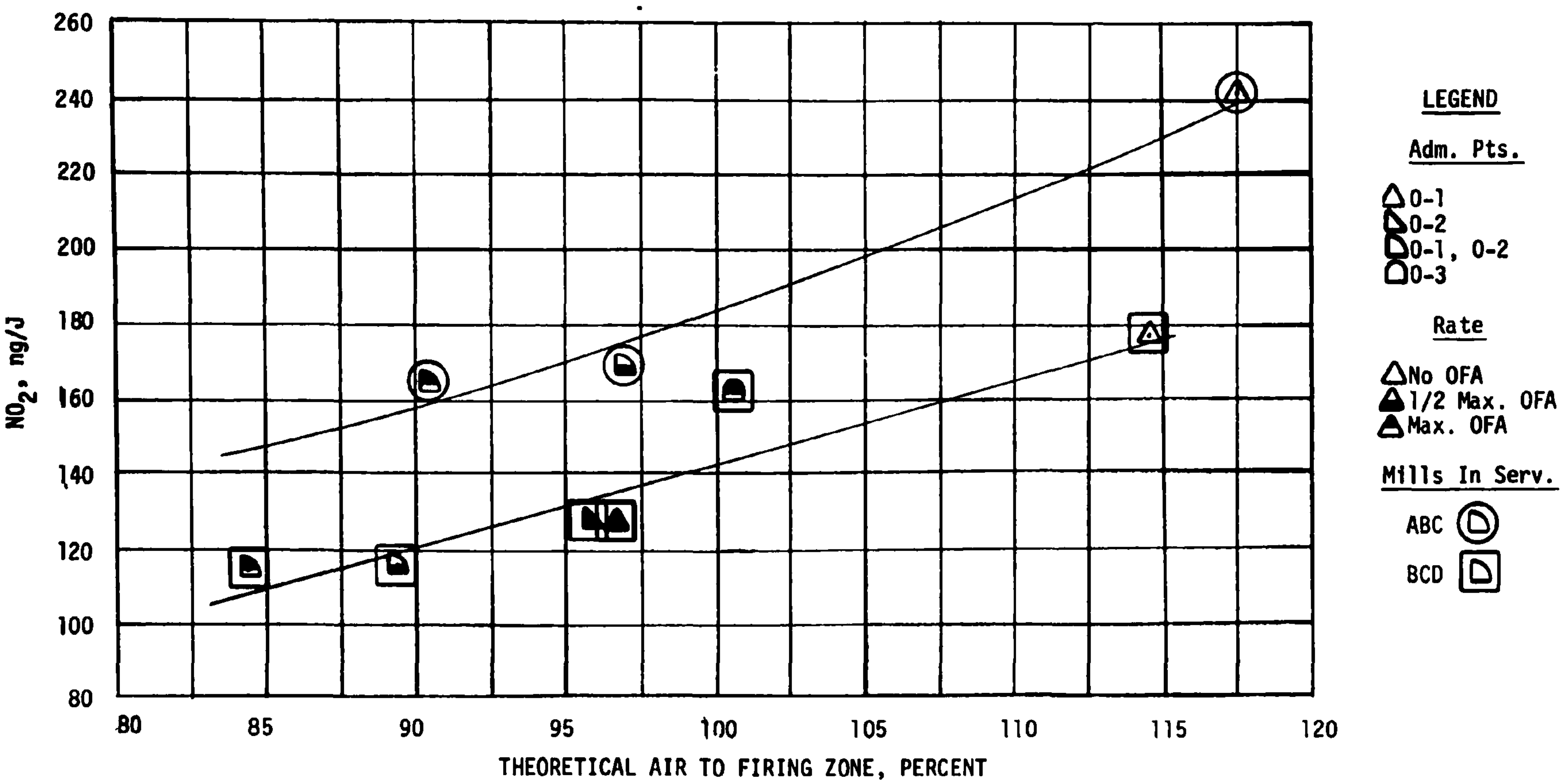


Figure 88: $NO_2$ vs. theoretical air to firing zone, overfire air location, rate & velocity variation, Tests 15-23

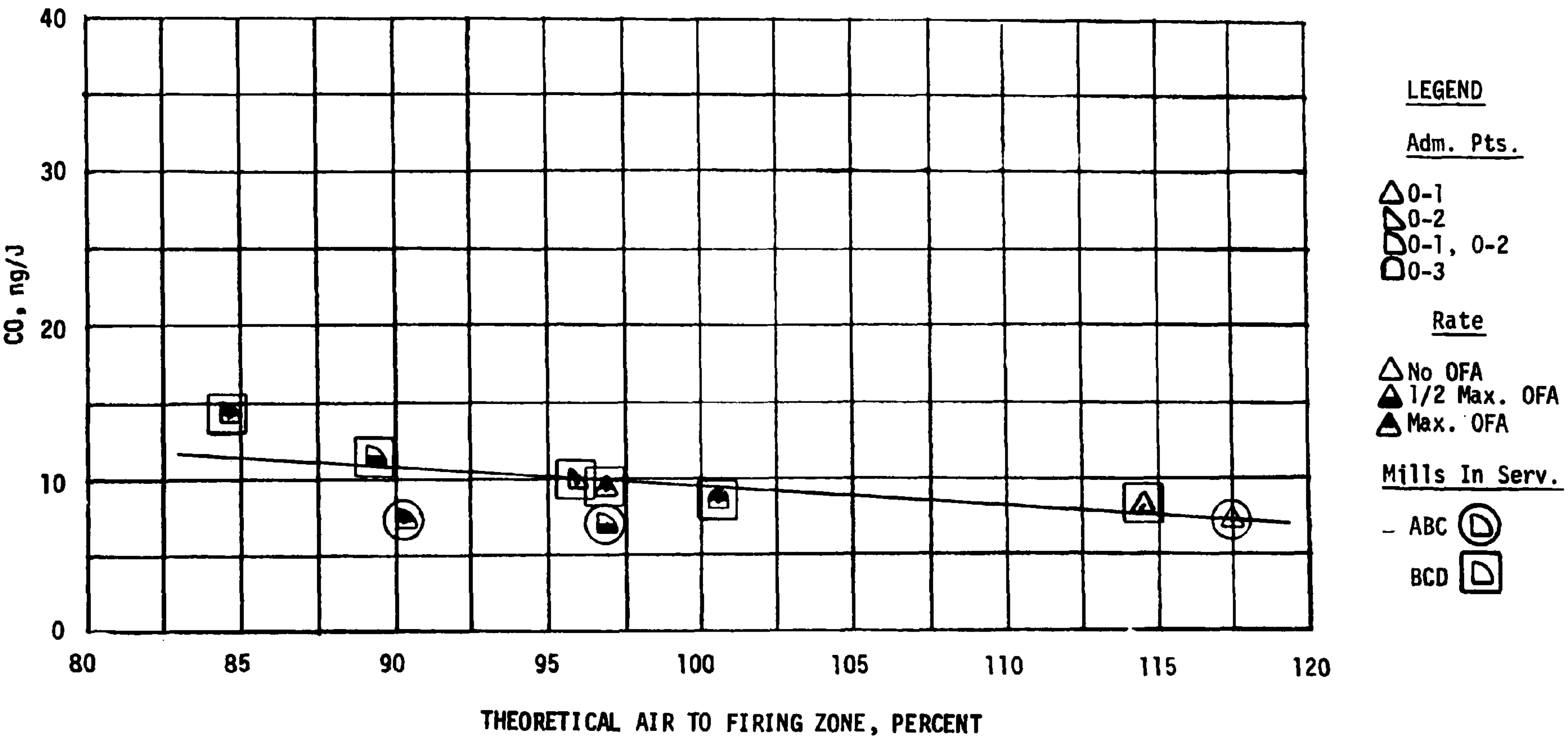


Figure 89: CO vs. theoretical air to firing zone, overfire air location, rate & velocity variation, Tests 15-23

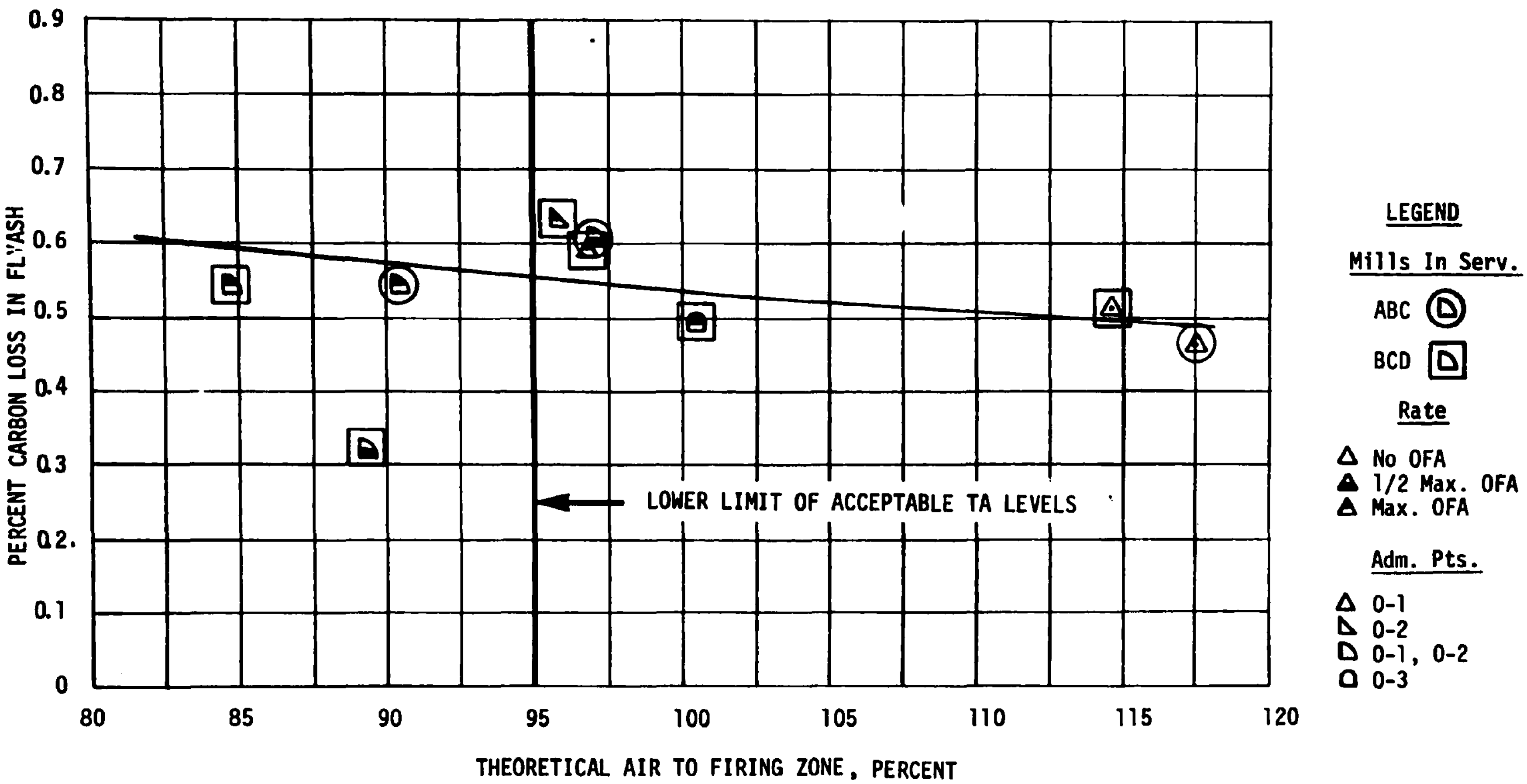


Figure 90: Percent carbon loss vs. theoretical air to firing zone, overfire air location rate & velocity variation, Tests 15-23

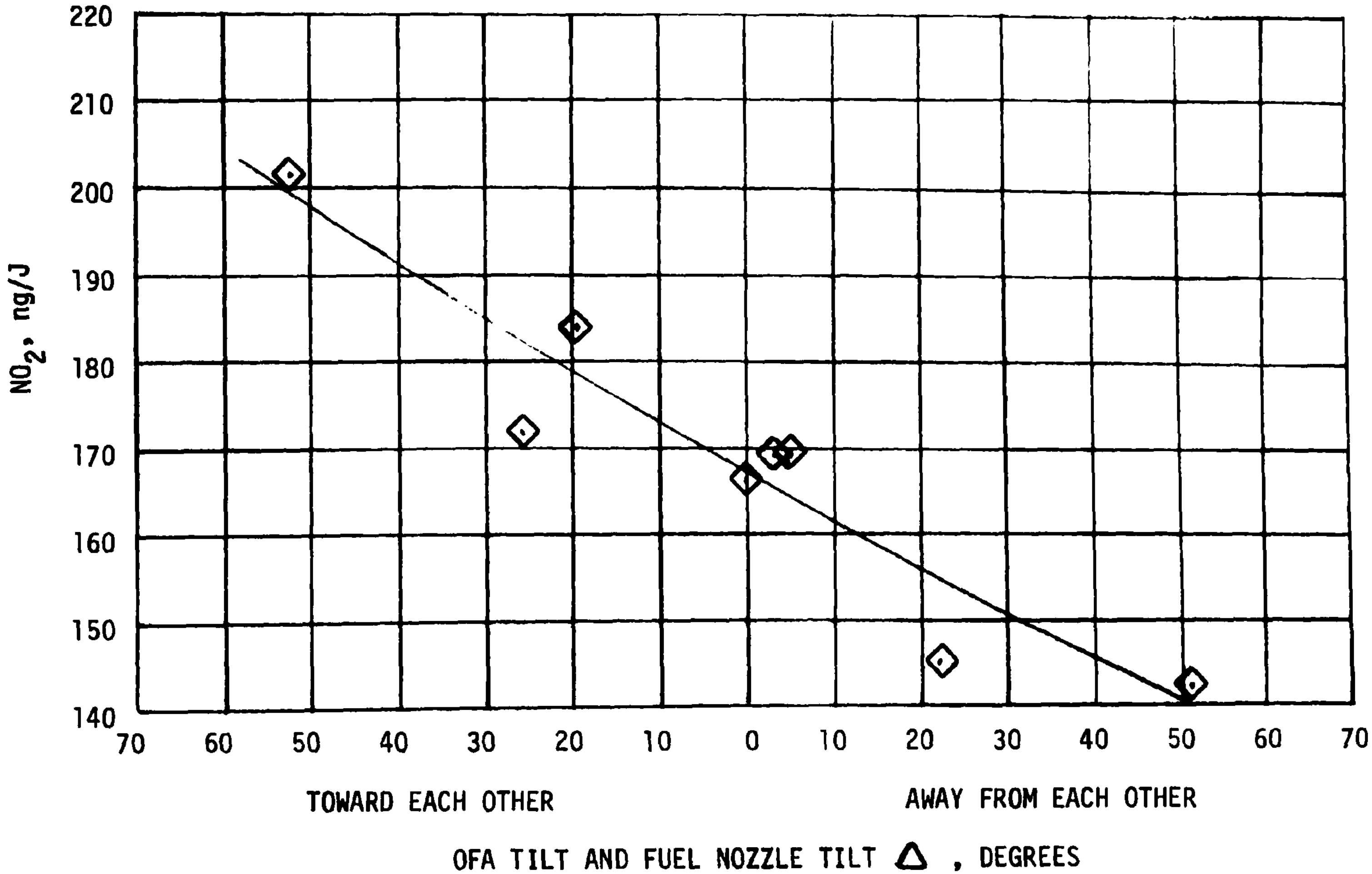


Figure 91: $NO_2$ vs. OFA tilt and fuel nozzle tilt differential, OFA tilt variation Tests 24-33

When the OFA tilts are maximum minus and the fuel nozzle tilts maximum plus, the term overfire air becomes ambiguous. The actual overfire air is less than the reported value, because the air is being forced down into the raised firing zone. At this point where the combined fuel nozzle and OFA tilt differential is 52 degrees toward each other, the $NO_x$ emission level reaches a maximum of 202.1 ng/J.

Percent carbon loss in the fly ash exhibits a definite increase as the fuel nozzle tilts and OFA tilts move away from each other. This can be seen in Figure 92.

CO emission levels also show an increase as the tilt differential increases, yet there is enough total excess air to maintain an acceptable emission level as shown in Figure 93.

Flame stability arises as a limiting factor in variation of the tilts. As the tilts move substantially away from each other, the fire becomes unstable and pulsing may result. Test 29 was performed with a fuel nozzle and OFA tilt differential of 51 degrees away from each other. $NO_x$ emission levels decreased to 142.3 ng/J, yet the CO emission levels began to increase and the fire appeared less stable. Maintaining the fuel nozzle tilts and OFA tilts at approximately equal tilt angles resulted in acceptable flame stability as well as reduced $NO_x$ emission levels.

For all OFA tilt variation tests the $NO_x$ emissions level obtained was below the EPA limit of 301 ng/J.

Load Variation at Optimum Conditions

Tests 30 through 35 were conducted to evaluate unit performance and emission levels at optimum operating conditions as determined during Tests 15 through 29. Tests were conducted over the unit load range at varying furnace waterwall slagging conditions. The $NO_x$ emission level results of this series of tests versus unit loading, expressed as main steam flow, are shown on Figure 94.

| Test No. | Main Steam Flow kg/s | $NO_2$ ng/J | CO ng/J | X-S Air % | Theo. Air To Firing Zone - % | Unit Effic. % | WW Slag |
|---|---|---|---|---|---|---|---|
| 30 | 116 | 169.6 | 7.9 | 21.6 | 90.7 | 89.0 | Clean |
| 31 | 87 | 169.1 | 7.9 | 25.2 | 89.4 | 89.1 | Clean |
| 32 | 57 | 197.8 | 7.4 | 46.9 | 88.5 | 89.2 | Clean |
| 33 | 114 | 166.5 | 7.5 | 27.4 | 94.6 | 89.0 | Max |
| 34 | 86 | 145.2 | 8.0 | 27.4 | 90.6 | 88.2 | Max |
| 35 | 57 | 156.4 | 7.6 | 45.9 | 88.5 | 89.0 | Max |

This figure illustrates the range of $NO_2$ levels obtained both during baseline (after modification) and optimum unit operations. Not all the baseline tests are included as in some cases unit operation was felt to depart excessively from normal operations. Low excess air operation can be cited as an example.

The wide range of $NO_2$ levels obtained, particularly during the baseline tests

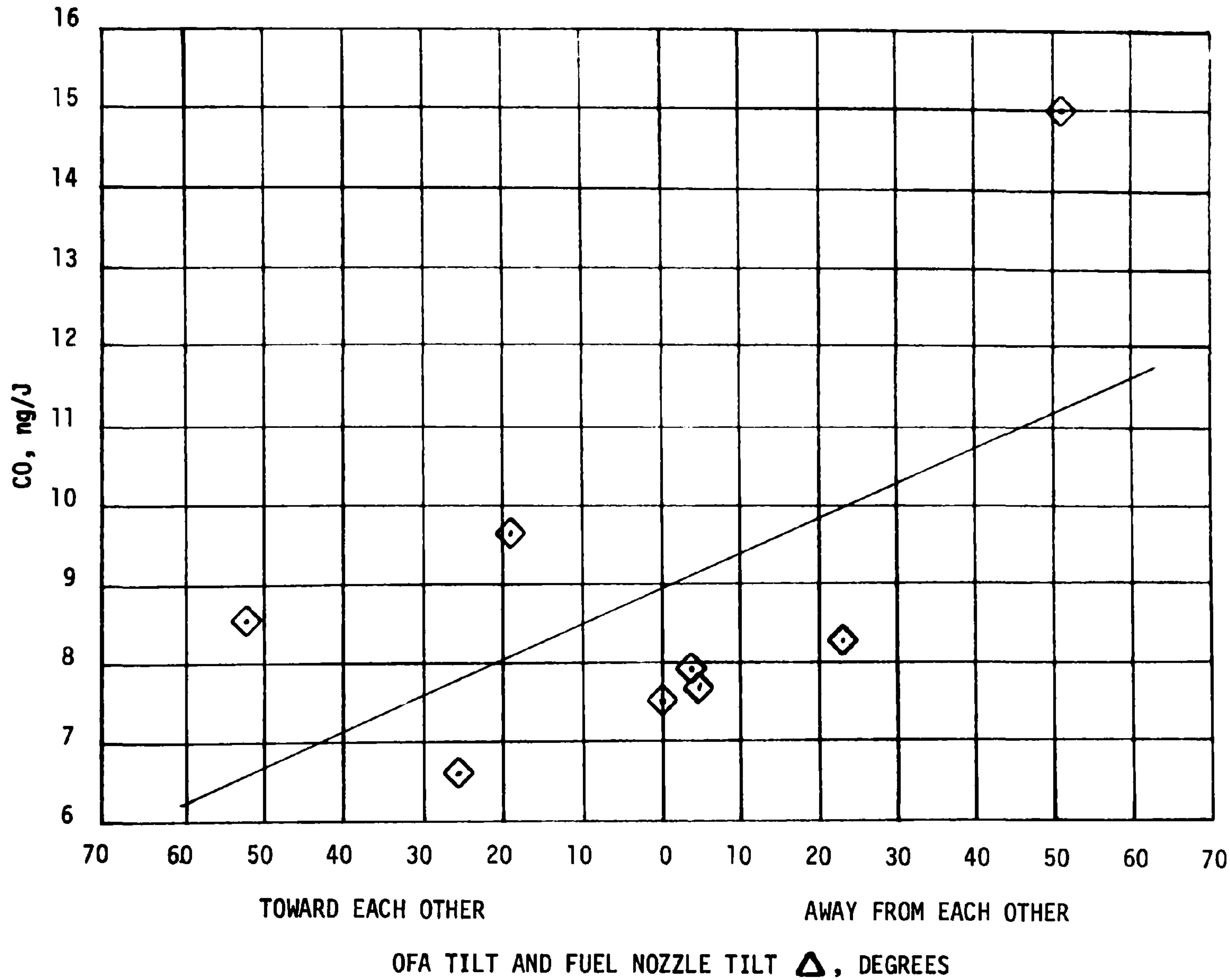


**Figure 92:** CO vs. OFA tilt and fuel nozzle tilt differential, OFA variation
Tests 24-33

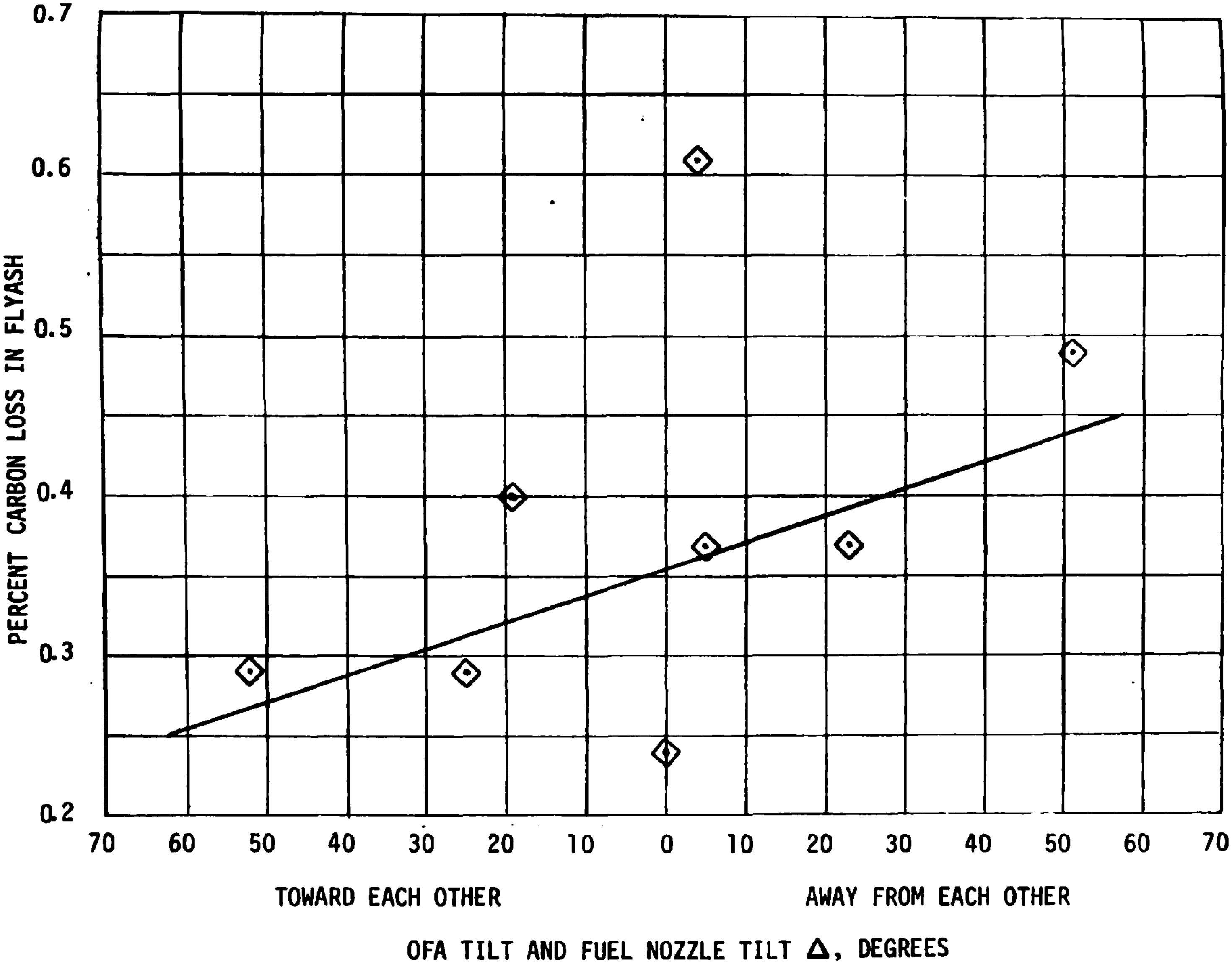


Figure 93: Percent carbon loss vs. OFA tilt and fuel nozzle tilt differential, OFA tilt variation, Tests 24-33

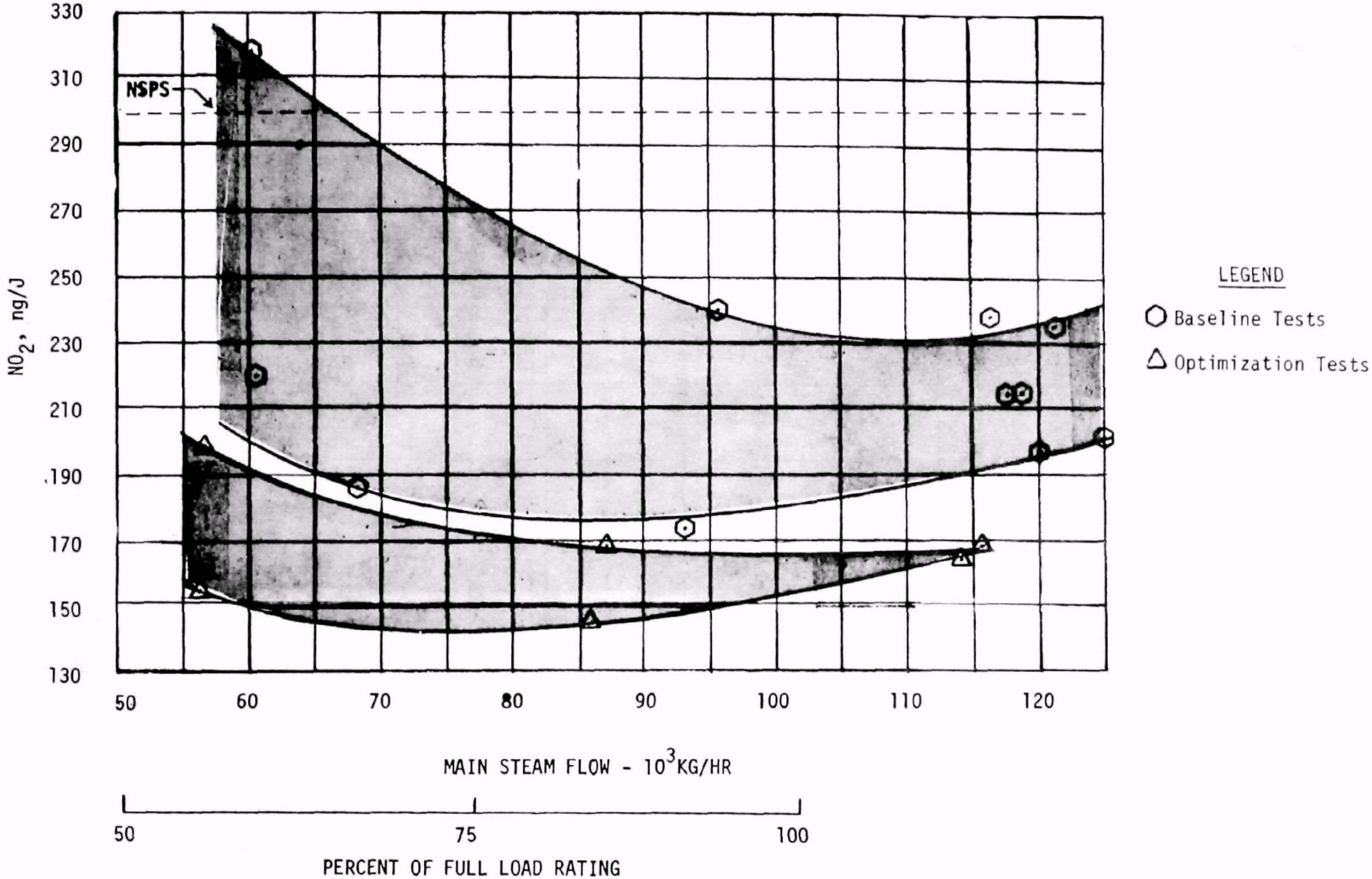


Figure 94: $NO_2$ vs. main steam flow, ranges for normal & optimum operation

are due to variations in unit operating parameters such as excess air level. During the optimization tests, total excess air at the unit economizer outlet was maintained between 20 and 28% at full and 3/4 load and 45 to 47% at 1/2 load and fuel nozzle tilts raised or lowered as required to maintain acceptable reheat and superheat outlet temperatures. Also minimum excess air levels were established on the basis of maintaining acceptable CO emission levels and flame stability.

Tests 30, 31 and 32 were conducted as a series and no problems were encountered while changing load with optimum operation.

FURNACE PERFORMANCE

During the test program, furnace performance was monitored by use of chrodal thermocouples installed in the furnace waterwalls. A schematic of the thermocouple locations is shown in Figure 95 and a tabulation of the absorption rates obtained is presented on Sheets C6, C7 and C8. The temperatures and corresponding absorption rates were found to vary significantly with wall slag conditions making data interpretation difficult. The method finally arrived at as representing an accurate indication of furnace performance is as follows:

The front and right side wall centertube profiles were plotted as shown in Figure 96 and the average of these profiles determined. It should be noted that the maximum and minimum profiles shown do not represent individual walls in every case, i.e., at given furnace elevations the maximum rate shown may switch from wall to wall.

For comparison of optimum and normal unit operation with respect to furnace performance, three full load tests with similar furnace slagging conditions, etc., were selected for comparison. The average centerline profiles for these tests (14, 24, 33) were determined, as shown on Figures 96, 97 and 98, and then plotted together as shown on Figure 99. As shown, furnace performance remained essentially unchanged when furnace slagging effects are taken into account.

It should be noted here that obtaining desired slag conditions proved to be difficult and somewhat unpredictable during overfire air operation. This situation was most pronounced in the firing zone where slag accumulations would normally shed themselves before appreciable accumulations could be built up.

WATERWALL CORROSION COUPON EVALUATION

Following completion of the steady state phases of the baseline, biased firing and overfire air test programs, thirty (30) day waterwall corrosion coupon evaluations were performed. The purpose of these evaluations was to determine whether any measurable changes in coupon weight losses could be obtained for the various firing modes studied.

The individual probes were exposed at five locations on the furnace front wall as shown on Figure 69. The coupon temperatures were maintained at the same levels for each 30 day run and a typical trace of the control temperature range for each of the twenty coupons is shown on Figure 70.

The individual coupon weights were determined before and after each thirty day test and the individual coupon and average probe weight losses are shown on

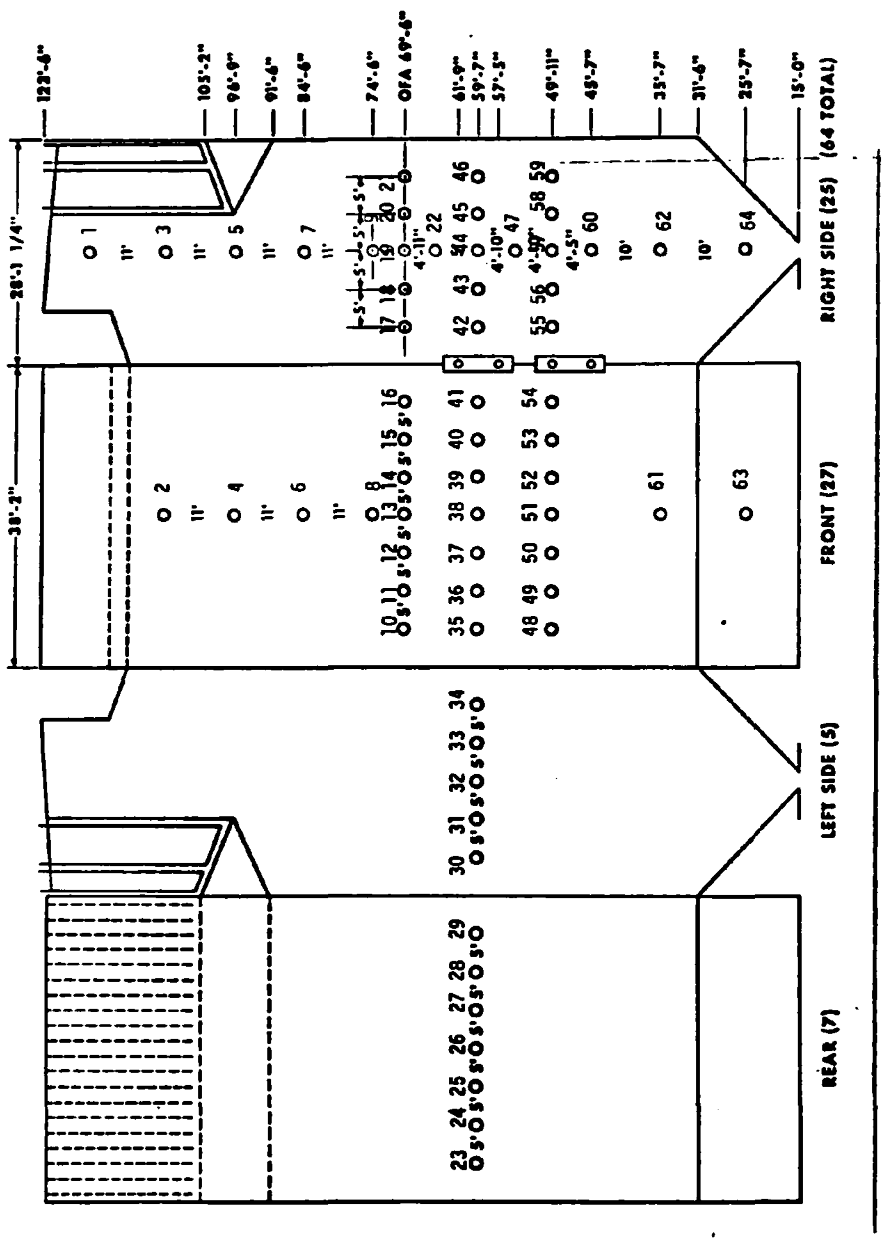


Figure 95: Chordal thermocouple locations on the furnace waterwalls

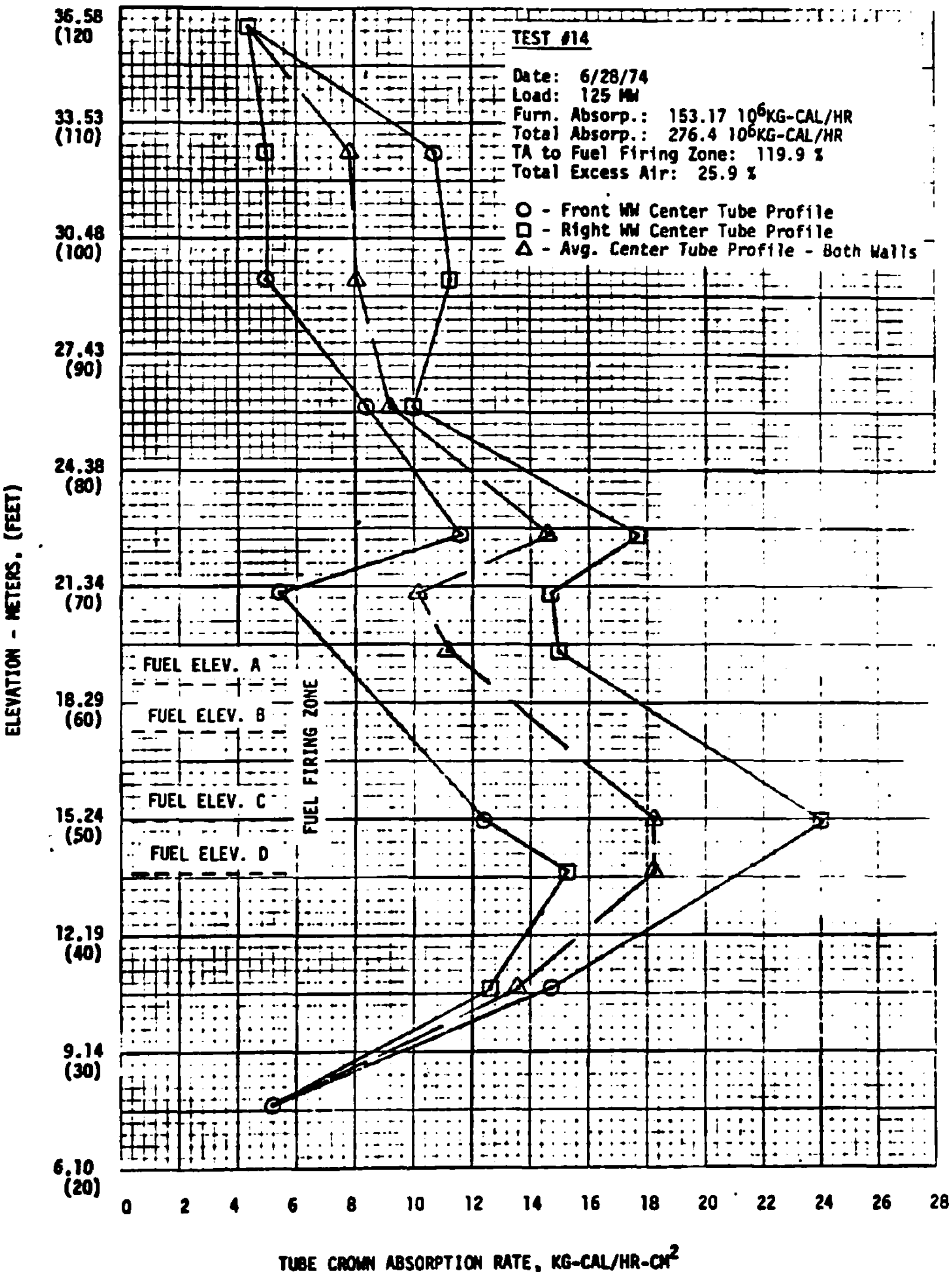


Figure 96: Average centerline absorption profile, Test 14

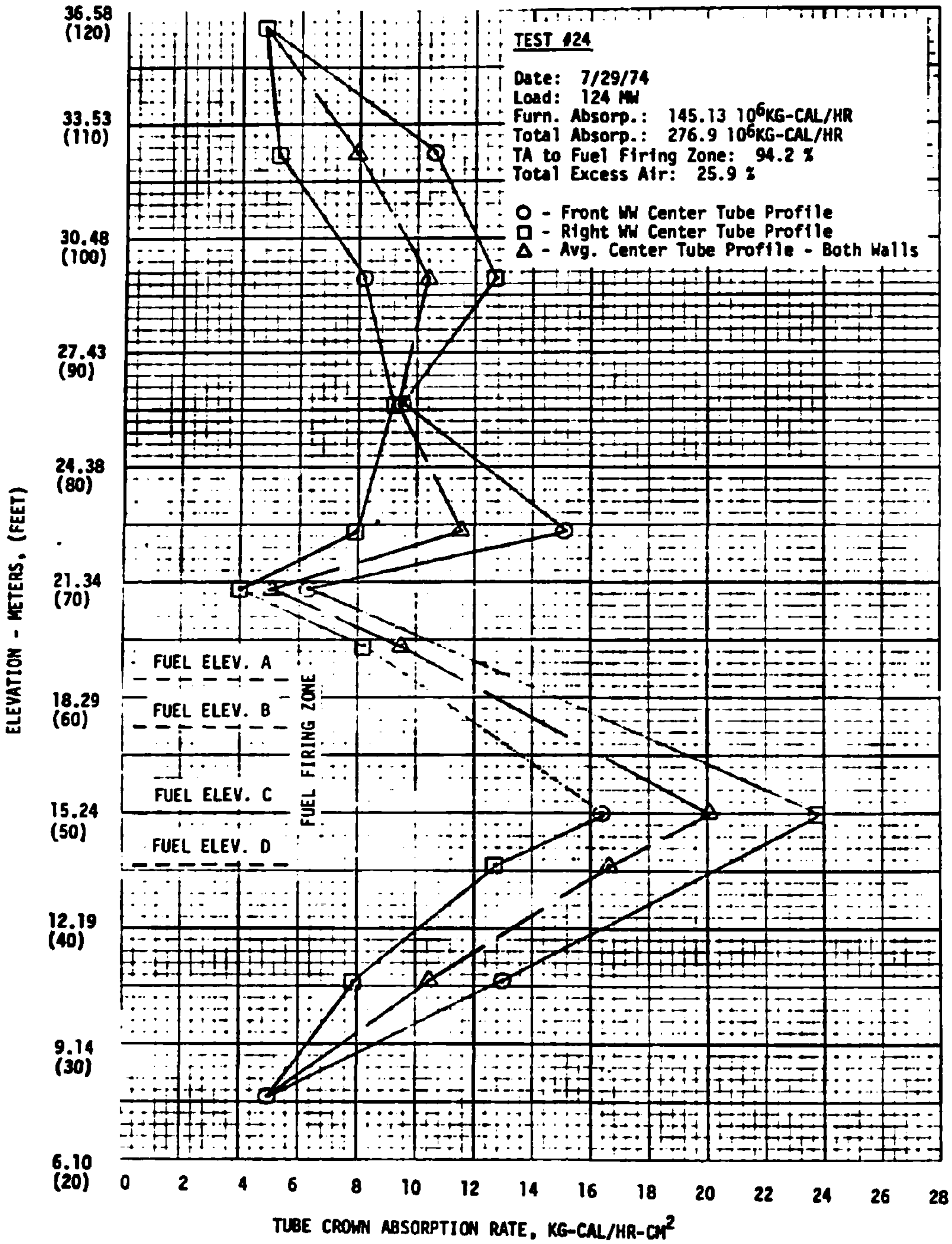


Figure 97: Average centerline absorption profile, Test 24

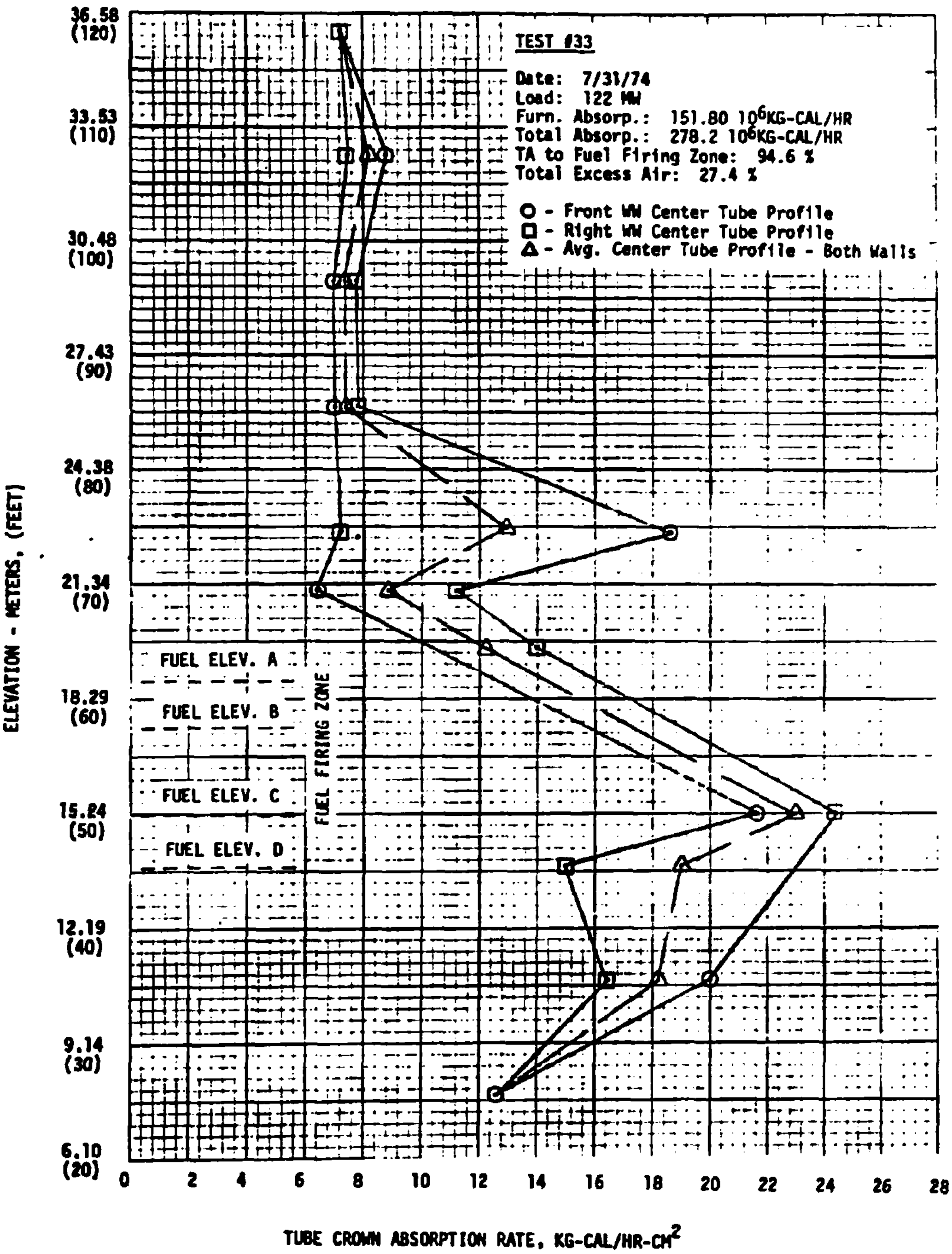


Figure 98: Average centerline absorption profile, Test 33

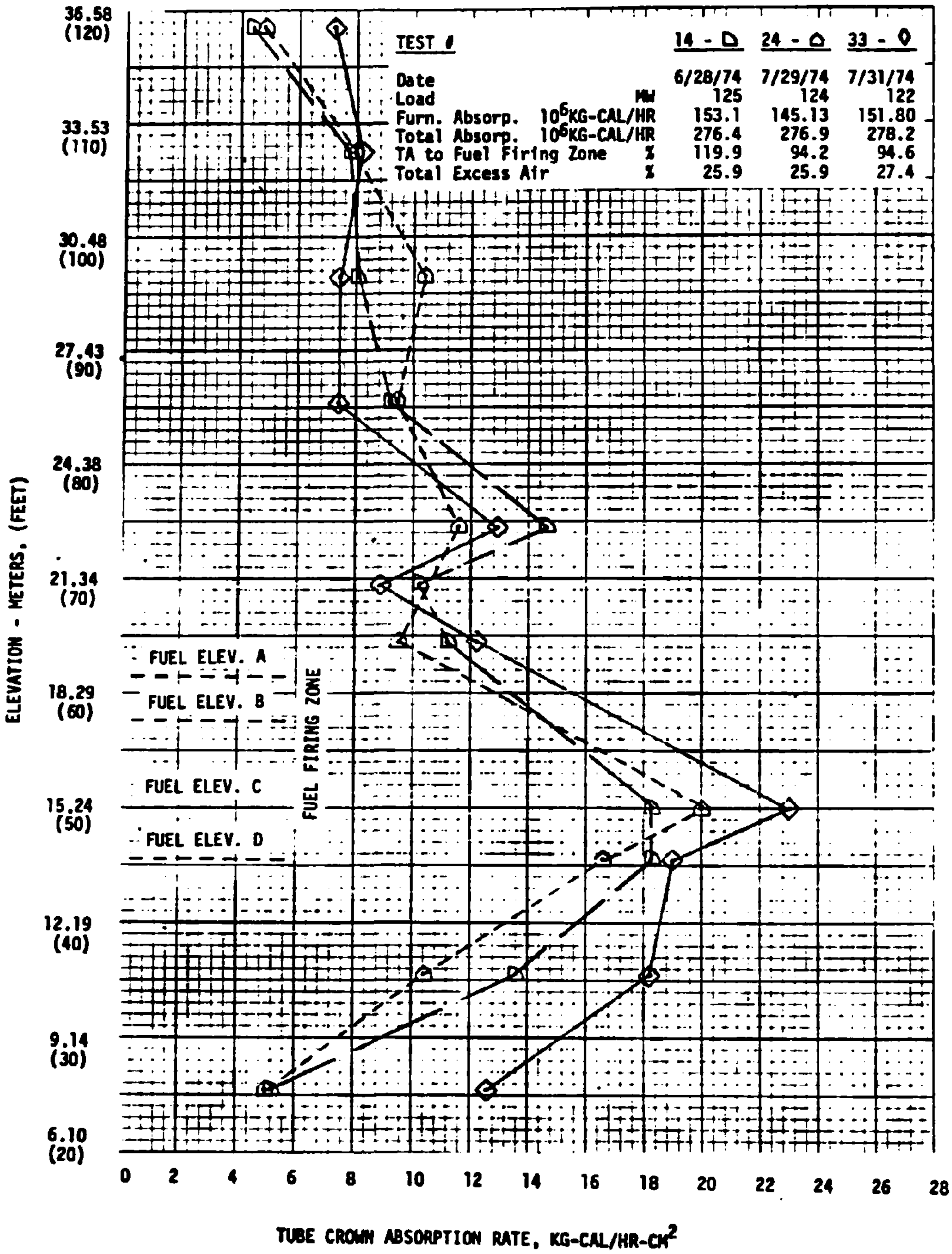


Figure 99: Average centerline absorption profile, All Tests

Sheets C9, C10 and C11. The weight losses are calculated as mg/cm$^2$ of coupon surface area. Of the sixty coupons exposed, three were damaged during disassembly and were therefore not included in the weight loss determinations. The affected coupons were as follows: Coupon K-1, baseline study, and coupons 2-1 and 2-4, overfire air study. In addition, five coupons from probes T and N of the overfire air study resisted disassembly and were therefore weighed as single units and average weight losses were determined.

Figures 100, 101 and 102 show the unit load schedules for each of the 30 day test periods.

The biased firing study was conducted with the top fuel firing elevation out of service as this operating condition was shown during steady state biased firing tests to produce the lowest $NO_x$ emission level of the biasing modes studied. The overfire air study was conducted using an "optimized" operating mode as determined during the overfire air steady state tests.

Throughout each study the following damper positions were maintained over the load ranges indicated.

At unit loadings below 56.7 kg/s steam flow, with two elevations of mills in service, damper positions were maintained as follows:

| Biased Firing Operation | | | Overfire Air Operation | |
|---|---|---|---|---|
| | | | OFA Dampers | 100 |
| | | | | 100 |
| Coal | Auxiliary | | Coal | Auxiliary |
| | 0 | | | 100 |
| 0 | | | 100 | |
| | 0 | | | 50 |
| 0 | | | 30 | |
| | 100 | - Combustion | | 50 |
| | 100 | Air Only | | 0 |
| 30 | | | 0 | |
| | 50 | | | 0 |
| 30 | | | 0 | |
| | | | | 0 |

From 56.7 to 75.5 kg/s steam flow, with three elevations of mills in service, the damper positions were as follows:

| Biased Firing Operation | | | Overfire Air Operation | |
|---|---|---|---|---|
| | | | OFA Dampers | 100 |
| | | | | 100 |
| Coal | Auxiliary | | Coal | Auxiliary |
| | 100 | - Combustion | | 100 |
| 100 | | Air Only | 100 | |
| | 50 | | | 50 |

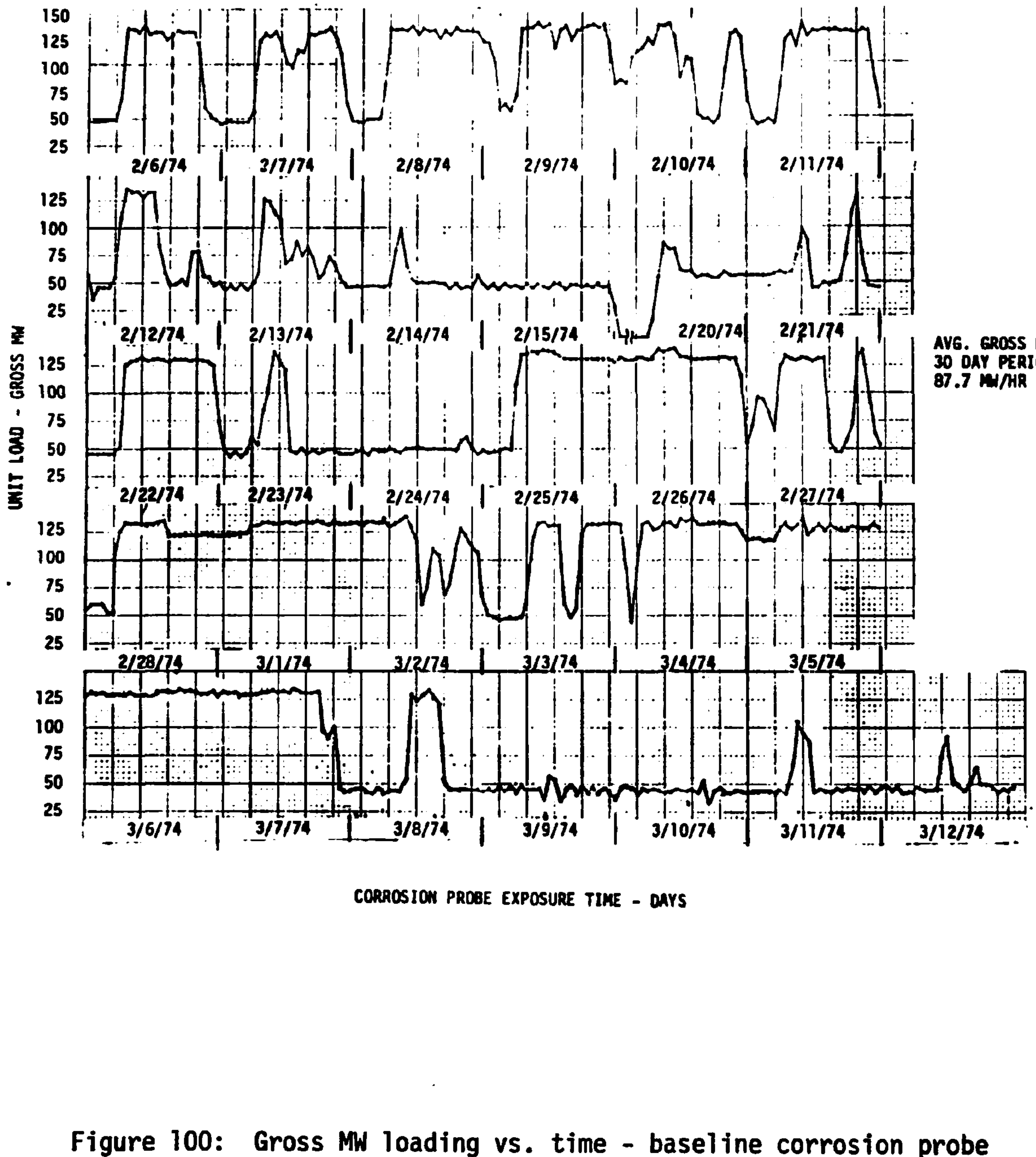


Figure 100: Gross MW loading vs. time - baseline corrosion probe study

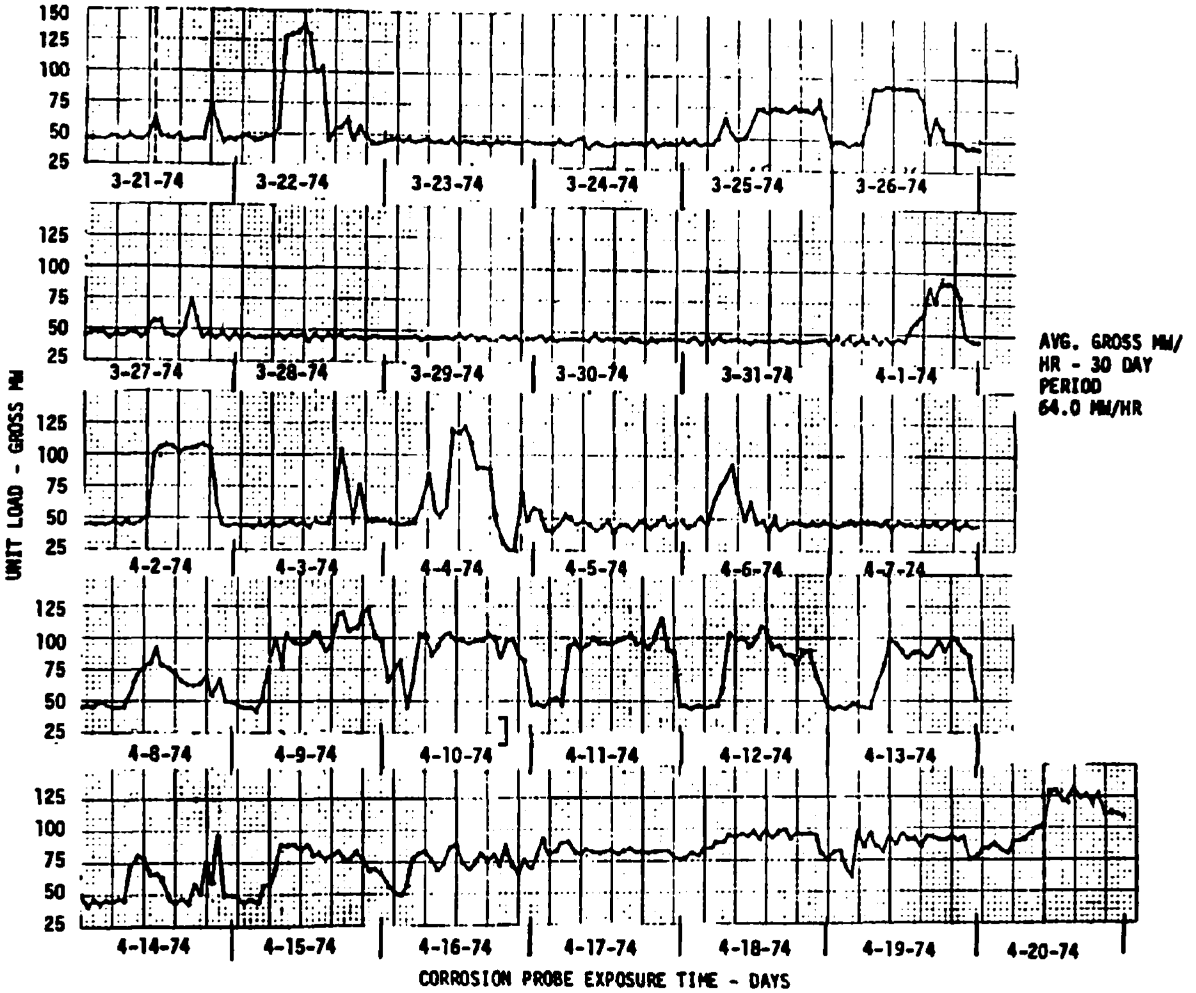


Figure 101: Gross MW loading vs. time - biased firing corrosion probe study

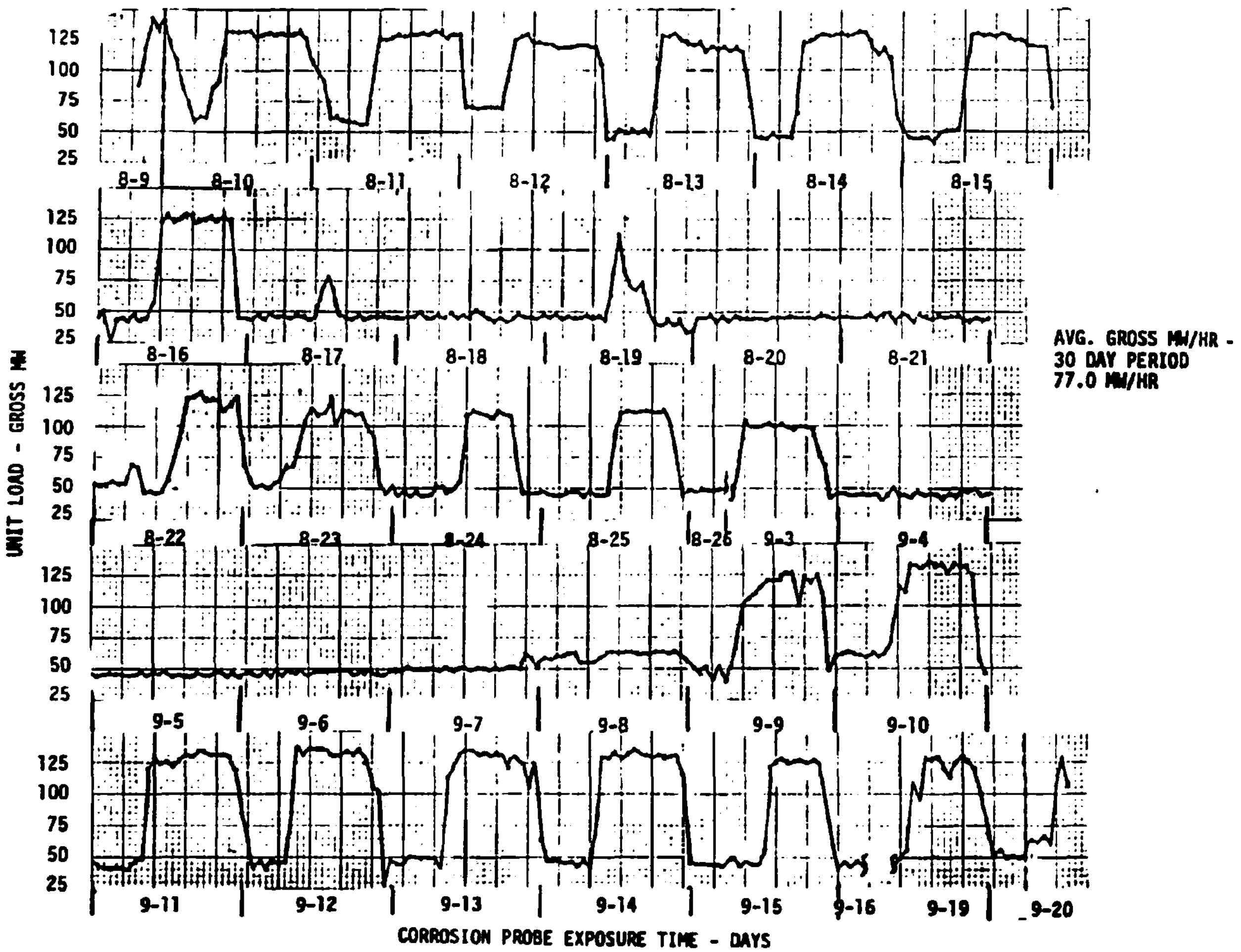


Figure 102: Gross MW loading vs. time - overfire air corrosion probe study

| Biased Firing Operation (Cont.) Coal | Biased Firing Operation (Cont.) Auxiliary | Overfire Air Operation (Cont.) Coal | Overfire Air Operation (Cont.) Auxiliary |
|---|---|---|---|
| 20 | | 30 | |
| | 50 | | 50 |
| | 50 | | 50 |
| 20 | | 30 | |
| | 50 | | 50 |
| 20 | | 0 | |
| | 50 | | 0 |

At unit loadings above 75.5 kg/s to the maximum steam flow with the maximum elevations of mills in service, the following damper positions were maintained.*

Overfire Air Operation: OFA Dampers 100, 100

| Biased Firing Operation Coal | Biased Firing Operation Auxiliary | Overfire Air Operation Coal | Overfire Air Operation Auxiliary |
|---|---|---|---|
| | 100 - Combustion Air Only | | 100 |
| | | 100 | |
| 100 | | | 50 |
| | 50 | 30 | |
| 30 | | | 50 |
| | 50 | | 50 |
| | 50 | 30 | |
| 30 | | | 50 |
| | 50 | 30 | |
| 30 | | | 50 |
| | 50 | | |

The percent oxygen was monitored daily during each thirty day study at each probe location and was found to be essentially the same for the various test conditions ranging between 16 and 19 percent $O_2$.

The weight losses calculated for the biased and overfire air portion of the test program were found to be greater than those for the baseline tests. The average weight losses for all five probes were as follows:

| Baseline | Biased Firing | Overfire Air |
|---|---|---|
| 2.6381 $mg/cm^2$ | 4.6429 $mg/cm^2$ | 4.4419 $mg/cm^2$ |

These values are within the range of losses which would be expected for oxidation of carbon steel for a 30 day period. To verify this premise control

* At no time during the biased firing study was the top elevation coal pulverizer placed in service. Maximum unit loading was therefore limited to the maximum with the lower three mills in service.

studies were conducted in C-E's Kreisinger Development Laboratory using probes exposed during the biased firing study. These probes were cleaned and prepared in an identical manner to those used for furnace exposure and placed in a muffle furnace for 30 and 60 day exposures at 399°C with a fresh air exchange. The test results were as follows:

| Probe | Wt. Loss $mg/cm^2$ - 30 Days |
|---|---|
| M (30 day) | 4.7999 |
| Q (30 day) | 4.7741 |
| R (60 day) | 5.1571/2 = 2.5785 |
| B (60 day) | 8.3493/2 = 4.1746 |

These results indicate that the test coupons oxidized more rapidly during the first 30 days exposure with average weight losses decreasing in the second thirty days. Based on these results, it appears that the differences in weight losses observed during the test program are within the ranges to be expected from oxidation alone.

Chemical analysis of deposits taken during the test program does not, in itself, show that molten phase attack has occurred. The composition of the deposits does show some differences, primarily in the iron content as noted on Figure 103. The deposit collected during the biased firing and overfire air tests show 50 and 35 percent iron, respectively, versus 30 percent in the baseline test. Higher iron is normally indicative of lower melting temperatures. However a certain quantity of CaO is necessary to flux the iron if it is to result in a low melting mixture. The CaO content is considerably less in the biased firing and overfire air tests as compared to that of the baseline test. Accordingly the fusibility temperatures are higher for the biased firing test and slightly higher for the overfire air tests. This agrees with observations made during the tests, i.e., deposits during biased firing were more friable and easily removed than in the baseline tests with the overfire air tests falling closer to baseline operation.

For comparison fusibilities and compositions have been given in Figure 39 for the coal ash as fired. This points out the selective deposition of certain constituents in the coal ash, like iron, and also shows that resultant fusibility temperatures of deposits can be significantly different than the coal ash as fired.

| | Waterwall Slag Sample Baseline Test | Coal Ash (As-Fired) | Waterwall Slag Sample Biased Firing Test | Waterwall Slag Sample Overfire Air Test |
|---|---|---|---|---|
| **Ash Fusibility** | | | | |
| IT | 1930 | 2150 | 2060 | 1930 |
| ST | 2090 | 2410 | 2170 | 2090 |
| HT | 2200 | 2500 | +2700 | 2250 |
| FT | 2500 | 2620 | +2700 | ---- |
| **Ash Composition** | | | | |
| $SiO_2$ | 46.2 | 45.8 | 38.4 | 38.5 |
| $Al_2O_3$ | 18.4 | 30.7 | 10.3 | 18.1 |
| $Fe_2O_3$ | 29.9 | 13.9 | 50.0 | 35.4 |
| CaO | 3.9 | 1.8 | 1.0 | 1.8 |
| MgO | 0.8 | 1.3 | 0.3 | 0.9 |
| $Na_2O$ | 0.32 | 0.4 | 0.1 | 0.4 |
| $K_2O$ | 0.61 | 1.4 | 0.7 | 1.9 |
| $TiO_2$ | N.R. | 0.8 | N.R. | 1.0 |
| $P_2O_5$ | N.R. | 0.5 | N.R. | N.R. |
| $SO_3$ | 0.34 | 1.2 | 0.8 | 0.4 |
| | 100.4 | 97.8 | 101.5 | 98.4 |

Figure 103: Ash Analysis

# SECTION IV - APPLICATION GUIDELINES

## INTRODUCTION

This section presents the results of Task IX of the Phase II - "Program for Reduction of $NO_x$ from Tangential Coal Fired Boilers" performed under the sponsorship of the Office of Research and Development of the Environmental Protection Agency (Contract 68-02-1367). These results were subsequently updated under Task VII d of Contract 68-02-1486, "Staged Combustion Technology for Tangentially Fired Utility Boilers Burning Western U.S. Coal Types." The results presented are based on field performance tests performed at Alabama Power Company, Barry #2; Utah Power & Light Company, Huntington Canyon #2; Wisconsin Power & Light Company, Columbia #1 and current contractor experience.

The utilization of overfire air as an $NO_x$ control technique is discussed relative to the following areas of interest:

1. Necessary equipment modifications and costs (as of January, 1977) associated with applying this technology to existing steam generators.

2. Specific limitations to the general applications of the technology developed.

3. Emission control and cost effectiveness of applying the developed technology to new steam generator designs.

## CONCLUSIONS

1. Prior to incorporating overfire air as an $NO_x$ control system on existing unit designs, an exploratory test program must be performed to determine the acceptability of the unit for modification.

2. The costs of installing an overfire air system on an existing unit could range between 2 to 4 times the cost as included on a new unit design. Based on January, 1977 estimates, existing unit modification costs could range from 0.24 to 1.8 $/kw, depending on unit size.

3. Approximately 40% of the existing coal fired units in the United States are of tangential design and could conceivably be modified to incorporate overfire air systems.

4. Unit size, heat rate and expected life must be considered in deciding whether modifications are justified.

5. Incorporation of an overfire air system will not significantly affect unit performance.

6. A large percentage of the existing tangentially coal fired units in the United States can meet current EPA standards for $NO_x$ emission levels. The necessity of applying the overfire air technique for $NO_x$ control should therefore be established prior to committing a unit for modification.

# RECOMMENDATIONS

## EXISTING STEAM GENERATING UNITS

The applicability of the technology developed in the course of this project should be qualified by the following conditions:

1. Any unit under consideration should be subjected to an exploratory test program to determine the necessity of modification with respect to applicable $NO_x$ compliance limits. The minimum test requirements recommended for such a study would consist of studying the effect of available process variables such as excess air level. The minimum test data would consist of $NO_x$, CO for combustion efficiency and sufficient board or test data to identify changes in unit operating characteristics.

2. A review should be made of the unit and turbine useful life expectancy, unit size versus modification costs, and unit heat rate.

## NEW STEAM GENERATING UNITS

All tangentially coal fired units since approximately 1970 have included Overfire Air (OFA) systems in the original unit design. The OFA system is therefore not considered by Combustion Engineering, Inc. as an additional $NO_x$ control device.

## DISCUSSION

The effectiveness of overfire air operation in reducing $NO_x$ emissions from existing utility steam generators was evaluated by selecting, modifying, testing one unit and selecting and testing two additional units designed with OFA systems. The effects of OFA system operation on unit performance and emission control was studied in each of these units. The modified test unit, Alabama Power Company's Barry #2, is a natural circulation, balanced draft design, firing coal through four elevations of tilting tangential fuel nozzles. Unit capacity at maximum continuous rating (MCR) is 113 kg/s main steam flow with a superheat outlet temperature and pressure of 538°C and 12.9 MPa.

The units designed with overfire air systems and burning Western coal types are described as follows:

Utah Power & Light Company, Huntington Canyon #2 is a controlled circulation, balanced draft design firing a Western bituminous coal type through five elevations of tilting tangential fuel nozzles. Unit capacity at maximum continuous rating (MCR) is 382 kg/s main steam flow with a superheat outlet temperature and pressure of 541°C and 18.2 MPa.

Wisconsin Power & Light Company, Columbia #1 is a controlled circulation, balanced draft design firing a Western subbituminous coal type through six elevations of tilting tangential fuel nozzles. Unit capacity at maximum continuous rating (MCR) is 478 kg/s main steam flow with a superheat outlet temperature and pressure of 541°C and 18.1 MPa.

Superheat and reheat temperatures for the three units are controlled by fuel nozzle tilt and spray desuperheating.

In order to evaluate unit performance during these studies, necessary steam, water, air and gas temperature and pressure measurements were performed as well as $NO_x$, CO, $O_2$, THC, $SO_2$ and carbon loss determinations to assess emission performance. The test program for the modified unit was conducted in three phases consisting of baseline and biased firing portions conducted prior to modification and baseline and overfire air portions conducted after unit modification. The effect of the modification on unit performance was found to be insignificant and the test data summaries for each phase are shown in Appendices A, B and C. Similar three phase programs were conducted on the two test units burning Western coal types evaluating baseline, biased firing and overfire air operation. Short term comparative corrosion tests were conducted on each unit over thirty day periods using corrosion coupons, which are made of the same material as the waterwalls. During this evaluation, both normal and OFA operation was evaluated. The unit load schedules for the baseline and biased firing and overfire air evaluations are shown on Figures 39, 40, 62, 63, 100, 101 and 102. The respective data summaries are shown on Sheets A1 through A6; B1 through B6 and C1 through C5. Corrosion coupon locations are shown on Figures 37, 60 and 69.

## DESIGN AND DESCRIPTION OF OFA SYSTEMS

The overfire air system as incorporated in tangential coal fired furnaces consists of air compartments and registers, ductwork, flow control dampers and nozzle tilting mechanisms. A typical arrangement of this system is shown on Figure 15. The overfire air compartments and registers are designed as vertical extensions of the corner windboxes unless, as in the case of some existing units, modification at that location is not possible due to structural considerations.

In the latter case, as was the situation with the modified test unit, the separate compartments and registers were installed within three meters of the top of the existing windbox. As shown on Figure 67, this arrangement requires additional ductwork for supplying air to the OFA system.

Control dampers for regulating the OFA flow rate should be coordinated with the windbox fuel and auxiliary air compartment dampers to correctly proportion air flow as required for various operating modes.

An independent OFA register tilt mechanism should also be provided on retrofits of existing units to permit coordinating these registers with the fuel and air nozzle tilts.

The overfire air registers and ducts should be sized for 15% of the full load secondary* air flow using the same register and duct velocities as the windbox. Each overfire air port consists of two registers above each windbox, usually as an extension of the windbox.

## FIELD TEST PROGRAM

The field performance tests conducted at Barry No. 2 firing Eastern bituminous coal and at Huntington Canyon No. 2 and Columbia No. 1 firing Western bituminous coals respectively showed that an overfire air system on a tangential coal fired furnace can reduce $NO_x$ emissions with no detriment to unit operation or maintenance. $NO_x$ emission reductions of 20 to 30% were obtained with 15 to 20 percent overfire air when operating at a total unit excess air of approximately 15 to 25 percent as measured at the economizer outlet. This condition provided an <u>average</u> fuel firing zone stoichiometry of 95 to 105 percent of theoretical air. The firing zone stoichiometries attainable at given overall excess air levels did vary somewhat from unit to unit. Stoichiometries below the 95 percent level did not result in large enough decreases in $NO_x$ levels to justify their use. Biased firing (removing the top burner elevation from service), while potentially as effective, necessitated a reduction in unit loading and is therefore less desirable a method of $NO_x$ control. In essence, this method uses the uppermost fuel and air compartment as a windbox extension.

When using overfire air as a means of decreasing the theoretical air to the fuel firing zone the percent carbon in the fly ash and CO emission levels were less

* Secondary air does not include coal pulverizer transport air.

affected than when operating with low excess air.* This is due to the ability to maintain acceptable total excess air levels, as measured at the economizer outlet, during overfire air operation while the theoretical air to the fuel firing zone is reduced.

Furnace performance as indicated by waterwall slag accumulations, visual observations and absorption rates, was not significantly affected by overfire air operation.

On existing units where, for structural reasons, an overfire air port might not be installed as a windbox extension, test results indicate that the centerline of the overfire air port be kept within three meters of the centerline of the top fuel elevation. Distances greater than three meters did not result in decreased $NO_x$ levels. Changes within the three meters limit did affect $NO_x$ levels slightly with the $NO_x$ levels increasing as the distance decreased.

The overfire air nozzles should tilt in unison with the fuel nozzles where possible. Tilting the overfire air and fuel nozzles towards each other directs the overfire air into the fuel admission zone thereby negating the original intent, while tilting the nozzles away from each other may result in decreased flame stability. If the overfire air nozzle tilt is fixed in a horizontal position $NO_x$ levels would probably then vary to a limited extent with fuel nozzle position. In other words, the $NO_x$ levels may increase or decrease as the total included angle between the fuel and OFA nozzles is decreased or increased respectively.

The results of the 30 day baseline, biased firing and overfire air corrosion coupon runs indicate that the overfire air operation for low $NO_x$ optimization did not result in significant increases in corrosion coupon degradation. The results of this study are shown on Sheets A57 and A58, B45 and B46 and C9 through C11. Potential long term corrosion effects were not evaluated as part of this program.

## EXPLORATORY FIELD TEST PROGRAM - EXISTING UNITS

To determine both the necessity and acceptability of applying the OFA technique for $NO_x$ emissions control on existing tangentially fired units, an evaluation should be performed prior to committing the unit to modification.

This evaluation should include the study of existing process variables, such as excess air, as an $NO_x$ control method. If these techniques should prove unsatisfactory, the program should then be expanded to evaluate the effect of biased firing on $NO_x$ emissions. This technique consists of removing the top fuel elevations from service and using the upper air and fuel compartments for the introduction of overfire air. This evaluation should be conducted at the maximum possible unit loading with one pulverizer out of service and otherwise normal operation.

During biased firing operation, changes in total excess air required to maintain acceptable CO levels, the amount of carryover from the furnace outlet, and

* A minimum of 20 to 25 percent excess air was generally established for the test units.

furnace slagging tendencies should be observed. Carryover could be visually observed, while increased slagging might be evaluated both visually and in terms of bottom ash handling system performance. Outlet steam temperatures and air heater exit gas temperatures should also be observed for comparison of normal operation.

The minimum instrumentation necessary for a comprehensive evaluation is as follows:

Unit Performance

| | |
|---|---|
| Superheat (S.H.) Outlet Temp. | Calibrated Board Data* |
| Reheat (R.H.) Outlet Temp. | Calibrated Board Data* |
| R.H. & S.H. Spray Flows | Calibrated Board Data* |
| Gas Temp. Lvg. Air Heater (A.H.) | Thermocouple Grid in A.H. Outlet Duct |
| Excess Air Lvg. A.H. | Gas Sampling Grid in A.H. Outlet Duct |
| Furnace Carryover | Visual Observation |
| Furnace Slagging | Visual Observation & Ash System Performance, Nozzle Tilt Changes & Desuperheating Sprays |
| Unit Gas Side Pressure Drop | Calibrated Board Readings* |

Emissions Performance

| | |
|---|---|
| $NO_x$, CO & $O_2$ | Gas Sampling Grid in A.H. Inlet Duct |

EFFECT ON UNIT PERFORMANCE

The application of OFA as an $NO_x$ control device spreads out the furnace fire, which reduces flame intensity and temperature and the initial oxygen concentration. These effects combine to limit the formation of oxides of nitrogen compounds with the reduced oxygen apparently affecting the formation of NO by the fuel bound nitrogen.

In the case of coal firing, the $NO_x$ emissions originate from two sources, fuel bound and atmospheric nitrogen, and thus $(NO)\ Total = (NO)_{Fuel\ N} + (NO)_{N_2\ in\ air}$.

Test results from all three units indicated that as long as the total excess oxygen (fuel compartment $O_2$ + OFA $O_2$), as measured at the economizer, remains changed from the baseline condition, unit performance would remain unaffected. In some cases, however, a slightly increased total oxygen may be required to prevent an increase in CO and unburned carbon emission levels. This situation

* If not available, test instrumentation should be considered.

could be simulated with a biased firing test (top fuel elevation out of service) conducted during the exploratory program to determine the necessity of unit modification. While this approach will necessitate a reduction in unit loading, testing should be conducted at the highest possible loading obtainable for comparison to normal unit operation.

Otherwise, overall steam generator performance, including fan power, final steam temperatures, furnace wall tube temperatures and corrosion, and unit efficiency remain essentially unchanged.

The effect on furnace slagging has been found to vary somewhat with coal types and in particular with blends of various coals. Therefore, since coal types vary widely, the effect of changing firing zone stoichiometries on slagging tendencies should be evaluated during the exploratory program, again by using the biased firing technique. Where evaluating units with spare coal pulverizer capacity, this check should, if at all possible, be made at, or close, to full unit rating, particularly from the standpoint of evaluating unit slagging tendencies. A minimum evaluation period of one week is recommended for studying slagging tendencies.

On some units, the spreading out of the furnace fire might result in some combustible carryover from the unit furnace to the superheat sections. The tendency toward this condition can also be evaluated during the exploratory program by visual observation and watching for changes in unit performance.

## ECONOMIC EVALUATION

The cost of incorporating overfire air systems on existing and new unit designs was evaluated for steam generating units from 125 to 1000 MW capacity. The results of this study are shown on Figure 104.

The cost estimates for the revision of existing units are based on studies performed on units within this size range including the actual costs for modification of the Barry 2 unit. The cost estimates presented for including the overfire air system in new unit designs are based on current experience with these systems.

The accuracy of the January, 1977 cost estimates is plus or minus ten percent. Because the overfire air system is included as an integral part of new unit design, it is not therefore, considered as an optional or additional emissions control device. The costs of existing units could be from 0.24 to 1.8 $/kw, due to variations in existing unit design and construction which might make modifications more complicated. These costs may also vary and escalate with the prevailing economic climate.

The largest four-windbox (single cell) furnaces manufactured to date have been in the 625 MW size range at which point eight-windbox furnaces (generally divided into two cells) have been selected. Since an eight windbox tangentially fired furnace has double the firing corners of a four-windbox furnace, the costs of windboxes and ducts increase significantly.

The resulting increase in the cost of electricity generated is approximately

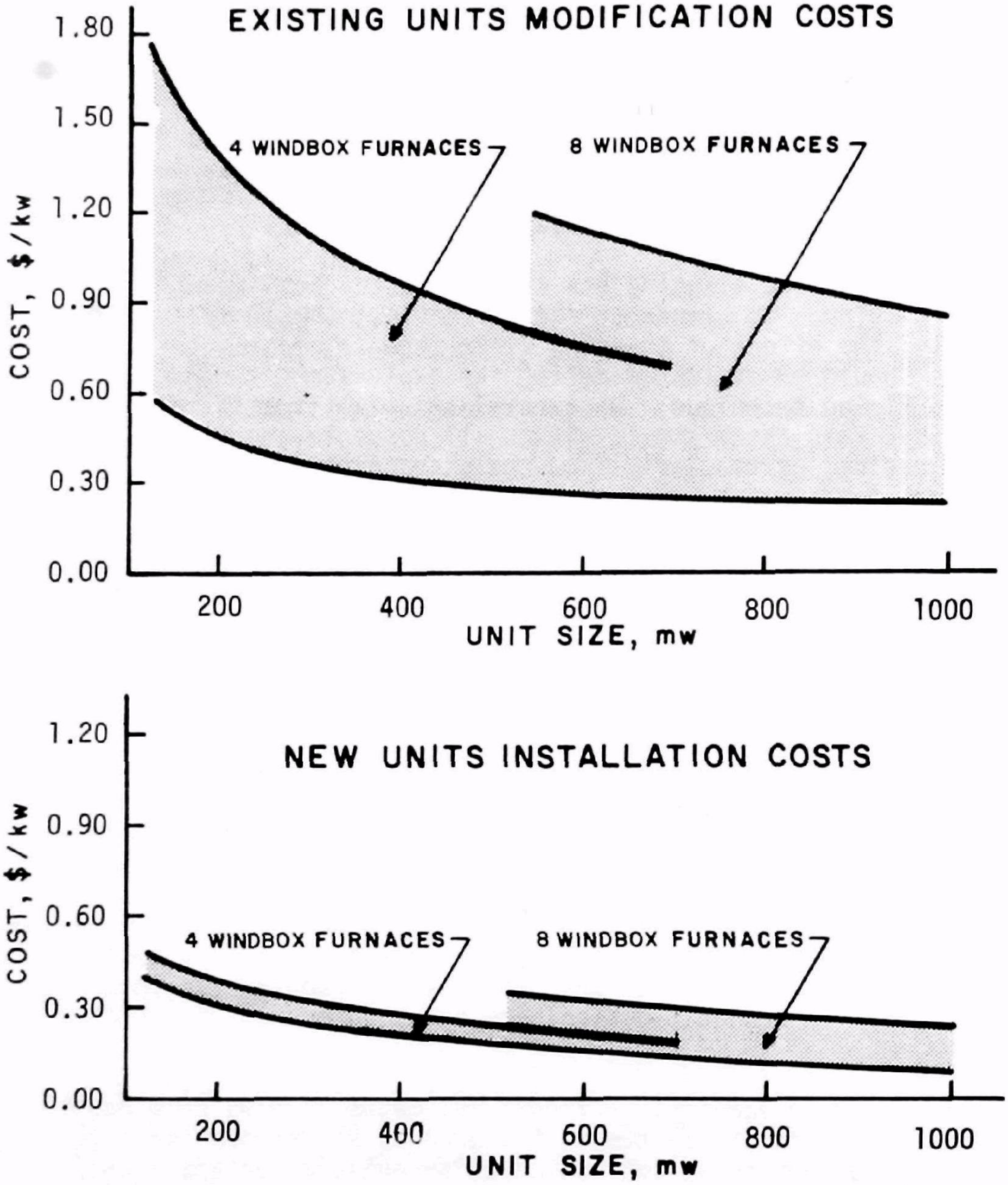


Figure 104: Overfire Air System Costs - Tangential coal fired steam generators - January, 1977 equipment costs

0.02% for a typical new 500 MW plant* costing 600 \$/kw using coal costing 1.00 \$/$10^6$BTU, as illustrated in Table 1. The overfire air system increases capital costs by 0.2 \$/kw, and all other costs are unchanged. The mills/kwhr increase is 0.006.

An existing 500 MW plant has overfire air system costs up to 0.8 \$/kw. Generation costs for a 600 \$/kw plant increase by up to 0.10% or 0.026 mills/kwhr. An existing 500 MW plant which was installed for 300 \$/kw and receives coal costing 0.50 \$/$10^6$BTU has much lower operating costs than the previous example. The cost increase percentage is 0.14%, but the increase in mills/kwhr remains unchanged at 0.026, as shown in the last column of Table 1.

| | | $/KW |
|---|---|---|
| Coal Handling, Storage, Pulverizing, Ash Handling | | 53 |
| $SO_2$ Scrubber System | | 90 |
| Boiler, Air Heaters, Fans, Stack | | 74 |
| Steam Turbine-Generator, Piping, Heaters, Water Treatment, Condenser, Cooling Towers | | 110 |
| Structures, Sitework Foundations, Offices, Land, Workshops, Controls, Switchgear, Transformers | | 76 |
| | Subtotal | 403 |
| Engineering, Construction | | 53 |
| Contingency | | 44 |
| Interest During Construction | | 100 |
| | Total | 600 |

The increases in generating costs (mills/kwhr) for typical 100 MW plants are approximately double the increases for 500 MW plants. The increases for 600 MW plants with divided furnaces are 25% to 35% higher; and the increases for 1000 MW plants are the same as for 500 MW plants.

Transmission and distribution costs are not included in these comparisons. These examples are only typical; a specific plant has to be evaluated on its particular economic criteria.

* January, 1977 equipment costs for 500 MW Coal Fired Power Plant with Limestone $SO_2$ Scrubbing System.

## TABLE 1. COST OF ELECTRICITY GENERATED - 500 MW PLANTS
Net Heat Rate 9500 Btu/Kwhr
January, 1977 Equipment Costs

| | New Plant Without Overfire Air | New Plant With Overfire Air | Recent Existing With Added Overfire Air | Older Existing Without Overfire Air | Older Existing With Added Overfire Air |
|---|---|---|---|---|---|
| Capital Costs, $/kw | 600.00 | 600.20 | 600.80 | 300.00 | 300.80 |
| Annual Cap. Cost, $ | 54,000,000 (a) | 54,018,000 | 54,072,000 | 27,000,000 (b) | 27,072,000 |
| Annual Fuel Cost, $ | 26,000,000 (c) | 26,000,000 | 26,000,000 | 13,000,000 (d) | 13,000,000 |
| Labor & Maint. (e), $ | 10,800,000 | 10,800,000 | 10,800,000 | 10,800,000 | 10,800,000 |
| Total Annual Cost (f), $ | 90,800,000 | 90,818,000 | 90,872,000 | 50,800,000 | 50,872,000 |
| Electricity Cost (g), Mills/kwhr | 33.630 | 33.636 | 33.656 | 18.815 | 18.841 |
| Increase, % | --- | 0.018 | 0.077 | --- | 0.140 |
| Increase, Mills/kwhr | --- | 0.006 | 0.026 | --- | 0.026 |

Based on:
- (a) Annual Fixed Charge Rate of 18% X 600 $/kw X 500,000 kw.
- (b) 18% X 300 $/kw X 500,000 kw.
- (c) 1.00 $/$10^6$ BTU coal cost X 5400 hr/yr X 500,000 kw X 9500 BTU/kwhr.
- (d) 0.50 $/$10^6$ BTU coal cost X 5400 hr/yr X 500,000 kw X 9500 BTU/kwhr.
- (e) Labor and maintenance cost of 4.0 mills/kwhr.
- (f) 5400 hr/yr at 500 MW = 2700 gwhr/yr.
- (g) Cost at plant bus bar; transmission and distribution not included.

## APPLICABILITY

### EXISTING STEAM GENERATING UNITS

In a specific existing plant, the exploratory field test program will provide the data to determine whether an overfire air system is needed to meet $NO_x$ limits. If so, the biased firing tests will show operating effects such as combustible loss, corrosion, or furnace slagging. Favorable results from the field tests should be followed by an evaluation, as shown in Table 1, to determine whether modification costs are economically justified.

Economic considerations include plant age and efficiency. Will the plant continue to operate long enough to pay off the investment? The annual capital cost is inversely proportional to the number of years. Steam generator size also has an effect on the relative economics of overfire air system modifications. For example, the minimum modification cost is about $120,000, which is 4.8 $/kw for a 25 MW unit. With complications, 12 $/kw is possible for a 25 MW unit.

Approximately 40% of the existing coal fired units in the United States are of tangential design and could conceivably be modified to incorporate overfire air systems, if the field test and economic evaluation results are favorable. Since 1949, approximately 320 tangential units have been put into service without overfire air systems.

### NEW STEAM GENERATING UNITS

At the current levels of $NO_x$ limits, an overfire air system should be included as a standard design feature of a new unit. The technology is proven, and the cost is minimal when included in the original design.

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APPENDIX A

TEST DATA & RESULTS
FOR
WISCONSIN POWER & LIGHT COMPANY
COLUMBIA ENERGY CENTER
UNIT #1

# BASELINE OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | ← | | | | EXCESS AIR | VARIATION | | | | → |
| UNIT LOAD CONDITION | | MAX | MAX | MAX | 3/4 MAX | 1/2 MAX | 1/2 MAX | 1/2 MAX | MAX | MAX | MAX |
| FURNACE CONDITION | | CLEAN | CLEAN | CLEAN | CLEAN | CLEAN | CLEAN | CLEAN | | MODERATELY DIRTY | |
| EXCESS AIR CONDITION | | MIN | NORM | MAX | NORM | MIN | NORM | MAX | MIN | NORM | MAX |
| DATE | 1976 | 3/10 | 3/8 | 3/15 | 3/13 | 5/23 | 5/23 | 5/23 | 3/10 | 3/9 | 3/10 |
| UNIT LOAD | MW | 524 | 524 | 485 | 399 | 324 | 323 | 322 | 514 | 515 | 482 |
| MAIN STEAM FLOW | KG/S | 441 | 442 | 400 | 334 | 267 | 269 | 268 | 427 | 432 | 394 |
| SHO TEMPERATURE | °C | 536 | 540 | 543 | 542 | 546 | 543 | 548 | 540 | 540 | 540 |
| RHO TEMPERATURE | °C | 541 | 542 | 541 | 539 | 522 | 521 | 522 | 541 | 541 | 544 |
| FUEL ELEVATIONS IN SERVICE | | ABDEF | ABDEF | ABDEF | ABDEF | CDEF | CDEF | CDEF | ABDEF | ABDEF | ABDEF |
| OFA NOZZLE TILT | DEG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FUEL NOZZLE TILT | DEG | -4 | +1 | -2 | +17 | +10 | +10 | +9 | -4 | +3 | -4 |

NOZZLE COMPARTMENT DAMPER POSITION - % OPEN

| Compartment | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OFA | % OPEN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OFA | % OPEN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AUX | % OPEN | 100 | 100 | 100 | 55 | 0 | 5 | 10 | 55 | 100 | 100 |
| 1-F FUEL | % OPEN | 50 | 50 | 50 | 40 | 85 | 75 | 80 | 40 | 50 | 50 |
| AUX | % OPEN | 100 | 100 | 100 | 50 | 0 | 5 | 15 | 60 | 100 | 100 |
| 1-E FUEL | % OPEN | 50 | 50 | 50 | 45 | 90 | 85 | 80 | 40 | 50 | 50 |
| AUX | % OPEN | 100 | 100 | 100 | 50 | 0 | 5 | 10 | 55 | 100 | 100 |
| 1-D FUEL | % OPEN | 50 | 50 | 50 | 40 | 85 | 80 | 85 | 35 | 50 | 50 |
| AUX | % OPEN | 100 | 100 | 100 | 50 | 5 | 10 | 20 | 50 | 100 | 100 |
| 1-C FUEL | % OPEN | 0 | 0 | 0 | 0 | 90 | 70 | 85 | 0 | 0 | 0 |
| AUX | % OPEN | 100 | 100 | 100 | 50 | 0 | 10 | 15 | 50 | 100 | 100 |
| 1-B FUEL | % OPEN | 50 | 50 | 50 | 40 | 0 | 0 | 0 | 35 | 50 | 50 |
| AUX | % OPEN | 100 | 100 | 100 | 50 | 0 | 0 | 0 | 50 | 100 | 100 |
| 1-A FUEL | % OPEN | 50 | 50 | 50 | 40 | 0 | 0 | 0 | 35 | 50 | 50 |
| AUX | % OPEN | 100 | 100 | 100 | 50 | 0 | 0 | 0 | 55 | 100 | 100 |

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EXCESS AIR AT ECONOMIZER OUTLET | % | 20.7 | 21.8 | 34.7 | 35.6 | 27.7 | 37.5 | 43.5 | 19.4 | 23.7 | 30.6 |
| THEO. AIR TO THE FUEL FIRING ZONE | % | 117.8 | 118.9 | 131.4 | 132.5 | 126.7 | 136.2 | 141.4 | 116.5 | 120.7 | 127.5 |
| $NO_x$ (ADJ. TO 0% $O_2$) | PPM | 650 | 520 | 599 | 498 | 593 | 653 | 662 | 596 | 578 | 626 |
| $NO_x$ AS $NO_2$ | NG/J | 322.9 | 260.2 | 303.7 | 246.3 | 291.2 | 335.2 | 333.8 | 295.7 | 290.2 | 310.6 |
| $SO_2$ (ADJ. TO 0% $O_2$) | PPM | 1156 | 1138 | 1003 | 1119 | 1362 | 1379 | 1230 | 1184 | 1230 | 1171 |
| $SO_2$ | NG/J | 799.7 | 792.6 | 708.4 | 770.4 | 931.8 | 985.0 | 864.0 | 817.9 | 859.4 | 809.1 |
| CO (ADJ. TO 0% $O_2$) | PPM | 16 | 16 | 18 | NA | 5 | 6 | 7 | 17 | 16 | 17 |
| CO | NG/J | 4.8 | 4.8 | 5.4 | NA | 1.5 | 1.7 | 2.2 | 5.1 | 4.9 | 5.1 |
| HC (ADJ. TO 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ AT ECONOMIZER OUTLET | % | 3.6 | 3.8 | 5.5 | 5.6 | 4.6 | 5.8 | 6.4 | 3.5 | 4.1 | 5.0 |
| $O_2$ AT A.H. INLET | % | 4.3 | 4.4 | 5.7 | 5.7 | 4.9 | 6.0 | 6.5 | 4.0 | 4.5 | 5.2 |
| $O_2$ AT A.H. OUTLET | % | 4.5 | 5.3 | 6.8 | 7.6 | 7.2 | 7.6 | 8.1 | 4.2 | 5.6 | 5.6 |
| $CO_2$ AT ECONOMIZER OUTLET | % | 15.6 | 15.6 | 14.1 | 14.0 | 14.9 | 13.5 | 13.1 | 15.9 | 15.2 | 14.5 |
| $CO_2$ AT A.H. INLET | % | 15.0 | 15.1 | 13.9 | 13.9 | 14.6 | 13.3 | 13.0 | 15.4 | 14.8 | 14.2 |
| $CO_2$ AT A.H. OUTLET | % | 14.8 | 14.2 | 12.9 | 12.2 | 12.5 | 11.9 | 11.6 | 15.2 | 13.8 | 13.9 |
| CARBON LOSS IN FLY ASH | % | 0.02 | 0.03 | 0.02 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.11 |

# BASELINE OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | EXCESS AIR VARIATION | | | | | | | | |
| Unit Load Condition | | 1/2 Max | 1/2 Max | Max | Max | Max | 3/4 Max | 1/2 Max | 1/2 Max | 1/2 Max |
| Furnace Condition | | Moderate | | Dirty | Dirty | Dirty | Dirty | Dirty | Dirty | Dirty |
| Excess Air Condition | | Min | Max | Min | Norm | Max | Norm | Min | Norm | Max |
| Date | 1976 | 5/21 | 5/25 | 3/12 | 3/9 | 3/10 | 3/13 | 5/25 | 5/25 | 5/25 |
| Unit Load | MW | 321 | 321 | 524 | 513 | 484 | 401 | 322 | 325 | 322 |
| Main Steam Flow | kg/s | 263 | 265 | 432 | 426 | 397 | 329 | 264 | 267 | 263 |
| SHO Temperature | °C | 546 | 546 | 543 | 539 | 540 | 542 | 545 | 545 | 548 |
| RHO Temperature | °C | 541 | 536 | 543 | 540 | 544 | 540 | 529 | 534 | 536 |
| Fuel Elevations in Service | | ABCD | ABCD | ABDEF | ABDEF | ABDEF | ABDEF | ABCD | ABCD | ABCD |
| OFA Nozzle Tilt | Deg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fuel Nozzle Tilt | Deg | +10 | +6 | -4 | +3 | -4 | +18 | +7 | +6 | +7 |
| Nozzle Compartment Damper Position - % Open: OFA | % Open | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OFA | % Open | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AUX | % Open | 0 | 0 | 100 | 100 | 100 | 55 | 0 | 0 | 0 |
| 1-F FUEL | % Open | 0 | 0 | 45 | 50 | 50 | 40 | 0 | 0 | 0 |
| AUX | % Open | 0 | 0 | 100 | 100 | 100 | 50 | 0 | 0 | 0 |
| 1-E FUEL | % Open | 0 | 0 | 50 | 50 | 50 | 45 | 0 | 0 | 0 |
| AUX | % Open | 0 | 30 | 100 | 100 | 100 | 50 | 0 | 10 | 55 |
| 1-D FUEL | % Open | 50 | 90 | 50 | 50 | 50 | 40 | 80 | 80 | 70 |
| AUX | % Open | 0 | 35 | 100 | 100 | 100 | 50 | 0 | 15 | 45 |
| 1-C FUEL | % Open | 65 | 90 | 0 | 0 | 0 | 0 | 85 | 80 | 90 |
| AUX | % Open | 0 | 30 | 100 | 100 | 100 | 50 | 0 | 15 | 50 |
| 1-B FUEL | % Open | 50 | 80 | 50 | 50 | 50 | 40 | 75 | 80 | 70 |
| AUX | % Open | 0 | 35 | 100 | 100 | 100 | 50 | 0 | 15 | 40 |
| 1-A FUEL | % Open | 55 | 80 | 50 | 50 | 50 | 40 | 80 | 80 | 85 |
| AUX | % Open | 100 | 100 | 100 | 100 | 100 | 50 | 100 | 100 | 100 |
| Excess Air at Economizer Outlet | % | 20.4 | 52.5 | 17.1 | 22.6 | 32.2 | 35.7 | 26.1 | 39.5 | 54.8 |
| Theo. Air to the Fuel Firing Zone | % | 117.2 | 145.0 | 114.3 | 119.7 | 129.0 | 132.5 | 122.8 | 134.3 | 144.6 |
| $NO_x$ (Adj. to 0% $O_2$) | PPM | 536 | 733 | 626 | 617 | 674 | 478 | 586 | 690 | 733 |
| $NO_x$ as $NO_2$ | ng/J | 270.5 | 368.3 | 315.7 | 309.5 | 334.3 | 252.9 | 294.6 | 347.7 | 369.2 |
| $SO_2$ (Adj. to 0% $O_2$) | PPM | 1318 | 1131 | 1197 | 1070 | 1293 | 975 | 1250 | 1460 | 1140 |
| $SO_2$ | ng/J | 926.4 | 791.8 | 839.8 | 747.0 | 891.1 | 718.5 | 875.4 | 1024.4 | 800.1 |
| CO (Adj. to 0% $O_2$) | PPM | 5 | 6 | NA | 16 | 19 | NA | 4 | 4 | 5 |
| CO | ng/J | 1.5 | 1.9 | NA | 4.9 | 5.6 | NA | 1.2 | 1.3 | 1.4 |
| HC (Adj. to 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ at Economizer Outlet | % | 3.6 | 7.3 | 3.1 | 3.9 | 5.2 | 5.6 | 4.4 | 6.0 | 7.5 |
| $O_2$ at A.H. Inlet | % | 3.7 | 7.6 | 3.5 | 4.6 | 5.5 | 6.0 | 4.8 | 6.3 | 7.7 |
| $O_2$ at A.H. Outlet | % | 5.8 | 9.5 | 4.9 | 5.5 | 6.1 | 7.4 | 6.6 | 7.7 | 9.6 |
| $CO_2$ at Economizer Outlet | % | 15.6 | 12.3 | 16.2 | 15.5 | 14.3 | 14.0 | 15.1 | 13.6 | 12.2 |
| $CO_2$ at A.H. Inlet | % | 15.5 | 12.0 | 15.8 | 14.9 | 14.0 | 13.6 | 14.7 | 13.3 | 12.0 |
| $CO_2$ at A.H. Outlet | % | 13.6 | 10.3 | 14.5 | 14.0 | 13.5 | 12.3 | 13.0 | 12.0 | 10.3 |
| Carbon Loss in Fly Ash | % | 0.01 | 0.02 | 0.30 | 0.01 | 0.19 | 0.04 | 0.02 | 0.02 | 0.02 |

# BIASED FIRING OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | | ← VARIATION OF FUEL ELEVATIONS IN SERVICE → | | | | | | | | |
| Unit Load Condition | | | Maximum | Maximum | Maximum | Maximum | 3/4 Max | 3/4 Max | 3/4 Max | 1/2 Max | 1/2 Max |
| Excess Air Condition | | | Minimum | Minimum | Minimum | Minimum | Minimum | Minimum | Minimum | Minimum | Minimum |
| Furnace Condition | | | ← Moderately Dirty → | | | | | | | | Clean |
| Date | | 1976 | 5/19 | 5/19 | 3/14 | 5/19 | 5/12 | 5/12 | 5/16 | 5/21 | 6/27 |
| Unit Load | | MW | 505 | 506 | 525 | 506 | 422 | 422 | 421 | 320 | 314 |
| Main Steam Flow | | kg/s | 426 | 428 | 433 | 431 | 352 | 352 | 344 | 263 | 258 |
| SHO Temperature | | °C | 546 | 546 | 543 | 545 | 545 | 543 | 546 | 545 | 544 |
| RHO Temperature | | °C | 550 | 547 | 542 | 548 | 544 | 545 | 547 | 545 | 504 |
| Fuel Elevations in Service | | | ABCDE | ABCDF | ABDEF | BCDEF | ABCE | ABCE | BCDE | ABCD | ABEF |
| OFA Nozzle Tilt | | Deg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fuel Nozzle Tilt | | Deg | +4 | -4 | -4 | -8 | -2 | 0 | +13 | +10 | 0 |
| Nozzle Compartment Damper Position - % Open | OFA | % Open | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | OFA | % Open | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | AUX | % Open | 0 | 30 | 90 | 35 | 0 | 0 | 0 | 0 | 0 |
| | 1-F FUEL | % Open | 100 | 100 | 50 | 100 | 100 | 0 | 0 | 100 | 90 |
| | AUX | % Open | 45 | 35 | 90 | 35 | 20 | 20 | 25 | 0 | 0 |
| | 1-E FUEL | % Open | 100 | 100 | 50 | 100 | 100 | 100 | 100 | 100 | 90 |
| | AUX | % Open | 45 | 30 | 90 | 30 | 20 | 10 | 20 | 0 | 0 |
| | 1-D FUEL | % Open | 100 | 100 | 50 | 100 | 0 | 100 | 100 | 85 | 100 |
| | AUX | % Open | 45 | 30 | 90 | 30 | 15 | 15 | 15 | 0 | 0 |
| | 1-C FUEL | % Open | 100 | 100 | 95 | 100 | 100 | 100 | 100 | 90 | 100 |
| | AUX | % Open | 45 | 25 | 90 | 30 | 15 | 15 | 15 | 0 | 0 |
| | 1-B FUEL | % Open | 100 | 100 | 40 | 100 | 100 | 100 | 90 | 90 | 80 |
| | AUX | % Open | 45 | 35 | 80 | 30 | 10 | 15 | 10 | 0 | 0 |
| | 1-A FUEL | % Open | 100 | 100 | 50 | 100 | 100 | 100 | 100 | 90 | 80 |
| | AUX | % Open | 50 | 45 | 95 | 0 | 100 | 100 | 100 | 100 | 80 |
| Excess Air at Economizer Outlet | | % | 20.4 | 18.4 | 15.2 | 19.0 | 26.1 | 21.7 | 30.7 | 19.7 | 34.2 |
| Theo. Air to the Fuel Firing Zone | | % | 108.2 | 116.6 | 112.6 | 116.9 | 110.0 | 117.5 | 125.6 | 94.4 | 133.5 |
| $NO_x$ (Adj. to 0% $O_2$) | | PPM | 408 | 413 | 492 | 504 | 417 | 507 | 442 | 326 | 513 |
| $NO_x$ as $NO_2$ | | ng/J | 203.9 | 209.1 | 249.2 | 250.3 | 215.9 | 260.2 | 227.3 | 162.2 | 245.1 |
| $SO_2$ (Adj. to 0% $O_2$) | | PPM | 1152 | 1101 | 1170 | NA | 1088 | 1088 | 1088 | 1252 | 995 |
| $SO_2$ | | ng/J | 802.4 | 776.6 | 826.1 | NA | 783.6 | 778.1 | 778.6 | 865.9 | 662.2 |
| CO (Adj. to 0% $O_2$) | | PPM | NA | NA | NA | NA | 25 | 13 | 143 | 5 | 4 |
| CO | | ng/J | NA | NA | NA | NA | 8.0 | 4.2 | 44.8 | 1.4 | 1.2 |
| HC (Adj. to 0% $O_2$) | | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ at Economizer Outlet | | % | 3.6 | 3.3 | 2.8 | 3.4 | 4.4 | 3.8 | 5.0 | 3.5 | 5.4 |
| $O_2$ at A.H. Inlet | | % | 4.0 | 4.0 | 3.3 | 4.0 | 4.7 | 4.2 | 5.2 | 3.7 | 5.6 |
| $O_2$ at A.H. Outlet | | % | 6.3 | 6.2 | 4.7 | 6.1 | 6.8 | 5.9 | 6.6 | 6.0 | 7.6 |
| $CO_2$ at Economizer Outlet | | % | 15.8 | 16.1 | 16.5 | 16.0 | 14.9 | 15.3 | 14.3 | 15.9 | 14.3 |
| $CO_2$ at A.H. Inlet | | % | 15.4 | 15.4 | 16.0 | 15.4 | 14.6 | 14.9 | 14.1 | 15.7 | 14.1 |
| $CO_2$ at A.H. Outlet | | % | 13.3 | 13.4 | 14.7 | 13.5 | 12.7 | 13.4 | 12.8 | 13.6 | 12.2 |
| Carbon Loss in Fly Ash | | % | 0.02 | 0.03 | 0.35 | 0.02 | 0.03 | 0.02 | 0.02 | 0.01 | 0.02 |

# BIASED FIRING OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | ← VARIATION OF FUEL ELEVATIONS IN SERVICE → | | | | | | | | |
| Unit Load Condition | | 1/2 Max | Maximum | Maximum | Maximum | 3/4 Max | 3/4 Max | 3/4 Max | 1/2 Max | 1/2 Max |
| Excess Air Condition | | Minimum | Normal | Normal | Normal | Normal | Normal | Normal | Normal | Normal |
| Furnace Condition | | Clean | ← Moderately Dirty → | | | | | | | Clean |
| Date | 1976 | 5/23 | 5/19 | 5/10 | 3/16 | 5/12 | 3/13 | 5/16 | 5/21 | 5/23 |
| Unit Load | MW | 324 | 491 | 497 | 523 | 423 | 400 | 422 | 320 | 323 |
| Main Steam Flow | kg/s | 268 | 417 | 417 | 438 | 353 | 325 | 350 | 261 | 264 |
| SHO Temperature | °C | 547 | 546 | 547 | 542 | 545 | 543 | 546 | 545 | 545 |
| RHO Temperature | °C | 529 | 550 | 546 | 542 | 544 | 540 | 547 | 543 | 530 |
| Fuel Elevations in Service | | CDEF | ABCDF | ABCEF | ABDEF | ABCE | ABDEF | BCDE | ABCD | CDEF |
| OFA Nozzle Tilt | Deg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fuel Nozzle Tilt | Deg | +5 | +5 | -2 | -4 | 0 | 0 | +10 | +12 | +9 |
| Nozzle Compartment Damper Position - % Open: OFA | % Open | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OFA | % Open | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AUX | % Open | 0 | 0 | 15 | 95 | 0 | 55 | 0 | 0 | 0 |
| 1-F FUEL | % Open | 55 | 100 | 100 | 50 | 100 | 40 | 0 | 100 | 85 |
| AUX | % Open | 0 | 50 | 35 | 95 | 30 | 50 | 35 | 0 | 0 |
| 1-E FUEL | % Open | 65 | 100 | 100 | 50 | 100 | 45 | 100 | 100 | 90 |
| AUX | % Open | 0 | 45 | 30 | 90 | 35 | 50 | 35 | 0 | 0 |
| 1-D FUEL | % Open | 55 | 100 | 100 | 50 | 0 | 35 | 100 | 90 | 80 |
| AUX | % Open | 0 | 40 | 35 | 95 | 30 | 50 | 40 | 0 | 0 |
| 1-C FUEL | % Open | 60 | 100 | 100 | 50 | 100 | 100 | 100 | 90 | 90 |
| AUX | % Open | 0 | 45 | 30 | 95 | 25 | 50 | 35 | 0 | 0 |
| 1-B FUEL | % Open | 90 | 100 | 95 | 100 | 100 | 40 | 100 | 90 | 100 |
| AUX | % Open | 0 | 50 | 30 | 85 | 20 | 50 | 50 | 0 | 0 |
| 1-A FUEL | % Open | 100 | 100 | 100 | 50 | 100 | 40 | 100 | 70 | 100 |
| AUX | % Open | 0 | 50 | 100 | 95 | 100 | 50 | 100 | 100 | 0 |
| Excess Air at Economizer Outlet | % | 29.2 | 23.1 | 24.6 | 18.4 | 34.1 | 35.8 | 41.3 | 35.9 | 36.6 |
| Theo. Air to the Fuel Firing Zone | % | 128.4 | 122.7 | 123.4 | 115.8 | 117.9 | 132.9 | 135.8 | 105.8 | 135.8 |
| $NO_x$ (Adj. to 0% $O_2$) | PPM | 525 | 454 | 590 | 556 | 443 | 462 | 494 | 462 | 629 |
| $NO_x$ as $NO_2$ | ng/J | 266.8 | 231.2 | 297.2 | 280.4 | 222.5 | 231.7 | 246.4 | 228.7 | 316.9 |
| $SO_2$ (Adj. to 0% $O_2$) | PPM | 1313 | 1174 | 870 | 1029 | 1139 | 859 | 1166 | 1256 | 1278 |
| $SO_2$ | ng/J | 929.3 | 831.0 | 610.3 | 721.9 | 796.9 | 599.6 | 810.7 | 865.4 | 897.1 |
| CO (Adj. to 0% $O_2$) | PPM | 5 | NA | 18 | NA | 74 | NA | NA | 4 | 7 |
| CO | ng/J | 1.6 | NA | 5.4 | NA | 22.6 | NA | NA | 1.2 | 2.1 |
| HC (Adj. to 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ at Economizer Outlet | % | 4.8 | 4.0 | 4.2 | 3.3 | 5.4 | 5.6 | 6.2 | 5.6 | 5.7 |
| $O_2$ at A.H. Inlet | % | 5.2 | 4.1 | 4.8 | 4.3 | 5.7 | 5.7 | 6.4 | 5.8 | 5.9 |
| $O_2$ at A.H. Outlet | % | 6.9 | 6.7 | 6.2 | 5.6 | 7.1 | 7.4 | 8.4 | 7.6 | 7.8 |
| $CO_2$ at Economizer Outlet | % | 14.5 | 15.3 | 15.2 | 16.1 | 14.1 | 13.8 | 13.4 | 13.9 | 13.6 |
| $CO_2$ at A.H. Inlet | % | 14.2 | 15.2 | 14.7 | 15.2 | 13.8 | 13.8 | 13.2 | 13.7 | 13.4 |
| $CO_2$ at A.H. Outlet | % | 12.6 | 12.8 | 13.4 | 13.9 | 12.5 | 12.1 | 11.4 | 12.1 | 11.7 |
| Carbon Loss in Fly Ash | % | 0.04 | 0.02 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.04 |

# OVERFIRE AIR OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 TILT VAR. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | OVERFIRE AIR DAMPER VARIATION | | | | | | | | | | | WITH OFA |
| UNIT LOAD CONDITION | | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM |
| EXCESS AIR CONDITION | | NORMAL | NORMAL | NORMAL | NORMAL | NORMAL | MINIMUM | MINIMUM | MINIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MINIMUM |
| FURNACE CONDITION | | MODERATELY DIRTY | | | | CLEAN | | | | MODERATE | CLEAN | | |
| DATE | 1976 | 3/17 | 3/17 | 3/20 | 3/20 | 3/22 | 3/20 | 3/20 | 3/20 | 3/24 | 3/24 | 3/24 | 6/24 |
| UNIT LOAD | MW | 517 | 512 | 524 | 525 | 526 | 521 | 522 | 522 | 476 | 473 | 472 | 524 |
| MAIN STEAM FLOW | KG/S | 425 | 426 | 439 | 445 | 444 | 446 | 441 | 439 | 398 | 390 | 389 | 446 |
| SHO TEMPERATURE | °C | 542 | 541 | 533 | 534 | 534 | 543 | 532 | 532 | 538 | 539 | 534 | 540 |
| RHO TEMPERATURE | °C | 542 | 541 | 534 | 533 | 538 | 547 | 534 | 532 | 540 | 540 | 539 | 547 |
| FUEL ELEVATIONS IN SERVICE | | ACDEF | ACDEF | ACDEF | ACDEF | ACDEF | ACDEF | ACDEF | ACDEF | ABCEF | ABCEF | ABCEF | ABDEF |
| OFA NOZZLE TILT | DEG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -5 |
| FUEL NOZZLE TILT | DEG | -4 | -4 | -8 | +1 | +1 | +6 | +8 | +1 | +2 | +1 | +3 | -5 |
| NOZZLE COMPARTMENT DAMPER POSITION - % OPEN: OFA | % OPEN | 0 | 25 | 50 | 70 | 95 | 0 | 50 | 100 | 25 | 80 | 100 | 100 |
| OFA | % OPEN | 0 | 25 | 50 | 70 | 95 | 0 | 50 | 100 | 25 | 80 | 100 | 100 |
| AUX | % OPEN | 100 | 95 | 85 | 75 | 65 | 65 | 55 | 50 | 100 | 80 | 55 | 25 |
| 1-F FUEL | % OPEN | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 100 |
| AUX | % OPEN | 100 | 100 | 85 | 75 | 65 | 65 | 50 | 50 | 90 | 75 | 50 | 20 |
| 1-E FUEL | % OPEN | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 100 |
| AUX | % OPEN | 100 | 95 | 85 | 75 | 70 | 65 | 55 | 50 | 90 | 80 | 50 | 20 |
| 1-D FUEL | % OPEN | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 0 | 0 | 0 | 100 |
| AUX | % OPEN | 100 | 100 | 80 | 70 | 60 | 60 | 50 | 50 | 95 | 80 | 50 | 20 |
| 1-C FUEL | % OPEN | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 45 | 0 |
| AUX | % OPEN | 100 | 95 | 85 | 70 | 70 | 65 | 55 | 50 | 95 | 75 | 50 | 15 |
| 1-B FUEL | % OPEN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 50 | 50 | 100 |
| AUX | % OPEN | 100 | 95 | 80 | 70 | 65 | 60 | 50 | 50 | 90 | 80 | 50 | 20 |
| 1-A FUEL | % OPEN | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 100 |
| AUX | % OPEN | 100 | 95 | 85 | 70 | 70 | 75 | 70 | 50 | 100 | 90 | 85 | 100 |
| EXCESS AIR AT ECONOMIZER OUTLET | % | 23.9 | 23.2 | 21.8 | 19.7 | 20.4 | 13.3 | 13.9 | 15.1 | 36.8 | 35.8 | 30.0 | 23.9 |
| THEO. AIR TO THE FUEL FIRING ZONE | % | 120.9 | 115.7 | 109.7 | 105.2 | 104.6 | 110.7 | 101.8 | 99.0 | 128.2 | 118.8 | 111.5 | 102.8 |
| $NO_x$ (ADJ. TO 0% $O_2$) | PPM | 718 | 710 | 442 | 409 | 434 | 364 | 356 | 344 | 594 | 551 | 485 | 395 |
| $NO_x$ AS $NO_2$ | NG/J | 356.1 | 354.9 | 222.8 | 203.4 | 215.4 | 182.7 | 177.9 | 171.4 | 299.2 | 274.7 | 246.5 | 195.5 |
| $SO_2$ (ADJ. TO 0% $O_2$) | PPM | 1190 | 1207 | 1266 | 1404 | 1320 | 1203 | 1245 | 1240 | 1267 | 1342 | 1329 | 1023 |
| $SO_2$ | NG/J | 821.9 | 839.8 | 888.8 | 971.9 | 911.8 | 840.2 | 866.5 | 861.0 | 888.3 | 931.8 | 940.3 | 704.7 |
| CO (ADJ. TO 0% $O_2$) | PPM | 16 | 16 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 16 |
| CO | NG/J | 4.9 | 4.9 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 4.9 |
| HC (ADJ. TO 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ AT ECONOMIZER OUTLET | % | 4.1 | 4.0 | 3.8 | 3.5 | 3.6 | 2.5 | 2.6 | 2.8 | 5.7 | 5.6 | 4.9 | 4.1 |
| $O_2$ AT A.H. INLET | % | 4.3 | 5.0 | 4.0 | 3.9 | 4.1 | 3.3 | 3.4 | 3.5 | 5.8 | 5.8 | 5.0 | 4.4 |
| $O_2$ AT A.H. OUTLET | % | 5.3 | 5.4 | 5.3 | 5.1 | 5.0 | 4.5 | 5.0 | 4.5 | 7.0 | 7.0 | 6.1 | 5.6 |
| $CO_2$ AT ECONOMIZER OUTLET | % | 15.3 | 15.4 | 15.5 | 15.8 | 15.7 | 16.7 | 16.6 | 16.4 | 13.9 | 13.8 | 13.5 | 13.9 |
| $CO_2$ AT A.H. INLET | % | 15.1 | 14.5 | 15.3 | 15.4 | 15.2 | 16.0 | 15.9 | 15.8 | 13.8 | 13.7 | 14.5 | 15.0 |
| $CO_2$ AT A.H. OUTLET | % | 14.2 | 14.2 | 14.1 | 14.4 | 14.4 | 14.9 | 14.4 | 14.9 | 12.7 | 12.6 | 13.5 | 13.9 |
| CARBON LOSS IN FLY ASH | % | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.03 | 0.04 | 0.03 | 0.01 | 0.02 | 0.01 | 0.02 |

# OVERFIRE AIR OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | ← FUEL NOZZLE - OFA NOZZLE TILT VARIATION → | | | | | | | ← OPTIMUM OFA OPERATION → | | | | |
| UNIT LOAD CONDITION | | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | MAXIMUM | 3/4 MAX | 3/4 MAX | 1/2 MAX | 1/2 MAX |
| EXCESS AIR CONDITION | | MINIMUM | MINIMUM | MINIMUM | MINIMUM | MINIMUM | MINIMUM | MINIMUM | MINIMUM | MINIMUM | MINIMUM | MINIMUM | MINIMUM |
| FURNACE CONDITION | | MODERATE | ← CLEAN → | | | MODERATE | CLEAN | MODERATE | HEAVY | CLEAN | MODERATE | CLEAN | MODERATE |
| DATE | 1976 | 6/24 | 6/24 | 3/25 | 6/30 | 6/25 | 6/30 | 6/29 | 6/25 | 6/26 | 6/25 | 6/27 | 5/29 |
| UNIT LOAD | MW | 525 | 523 | 511 | 526 | 524 | 526 | 524 | 521 | 419 | 422 | 316 | 322 |
| MAIN STEAM FLOW | KG/S | 444 | 443 | 425 | 438 | 440 | 441 | 441 | 438 | 350 | 342 | 263 | 259 |
| SHO TEMPERATURE | °C | 548 | 544 | 533 | 548 | 547 | 548 | 546 | 548 | 546 | 548 | 538 | 546 |
| RHO TEMPERATURE | °C | 539 | 546 | 536 | 545 | 547 | 542 | 547 | 542 | 542 | 545 | 500 | 543 |
| FUEL ELEVATIONS IN SERVICE | | ABDEF | ABDEF | ABCEF | ABDEF | ABDEF | ABDEF | ABDEF | ABDEF | ABDE | ABDEF | ABEF | ABEF |
| OFA NOZZLE TILT | DEG | -5 | 0 | 0 | 0 | +30 | +30 | +10 | 0 | 0 | 0 | +10 | +10 |
| FUEL NOZZLE TILT | DEG | 0 | -5 | +1 | 26 | +2 | +26 | +1 | 0 | 0 | 0 | +7 | +12 |
| NOZZLE COMPARTMENT DAMPER POSITION - % OPEN: OFA | % OPEN | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| OFA | % OPEN | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | % OPEN | 20 | 25 | 50 | 20 | 25 | 20 | 10 | 20 | 0 | 0 | 0 | 0 |
| 1-F FUEL | % OPEN | 100 | 95 | 50 | 100 | 100 | 100 | 100 | 90 | 0 | 100 | 80 | 0 |
| AUX | % OPEN | 20 | 30 | 50 | 20 | 20 | 20 | 10 | 5 | 10 | 0 | 0 | 0 |
| 1-E FUEL | % OPEN | 100 | 100 | 50 | 100 | 100 | 100 | 100 | 90 | 100 | 100 | 85 | 85 |
| AUX | % OPEN | 20 | 20 | 50 | 20 | 20 | 20 | 10 | 5 | 5 | 0 | 0 | 0 |
| 1-D FUEL | % OPEN | 100 | 100 | 0 | 100 | 100 | 100 | 100 | 70 | 100 | 100 | 0 | 80 |
| AUX | % OPEN | 20 | 25 | 50 | 20 | 20 | 20 | 10 | 5 | 10 | 0 | 0 | 5 |
| 1-C FUEL | % OPEN | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AUX | % OPEN | 20 | 20 | 50 | 20 | 15 | 20 | 5 | 5 | 0 | 0 | 85 | 80 |
| 1-B FUEL | % OPEN | 100 | 100 | 50 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 0 |
| AUX | % OPEN | 20 | 15 | 50 | 20 | 20 | 20 | 10 | 5 | 0 | 0 | 0 | 0 |
| 1-A FUEL | % OPEN | 100 | 100 | 50 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 85 | 80 |
| AUX | % OPEN | 100 | 100 | 50 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 90 | 80 |
| EXCESS AIR AT ECONOMIZER OUTLET | % | 26.9 | 26.9 | 18.3 | 24.6 | 26.2 | 23.2 | 19.1 | 25.4 | 30.0 | 28.5 | 32.5 | 34.2 |
| THEO. AIR TO THE FUEL FIRING ZONE | % | 105.7 | 106.0 | 101.5 | 103.9 | 104.7 | 103.1 | 99.7 | 99.3 | 98.6 | 103.4 | 106.1 | 107.0 |
| $NO_x$ (ADJ. TO 0% $O_2$) | PPM | 428 | 389 | 392 | 558 | 460 | 473 | 385 | 483 | 340 | 456 | 341 | 334 |
| $NO_x$ AS $NO_2$ | NG/J | 205.4 | 188.5 | 198.9 | 273.7 | 224.6 | 223.4 | 182.8 | 234.8 | 171.8 | 220.6 | 161.9 | 161.0 |
| $SO_2$ (ADJ. TO 0% $O_2$) | PPM | 1008 | 937 | 1010 | 958 | 964 | 981 | 941 | 958 | 905 | 989 | 959 | 1069 |
| $SO_2$ | NG/J | 674.2 | 631.4 | 714.2 | 654.7 | 654.8 | 645.0 | 621.9 | 648.9 | 636.3 | 666.4 | 634.0 | 717.8 |
| CO (ADJ. TO 0% $O_2$) | PPM | 5 | 10 | NA | 8 | 15 | 59 | 76 | 4 | 4 | 4 | 4 | 5 |
| CO | NG/J | 1.5 | 3.0 | NA | 2.2 | 4.5 | 17.0 | 22.1 | 1.1 | 1.2 | 1.1 | 1.2 | 1.6 |
| HC (ADJ. TO 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ AT ECONOMIZER OUTLET | % | 4.5 | 4.5 | 3.3 | 4.2 | 4.4 | 4.0 | 3.4 | 4.3 | 4.9 | 4.7 | 5.3 | 5.4 |
| $O_2$ AT A.H. INLET | % | 4.7 | 4.6 | 3.6 | 4.4 | 4.7 | 4.2 | 3.5 | 4.6 | 5.2 | 4.9 | 5.5 | 5.4 |
| $O_2$ AT A.H. OUTLET | % | 6.2 | 5.9 | 5.0 | 5.7 | 6.1 | 5.8 | 5.0 | 6.0 | 6.9 | 6.3 | 7.2 | 7.1 |
| $CO_2$ AT ECONOMIZER OUTLET | % | 13.5 | 13.8 | 14.4 | 13.9 | 13.6 | 13.9 | 14.7 | 13.7 | 14.6 | 14.9 | 14.5 | 14.2 |
| $CO_2$ AT A.H. INLET | % | 14.9 | 15.0 | 15.6 | 15.0 | 14.9 | 15.4 | 16.1 | 15.0 | 14.3 | 14.7 | 14.2 | 14.2 |
| $CO_2$ AT A.H. OUTLET | % | 13.5 | 13.8 | 14.4 | 13.9 | 13.6 | 13.9 | 14.7 | 13.7 | 12.7 | 13.4 | 12.6 | 12.6 |
| CARBON LOSS IN FLY ASH | % | 0.02 | 0.02 | 0.01 | 0.06 | 0.05 | 0.05 | 0.03 | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 |

# BASELINE OPERATION STUDY

## TEST DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1976 | 3/10 | 3/08 | 3/15 | 3/13 | 5/23 | 5/23 | 5/23 | 3/10 | 3/09 | 3/10 |
| Unit Load | MW | 524 | 524 | 485 | 399 | 324 | 323 | 322 | 514 | 515 | 482 |
| **FLOWS** | kg/s | | | | | | | | | | |
| Feedwater | | 411.51 | 430.91 | 380.51 | 324.19 | 262.45 | 264.72 | 262.45 | 397.02 | 405.84 | 371.19 |
| **PRESSURES (GAUGE)** | MPa | | | | | | | | | | |
| Economizer Inlet | | 18.664 | 18.781 | 18.409 | 17.878 | 17.492 | 17.499 | 17.492 | 18.574 | 18.630 | 18.333 |
| Drum | | 18.271 | 18.326 | 18.078 | 17.582 | 17.278 | 17.251 | 17.264 | 18.202 | 18.230 | 18.009 |
| SH Outlet | | 16.892 | 16.878 | 16.872 | 16.706 | 16.699 | 16.685 | 16.706 | 16.865 | 16.885 | 16.802 |
| Turbine 1st Stage | | 11.232 | 11.321 | 10.163 | 8.246 | 6.433 | 6.440 | 6.440 | 10.901 | 10.956 | 10.080 |
| RH Inlet | | 3.654 | 3.634 | 3.330 | 2.641 | 2.068 | 2.068 | 2.068 | 3.571 | 3.578 | 3.302 |
| RH Outlet | | 3.447 | 3.413 | 3.151 | 2.489 | 1.896 | 1.896 | 1.889 | 3.372 | 3.385 | 3.110 |
| SH Spray Water | | 18.457 | 19.809 | 19.009 | 18.850 | 18.843 | 18.871 | 18.809 | 18.395 | 19.684 | 18.312 |
| RH Spray Water | | 10.052 | 10.122 | 9.908 | 9.542 | 9.329 | 9.336 | 9.329 | 9.991 | 10.011 | 9.853 |
| HP HTR's G1&G2 Stm In | | 3.606 | 3.606 | 3.323 | 2.627 | 2.068 | 2.068 | 2.062 | 3.558 | 3.572 | 3.303 |
| **TEMPERATURES** | °C | | | | | | | | | | |
| *Water and Steam* | | | | | | | | | | | |
| Economizer Inlet | | 247 | 247 | 243 | 230 | 219 | 219 | 219 | 247 | 246 | 243 |
| Economizer Outlet | L | 344 | 337 | 344 | 333 | 317 | 321 | 323 | 344 | 344 | 347 |
| Economizer Outlet | LC | 343 | 333 | 342 | 328 | 312 | 317 | 317 | 343 | 341 | 343 |
| Economizer Outlet | RC | NA | NA | NA | NA | 317 | 320 | 321 | NA | NA | NA |
| Economizer Outlet | R | 350 | 345 | 348 | 332 | 318 | 326 | 327 | 352 | 350 | 351 |
| SH Pend Div Inlet Link | L | 384 | 378 | 388 | 383 | 381 | 382 | 382 | 387 | 384 | 389 |
| SH Pend Div Inlet Link | R | 390 | 386 | 392 | 383 | 382 | 383 | 383 | 393 | 391 | 395 |
| SH Desh Outlet Link | L | 414 | 421 | 417 | 418 | 435 | 434 | 437 | 414 | 413 | 413 |
| SH Desh Outlet Link | R | 404 | 421 | 415 | 417 | 431 | 428 | 432 | 408 | 412 | 413 |
| SH Pend Spcd Front In Link | L | 496 | 498 | 497 | 507 | 518 | 513 | 521 | 496 | 497 | 496 |
| SH Pend Spcd Front In Link | R | 482 | 490 | 490 | 499 | 507 | 501 | 509 | 482 | 484 | 484 |
| SH Outlet Leads | L | 539 | 538 | 542 | 543 | 547 | 545 | 550 | 543 | 542 | 543 |
| SH Outlet Leads | R | 533 | 543 | 544 | 542 | 546 | 541 | 547 | 538 | 538 | 538 |
| RH Desh Inlet Comb. Line | | 319 | 321 | 316 | 298 | 283 | 280 | 283 | 321 | 322 | 314 |
| RH Radiant Wall Front In HDR | L | 275 | 292 | 268 | 298 | 283 | 280 | 283 | 261 | 269 | 279 |
| RH Radiant Wall Front In HDR | R | 267 | 283 | 272 | 297 | 282 | 280 | 285 | 263 | 267 | 268 |
| RH Pend Spcd Front In Links | L | 309 | 323 | 306 | 331 | 318 | 312 | 314 | 304 | 308 | 313 |
| RH Pend Spcd Front In Links | LC | 308 | 320 | 307 | 329 | 317 | 312 | 316 | 303 | 304 | 312 |
| RH Pend Spcd Front In Links | RC | 312 | 317 | 312 | NA | 318 | 313 | 316 | 308 | 309 | 309 |
| RH Pend Spcd Front In Links | R | 303 | 308 | 301 | 319 | 307 | 304 | 310 | 300 | 299 | 301 |
| RH Outlet Leads | L | 531 | 531 | 536 | 545 | 523 | 517 | 516 | 531 | 531 | 541 |
| RH Outlet Leads | R | 552 | 553 | 547 | 532 | 522 | 526 | 529 | 552 | 551 | 547 |
| SH Spray Water | | 173 | 173 | 171 | 159 | 156 | 154 | 155 | 173 | 172 | 168 |
| RH Spray Water | | 183 | 182 | 179 | 151 | 96 | 91 | 87 | 193 | 182 | 179 |
| Cold RH Ext Stm to G1&G2 HTR | | 328 | 328 | 323 | 305 | 288 | 287 | 291 | 329 | 327 | 322 |
| FW In to HP HTR G1 | | 207 | 206 | 203 | 192 | 184 | 184 | 184 | 206 | 205 | 203 |
| FW In to HP HTR G2 | | 206 | 205 | 202 | 191 | 184 | 184 | 184 | 206 | 204 | 202 |
| FW Out of HP HTR G1 | | 247 | 247 | 242 | 228 | 219 | 218 | 218 | 247 | 246 | 242 |
| FW Out of HP HTR G2 | | 247 | 246 | 242 | 229 | 218 | 219 | 218 | 246 | 246 | 242 |
| Stm Drain from HP HTR G1 | | 212 | 211 | 208 | 195 | 187 | 187 | 187 | 212 | 211 | 207 |
| Stm Drain from HP HTR G2 | | 208 | 208 | 205 | 193 | 187 | 186 | 186 | 208 | 208 | 204 |
| *Air & Gas* | | | | | | | | | | | |
| Pri Air AH Air Inlet | L | 9 | 4 | 4 | 2 | 27 | 27 | 26 | 10 | 7 | 9 |
| Pri Air AH Air Inlet | R | 5 | 3 | 4 | 0 | 23 | 23 | 23 | 7 | 5 | 7 |
| Sec Air AH Air Inlet | L | 16 | 22 | 20 | 34 | 37 | 38 | 36 | 16 | 17 | 17 |
| Sec Air AH Air Inlet | R | 15 | 23 | 21 | 33 | 36 | 37 | 36 | 14 | 18 | 16 |
| Pri Air AH Air Outlet | L | 369 | 354 | 364 | 329 | 311 | 302 | 306 | 371 | 366 | 369 |
| Pri Air AH Air Outlet | R | 374 | 361 | 369 | 328 | 303 | 305 | 309 | 378 | 371 | 374 |
| Sec Air AH Air Outlet | L | 361 | 346 | 354 | 323 | 303 | 302 | 302 | 363 | 357 | 350 |
| Sec Air AH Air Outlet | R | 362 | 349 | 353 | 320 | 298 | 301 | 302 | 366 | 359 | 363 |
| Economizer Gas Outlet | L | 418 | 402 | 409 | 371 | 339 | 346 | 346 | 416 | 411 | 413 |
| Economizer Gas Outlet | R | 431 | 413 | 422 | 379 | 341 | 349 | 351 | 432 | 427 | 427 |
| AH Gas Inlet | L | 398 | 383 | 395 | 355 | 322 | 327 | 328 | 398 | 396 | 396 |
| AH Gas Inlet | R | 409 | 392 | 401 | 357 | 324 | 331 | 333 | 411 | 403 | 406 |
| AH Gas Outlet | L | 122 | 111 | 118 | 110 | 117 | 118 | 118 | 123 | 117 | 122 |
| AH Gas Outlet | R | 119 | 119 | 118 | 106 | 101 | 101 | 101 | 121 | 119 | 119 |

# BASELINE OPERATION STUDY

TEST DATA

| TEST NO. | | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1976 | 5/21 | 5/25 | 3/12 | 3/09 | 3/10 | 3/13 | 5/25 | 5/25 | 5/25 |
| UNIT LOAD | MW | 321 | 321 | 524 | 513 | 484 | 401 | 322 | 325 | 322 |
| **FLOWS** | KG/S | | | | | | | | | |
| FEEDWATER | | 236.75 | 248.84 | 402.94 | 408.74 | 371.19 | 322.43 | 246.45 | 246.45 | 244.06 |
| **PRESSURES (GAUGE)** | MPA | | | | | | | | | |
| ECONOMIZER INLET | | 17.347 | 17.423 | 18.623 | 18.643 | 18.312 | 17.906 | 17.430 | 17.423 | 17.409 |
| DRUM | | 17.154 | 17.196 | 18.230 | 18.244 | 17.968 | 17,623 | 17.223 | 17.237 | 17.196 |
| SH OUTLET | | 16.685 | 16.678 | 16.878 | 16.899 | 16.816 | 16.741 | 16.727 | 16.720 | 16.692 |
| TURBINE 1ST STAGE | | 6.295 | 6.336 | 11.114 | 10.928 | 10.087 | 8.267 | 6.274 | 6.343 | 6.357 |
| RH INLET | | 2.075 | 2.068 | 3.661 | 3.564 | 3.309 | 2.654 | 2.075 | 2.096 | 2.082 |
| RH OUTLET | | 1.903 | 1.889 | 3.461 | 3.365 | 3.137 | 2.503 | 1.903 | 1.931 | 1.910 |
| SH SPRAY WATER | | 18.354 | 18.312 | 19.595 | 19.354 | 19.264 | 19.030 | 18.278 | 18.085 | 18.182 |
| RH SPRAY WATER | | 9.198 | 9.341 | 10.011 | 10.025 | 9.846 | 9.563 | 9.218 | 9.239 | 9.308 |
| HP HTR's G1&G2 STM IN | | 2.082 | 2.075 | 3.654 | 3.551 | 3.310 | 2.641 | 2.075 | 2.103 | 2.089 |
| **TEMPERATURES** | °C | | | | | | | | | |
| **WATER AND STEAM** | | | | | | | | | | |
| ECONOMIZER INLET | | 220 | 219 | 248 | 246 | 243 | 231 | 220 | 221 | 219 |
| ECONOMIZER OUTLET | L | 331 | 338 | 348 | 344 | 346 | 331 | 327 | 337 | 343 |
| ECONOMIZER OUTLET | LC | 328 | 331 | 346 | 344 | 342 | 327 | 322 | 337 | 343 |
| ECONOMIZER OUTLET | RC | 332 | 334 | NA | NA | NA | NA | 328 | 336 | 339 |
| ECONOMIZER OUTLET | R | 332 | 344 | 349 | 349 | 352 | 330 | 330 | 341 | 348 |
| SH PEND DIV INLET LINK | L | 391 | 392 | 391 | 386 | 389 | 381 | 387 | 392 | 393 |
| SH PEND DIV INLET LINK | R | 392 | 396 | 393 | 393 | 393 | 382 | 389 | 395 | 398 |
| SH DESH OUTLET LINK | L | 413 | 427 | 415 | 419 | 411 | 421 | 427 | 425 | 427 |
| SH DESH OUTLET LINK | R | 410 | 423 | 413 | 417 | 408 | 418 | 423 | 421 | 423 |
| SH PEND SPCD FRONT IN LINK | L | 509 | 508 | 496 | 494 | 499 | 507 | 512 | 508 | 507 |
| SH PEND SPCD FRONT IN LINK | R | 494 | 499 | 489 | 482 | 487 | 501 | 496 | 494 | 496 |
| SH OUTLET LEADS | L | 551 | 545 | 544 | 539 | 542 | 543 | 548 | 548 | 547 |
| SH OUTLET LEADS | R | 541 | 547 | 542 | 539 | 537 | 542 | 542 | 543 | 546 |
| RH DESH INLET COMB. LINE | | 283 | 282 | 327 | 321 | 315 | 297 | 283 | 283 | 283 |
| RH RADIANT WALL FRONT IN HDR | L | 257 | 274 | 256 | 269 | 273 | 296 | 265 | 266 | 270 |
| RH RADIANT WALL FRONT IN HDR | R | 244 | 266 | 268 | 266 | 261 | 297 | 249 | 249 | 256 |
| RH PEND SPCD FRONT IN LINKS | L | 306 | 309 | 301 | 308 | 311 | 330 | 306 | 304 | 306 |
| RH PEND SPCD FRONT IN LINKS | LC | 301 | 304 | 304 | 304 | 308 | 328 | 302 | 298 | 302 |
| RH PEND SPCD FRONT IN LINKS | RC | 299 | 301 | 316 | 307 | 304 | 327 | 295 | 292 | 296 |
| RH PEND SPCD FRONT IN LINKS | R | 285 | 293 | 308 | 300 | 296 | 319 | 283 | 281 | 287 |
| RH OUTLET LEADS | L | 546 | 527 | 544 | 533 | 541 | 545 | 528 | 530 | 528 |
| RH OUTLET LEADS | R | 536 | 545 | 542 | 548 | 547 | 536 | 531 | 538 | 543 |
| SH SPRAY WATER | | 156 | 155 | 176 | 173 | 169 | 158 | 156 | 156 | 156 |
| RH SPRAY WATER | | 162 | 162 | 184 | 182 | 179 | 129 | 163 | 163 | 163 |
| COLD RH EXT STM TO G1&G2 HTR | | 291 | 289 | 333 | 327 | 322 | 306 | 290 | 290 | 289 |
| FW IN TO HP HTR G1 | | 186 | 184 | 207 | 205 | 202 | 192 | 185 | 186 | 186 |
| FW IN TO HP HTR G2 | | 185 | 184 | 206 | 204 | 202 | 191 | 184 | 185 | 184 |
| FW OUT OF HP HTR G1 | | 219 | 218 | 248 | 245 | 242 | 229 | 218 | 219 | 218 |
| FW OUT OF HP HTR G2 | | 219 | 218 | 248 | 246 | 242 | 229 | 219 | 220 | 219 |
| STM DRAIN FROM HP HTR G1 | | 188 | 186 | 213 | 209 | 207 | 196 | 188 | 188 | 188 |
| STM DRAIN FROM HP HTR G2 | | 187 | 186 | 209 | 207 | 204 | 193 | 187 | 187 | 187 |
| **AIR & GAS** | | | | | | | | | | |
| PRI AIR AH AIR INLET | L | 22 | 28 | 11 | 8 | 6 | 6 | 29 | 29 | 29 |
| PRI AIR AH AIR INLET | R | 21 | 24 | 9 | 6 | 4 | 2 | 27 | 27 | 26 |
| SEC AIR AH AIR INLET | L | 33 | 35 | 14 | 14 | 17 | 29 | 34 | 34 | 36 |
| SEC AIR AH AIR INLET | R | 33 | 34 | 13 | 13 | 17 | 30 | 34 | 33 | 35 |
| PRI AIR AH AIR OUTLET | L | 315 | 323 | 377 | 376 | 366 | 332 | 313 | 321 | 324 |
| PRI AIR AH AIR OUTLET | R | 320 | 330 | 383 | 382 | 373 | 331 | 322 | 327 | 331 |
| SEC AIR AH AIR OUTLET | L | 313 | 317 | 369 | 367 | 357 | 326 | 311 | 317 | 318 |
| SEC AIR AH AIR OUTLET | R | 315 | 321 | 372 | 371 | 361 | 323 | 316 | 319 | 322 |
| ECONOMIZER GAS OUTLET | L | 351 | 363 | 422 | 425 | 412 | 372 | 350 | 361 | 368 |
| ECONOMIZER GAS OUTLET | R | 357 | 370 | 417 | 437 | 427 | 425 | 357 | 368 | 376 |
| AH GAS INLET | L | 337 | 347 | 406 | 405 | 393 | 357 | 336 | 344 | 349 |
| AH GAS INLET | R | 340 | 355 | 413 | 416 | 405 | 359 | 343 | 352 | 358 |
| AH GAS OUTLET | L | 120 | 119 | 126 | 120 | 120 | 109 | 118 | 119 | 121 |
| AH GAS OUTLET | R | 121 | 114 | 119 | 123 | 119 | 107 | 116 | 114 | 111 |

# BIASED FIRING OPERATION STUDY

## TEST DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1976 | 5/19 | 5/19 | 3/14 | 5/19 | 5/12 | 5/12 | 5/16 | 5/21 | 6/27 |
| Unit Load | MW | 505 | 506 | 525 | 506 | 422 | 422 | 421 | 320 | 314 |
| **FLOWS** | kg/s | | | | | | | | | |
| Feedwater | | 405.84 | 411.51 | 404.33 | 404.33 | 348.51 | 345.11 | 341.71 | 236.75 | 255.78 |
| **PRESSURES (GAUGE)** | MPa | | | | | | | | | |
| Economizer Inlet | | 18.636 | 18.643 | 18.636 | 18.588 | 18.043 | 18.023 | 18.037 | 17.306 | 17.471 |
| Drum | | 18.237 | 18.223 | 18.244 | 18.175 | 17.713 | 17.713 | 17.713 | 17.134 | 17.306 |
| SH Outlet | | 16.968 | 16.913 | 16.865 | 16.920 | 16.761 | 16.789 | 16.782 | 16.665 | 16.720 |
| Turbine 1st Stage | | 10.942 | 10.908 | 11.101 | 10.894 | 8.791 | 8.756 | 8.818 | 6.295 | 6.460 |
| RH Inlet | | 3.516 | 3.537 | 3.661 | 3.509 | 2.806 | 2.792 | 2.799 | 2.068 | 2.027 |
| RH Outlet | | 3.254 | 3.268 | 3.454 | 3.261 | 2.579 | 2.692 | 2.586 | 1.903 | 1.855 |
| SH Spray Water | | 19.891 | 20.016 | 19.650 | 19.774 | 19.429 | 19.292 | 19.250 | 18.306 | 18.974 |
| RH Spray Water | | 10.115 | 10.108 | 10.018 | 10.073 | 9.722 | 9.715 | 9.742 | 9.191 | 9.329 |
| HP HTR's G1&G2 Stm In | | 3.482 | 3.509 | 3.647 | 3.482 | 2.779 | 2.786 | 2.792 | 2.075 | NA |
| **TEMPERATURES** | °C | | | | | | | | | |
| **Water and Steam** | | | | | | | | | | |
| Economizer Inlet | | 247 | 247 | 248 | 248 | 235 | 234 | 234 | 220 | 216 |
| Economizer Outlet | L | 345 | 349 | 348 | 351 | 332 | 331 | 331 | 330 | 308 |
| Economizer Outlet | LC | 340 | 339 | 347 | 340 | 329 | 324 | 324 | 326 | 308 |
| Economizer Outlet | RC | 347 | 347 | NA | 347 | 335 | 329 | 333 | 331 | 312 |
| Economizer Outlet | R | 353 | 346 | 351 | 349 | 336 | 333 | 340 | 332 | 312 |
| SH Pend Div Inlet Link | L | 384 | 386 | 390 | 386 | 382 | 381 | 382 | 389 | 378 |
| SH Pend Div Inlet Link | R | 392 | 388 | 397 | 389 | 386 | 383 | 389 | 392 | 380 |
| SH Desh Outlet Link | L | 423 | 424 | 418 | 418 | 432 | 427 | 432 | 410 | 436 |
| SH Desh Outlet Link | R | 420 | 422 | 414 | 416 | 426 | 423 | 427 | 408 | 434 |
| SH Pend Spcd Front In Link | L | 504 | 504 | 492 | 496 | 507 | 510 | 506 | 509 | 519 |
| SH Pend Spcd Front In Link | R | 499 | 492 | 489 | 502 | 499 | 501 | 508 | 497 | 514 |
| SH Outlet Leads | L | 543 | 549 | 542 | 539 | 546 | 544 | 539 | 548 | 546 |
| SH Outlet Leads | R | 549 | 543 | 544 | 552 | 545 | 543 | 553 | 543 | 542 |
| RH Desh Inlet Comb. Line | | 326 | 327 | 326 | 326 | 306 | 302 | 304 | 284 | 278 |
| RH Radiant Wall Front In HDR | L | 292 | 277 | 257 | 292 | 305 | 303 | 305 | 266 | 277 |
| RH Radiant Wall Front In HDR | R | 284 | 277 | 268 | 287 | 304 | 304 | 305 | 253 | 278 |
| RH Pend Spcd Front In Links | L | 327 | 310 | 298 | 318 | 334 | 335 | 340 | 309 | 306 |
| RH Pend Spcd Front In Links | LC | 324 | 312 | 302 | 319 | 332 | 333 | 333 | 304 | 306 |
| RH Pend Spcd Front In Links | RC | 323 | 318 | 316 | 322 | 332 | 332 | 333 | 299 | 309 |
| RH Pend Spcd Front In Links | R | 315 | 310 | 310 | 316 | 325 | 326 | 329 | 287 | 299 |
| RH Outlet Leads | L | 534 | 543 | 542 | 544 | 540 | 542 | 528 | 547 | 500 |
| RH Outlet Leads | R | 566 | 552 | 542 | 553 | 548 | 548 | 566 | 543 | 508 |
| SH Spray Water | | 178 | 178 | 174 | 179 | 171 | 169 | 167 | 156 | 40 |
| RH Spray Water | | 184 | 185 | 183 | 185 | 118 | 120 | 99 | 163 | 82 |
| Cold RH Ext Stm to G1&G2 HTR | | 329 | 331 | 333 | 330 | 308 | 308 | 309 | 290 | 284 |
| FW Into HP HTR G1 | | 208 | 208 | 207 | 208 | 197 | 197 | 198 | 184 | 64 |
| FW Into HP HTR G2 | | 207 | 207 | 206 | 207 | 197 | 197 | 197 | 185 | 179 |
| FW Out of HP HTR G1 | | 247 | 247 | 248 | 247 | 234 | 234 | 234 | 219 | 88 |
| FW Out of HP HTR G2 | | 248 | 247 | 248 | 247 | 234 | 235 | 235 | 219 | 216 |
| Stm Drain from HP HTR G1 | | 213 | 213 | 213 | 213 | 202 | 201 | 202 | 187 | 47 |
| Stm Drain from HP HTR G2 | | 210 | 210 | 210 | 211 | 199 | 199 | 199 | 187 | 183 |
| **Air & Gas** | | | | | | | | | | |
| Pri Air AH Air Inlet | L | 32 | 31 | 11 | 27 | 24 | 21 | 24 | 24 | 36 |
| Pri Air AH Air Inlet | R | 32 | 31 | 10 | 26 | 23 | 20 | 22 | 22 | 31 |
| Sec Air AH Air Inlet | L | 34 | 33 | 15 | 30 | 33 | 33 | 31 | 31 | 36 |
| Sec Air AH Air Inlet | R | 34 | 33 | 14 | 29 | 33 | 34 | 30 | 29 | 34 |
| Pri Air AH Air Outlet | L | 369 | 369 | 382 | 368 | 340 | 334 | 334 | 318 | 293 |
| Pri Air AH Air Outlet | R | 383 | 373 | 391 | 368 | 346 | 340 | 342 | 323 | 300 |
| Sec Air AH Air Outlet | L | 361 | 363 | 375 | 361 | 333 | 329 | 327 | 316 | 232 |
| Sec Air AH Air Outlet | R | 371 | 363 | 379 | 359 | 336 | 331 | 332 | 317 | 292 |
| Economizer Gas Outlet | L | 418 | 418 | 436 | 417 | 389 | 381 | 379 | 354 | 284 |
| Economizer Gas Outlet | R | 433 | 422 | 446 | 421 | 391 | 383 | 387 | 354 | 328 |
| AH Gas Inlet | L | 396 | 397 | 411 | 395 | 367 | 360 | 359 | 338 | 314 |
| AH Gas Inlet | R | 412 | 403 | 421 | 398 | 372 | 364 | 368 | 342 | 320 |
| AH Gas Outlet | L | 143 | 145 | 137 | 142 | 122 | 120 | 119 | 123 | 111 |
| AH Gas Outlet | R | 147 | 142 | 134 | 138 | 123 | 121 | 121 | 123 | 112 |

# BIASED FIRING OPERATION STUDY

## TEST DATA

| TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1976 | 5/23 | 5/19 | 5/10 | 3/16 | 5/12 | 3/13 | 5/16 | 5/21 | 5/23 |
| Unit Load | MW | 324 | 491 | 497 | 523 | 423 | 400 | 422 | 320 | 323 |
| **FLOWS** | kg/s | | | | | | | | | |
| Feedwater | | 260.31 | 391.10 | 383.66 | 407.22 | 348.51 | 320.54 | 345.11 | 234.23 | 253.51 |
| **PRESSURES (GAUGE)** | MPa | | | | | | | | | |
| Economizer Inlet | | 17.458 | 18.506 | 18.464 | 18.671 | 18.078 | 17.892 | 18.064 | 17.361 | 17.478 |
| Drum | | 17.223 | 18.154 | 18.244 | 18.257 | 17.768 | 17.616 | 17.733 | 17.161 | 16.858 |
| SH Outlet | | 16,678 | 16.947 | 16.872 | 16.892 | 16.858 | 16.741 | 16.789 | 16.692 | 16.672 |
| Turbine 1st Stage | | 6.433 | 10.480 | 10.597 | 11.232 | 8.805 | 8.225 | 8.811 | 6.316 | 6.419 |
| RH Inlet | | 2.068 | 3.413 | 3.475 | 3.661 | 2.813 | 2.634 | 2.806 | 2.061 | 2.068 |
| RH Outlet | | 1.896 | 3.165 | 3.199 | 3.468 | 2.606 | 2.489 | 2.599 | 1.896 | 1.896 |
| SH Spray Water | | 18.761 | 18.816 | 19.347 | 19.629 | 19.422 | 19.036 | 19.236 | 18.361 | 18.657 |
| RH Spray Water | | 9.308 | 10.025 | 9,991 | 10.039 | 9.763 | 9.556 | 9.756 | 9.218 | 9.301 |
| HP HTR's G1&G2 Stm In | | 2.068 | 3.385 | 3.440 | 3.647 | 2.799 | 2.627 | 2.799 | 2.068 | 2.068 |
| **TEMPERATURES** | °C | | | | | | | | | |
| **Water and Steam** | | | | | | | | | | |
| Economizer Inlet | | 220 | 245 | 247 | 248 | 234 | 229 | 235 | 219 | 220 |
| Economizer Outlet | L | 318 | 348 | 352 | 346 | 337 | 328 | 336 | 334 | 323 |
| Economizer Outlet | LC | 313 | 342 | 346 | 343 | 334 | 324 | 332 | 331 | 318 |
| Economizer Outlet | RC | 316 | 348 | 349 | NA | 338 | NA | 340 | 336 | 322 |
| Economizer Outlet | R | 323 | 357 | 357 | 351 | 341 | 331 | 349 | 341 | 327 |
| SH Pend Div Inlet Link | L | 381 | 387 | 392 | 386 | 385 | 379 | 383 | 391 | 383 |
| SH Pend Div Inlet Link | R | 385 | 393 | 397 | 393 | 389 | 384 | 394 | 395 | 387 |
| SH Desh Outlet Link | L | 435 | 420 | 413 | 413 | 432 | 423 | 433 | 409 | 431 |
| SH Desh Outlet Link | R | 427 | 416 | 409 | 411 | 424 | 419 | 425 | 407 | 427 |
| SH Pend Spcd Front In Link | L | 517 | 500 | 505 | 494 | 504 | 504 | 502 | 508 | 510 |
| SH Pend Spcd Front In Link | R | 507 | 501 | 491 | 493 | 497 | 504 | 504 | 501 | 507 |
| SH Outlet Leads | L | 548 | 538 | 548 | 537 | 546 | 540 | 536 | 544 | 543 |
| SH Outlet Leads | R | 547 | 554 | 546 | 548 | 545 | 547 | 556 | 546 | 548 |
| RH Desh Inlet Comb. Line | | 283 | 324 | 328 | 326 | 304 | 295 | 303 | 283 | 283 |
| RH Radiant Wall Front In HDR | L | 284 | 287 | 265 | 264 | 303 | 298 | 304 | 271 | 283 |
| RH Radiant Wall Front In HDR | R | 284 | 278 | 269 | 272 | 304 | 298 | 304 | 262 | 283 |
| RH Pend Spcd Front In Links | L | 320 | 324 | 308 | 307 | 331 | 329 | 339 | 315 | 318 |
| RH Pend Spcd Front In Links | LC | 318 | 320 | 308 | 308 | 328 | 325 | 332 | 306 | 317 |
| RH Pend Spcd Front In Links | RC | 316 | 319 | 316 | 319 | 328 | 326 | 333 | 300 | 314 |
| RH Pend Spcd Front In Links | R | 308 | 309 | 307 | 308 | 321 | 324 | 328 | 289 | 307 |
| RH Outlet Leads | L | 521 | 533 | 531 | 529 | 542 | 535 | 524 | 542 | 524 |
| RH Outlet Leads | R | 537 | 567 | 561 | 556 | 547 | 544 | 571 | 544 | 536 |
| SH Spray Water | | 157 | 176 | 179 | 174 | 169 | 160 | 168 | 155 | 155 |
| RH Spray Water | | 101 | 182 | 183 | 184 | 173 | 119 | 93 | 163 | 107 |
| Cold RH Ext Stm to G1&G2 HTR | | 290 | 327 | 332 | 331 | 309 | 306 | 310 | 289 | 289 |
| FW Into HP HTR G1 | | 185 | 207 | 208 | 208 | 198 | 192 | 198 | 185 | 184 |
| FW Into HP HTR G2 | | 184 | 206 | 207 | 207 | 197 | 191 | 197 | 184 | 184 |
| FW Out of HP HTR G1 | | 219 | 245 | 246 | 248 | 235 | 229 | 234 | 218 | 218 |
| FW Out of HP HTR G2 | | 219 | 245 | 247 | 248 | 235 | 229 | 235 | 218 | 219 |
| Stm Drain from HP HTR G1 | | 187 | 211 | 212 | 212 | 202 | 195 | 201 | 187 | 187 |
| Stm Drain from HP HTR G2 | | 186 | 208 | 210 | 209 | 200 | 193 | 200 | 187 | 186 |
| **Air & Gas** | | | | | | | | | | |
| Pri Air AH Air Inlet | L | 26 | 31 | 27 | 3 | 27 | 5 | 24 | 25 | 22 |
| Pri Air AH Air Inlet | R | 22 | 32 | 28 | -1 | 26 | 4 | 22 | 24 | 19 |
| Sec Air AH Air Inlet | L | 38 | 34 | 29 | 18 | 29 | 29 | 30 | 30 | 41 |
| Sec Air AH Air Inlet | R | 37 | 33 | 29 | 18 | 30 | 29 | 29 | 29 | 41 |
| Pri Air AH Air Outlet | L | 300 | 371 | 376 | 370 | 347 | 331 | 340 | 327 | 295 |
| Pri Air AH Air Outlet | R | 305 | 381 | 389 | 377 | 353 | 334 | 351 | 334 | 296 |
| Sec Air AH Air Outlet | L | 298 | 362 | 367 | 361 | 339 | 325 | 332 | 322 | 291 |
| Sec Air AH Air Outlet | R | 299 | 369 | 376 | 364 | 342 | 325 | 339 | 327 | 289 |
| Economizer Gas Outlet | L | 342 | 419 | 426 | 427 | 397 | 378 | 389 | 361 | 348 |
| Economizer Gas Outlet | R | 344 | 431 | 437 | 434 | 399 | 380 | 403 | 362 | 349 |
| AH Gas Inlet | L | 321 | 398 | 404 | 399 | 376 | 357 | 367 | 347 | 319 |
| AH Gas Inlet | R | 326 | 410 | 418 | 409 | 381 | 361 | 381 | 354 | 322 |
| AH Gas Outlet | L | 116 | 144 | 137 | 129 | 122 | 118 | 124 | 126 | 112 |
| AH Gas Outlet | R | 118 | 142 | 134 | 112 | 123 | 114 | 123 | 127 | 109 |

# OVERFIRE AIR OPERATION STUDY

TEST DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Date | 1976 | 3/17 | 3/17 | 3/20 | 3/20 | 3/22 | 3/20 | 3/20 | 3/20 |
| Unit Load | MW | 517 | 512 | 524 | 525 | 526 | 521 | 522 | 522 |
| **FLOWS** | kg/s | | | | | | | | |
| Feedwater | | 398.53 | 400.04 | 432.30 | 432.30 | 419.95 | 444.27 | 437.72 | 434.94 |
| **PRESSURES** | MPa | | | | | | | | |
| Economizer Inlet | | 18.581 | 18.588 | 18.802 | 18.788 | 18.733 | 18.892 | 18.850 | 18.830 |
| Drum | | 18.216 | 18.188 | 18.354 | 18.319 | 18.299 | 18.409 | 18.409 | 18.361 |
| SH Outlet | | 16.920 | 16.892 | 16.920 | 16.913 | 16.927 | 16.913 | 16.940 | 16.920 |
| Turbine 1st Stage | | 10.908 | 10.845 | 11.356 | 11.300 | 11.356 | 11.356 | 11.300 | 9.915 |
| RH Inlet | | 3.585 | 3.572 | 3.640 | 3.654 | 3.675 | 3.627 | 3.634 | 3.640 |
| RH Outlet | | 3.392 | 3.378 | 3.426 | 3.440 | 3.461 | 3.385 | 3.413 | 3.420 |
| SH Spray Water | | 19.588 | 19.671 | 20.022 | 19.760 | 18.823 | 20.319 | 20.105 | 20.016 |
| RH Spray Water | | 9.963 | 9.950 | 10.163 | 10.129 | 10.136 | 10.239 | 10.177 | 10.163 |
| HP HTR's G1&G2 Stm In | | 3.523 | 3.509 | 3.572 | 3.592 | 3.606 | 3.530 | 3.558 | 3.572 |
| **TEMPERATURES** | °C | | | | | | | | |
| **Water & Steam** | | | | | | | | | |
| Economizer Inlet | | 247 | 247 | 241 | 241 | 242 | 246 | 239 | 241 |
| Economizer Outlet | L | 349 | 349 | 313 | 316 | 314 | 331 | 306 | 308 |
| Economizer Outlet | LC | 345 | 346 | 309 | 313 | 313 | 326 | 304 | 306 |
| Economizer Outlet | RC | 351 | 351 | 316 | 321 | 315 | 332 | 308 | 309 |
| Economizer Outlet | R | 352 | 352 | 319 | 322 | 324 | 339 | 314 | 318 |
| SH Pend Div Inlet Link | L | 387 | 388 | 356 | 358 | 358 | 377 | 352 | 353 |
| SH Pend Div Inlet Link | R | 392 | 393 | 363 | 366 | 366 | 382 | 359 | 361 |
| SH Desh Outlet Link | L | 410 | 414 | 402 | 400 | 393 | 433 | 404 | 402 |
| SH Desh Outlet Link | R | 408 | 412 | 397 | 399 | 388 | 422 | 401 | 397 |
| SH Pend Spcd Front In Link | L | 494 | 494 | 484 | 485 | 483 | 510 | 488 | 484 |
| SH Pend Spcd Front In Link | R | 491 | 486 | 475 | 472 | 477 | 497 | 481 | 478 |
| SH Outlet Leads | L | 538 | 541 | 532 | 534 | 530 | 544 | 528 | 528 |
| SH Outlet Leads | R | 546 | 542 | 534 | 534 | 537 | 543 | 536 | 536 |
| RH Desh Inlet Comb. Line | | 324 | 323 | 295 | 298 | 294 | 323 | 294 | 293 |
| RH Radiant Wall Front In HDR | L | 254 | 307 | 258 | 454 | 247 | 312 | 264 | 259 |
| RH Radiant Wall Front In HDR | R | 264 | 261 | 249 | 248 | 246 | 304 | 252 | 247 |
| RH Pend Spcd Front In Links | L | 299 | 296 | 295 | 287 | 288 | 339 | 299 | 296 |
| RH Pend Spcd Front In Links | LC | 301 | 298 | 294 | 287 | 289 | 337 | 296 | 291 |
| RH Pend Spcd Front In Links | RC | 310 | 308 | 291 | 287 | 286 | 332 | 291 | 289 |
| RH Pend Spcd Front In Links | R | 300 | 299 | 285 | 283 | 279 | 326 | 288 | 281 |
| RH Outlet Leads | L | 532 | 531 | 524 | 521 | 523 | 532 | 518 | 519 |
| RH Outlet Leads | R | 553 | 552 | 544 | 545 | 552 | 562 | 550 | 545 |
| SH Spray Water | | 173 | 173 | 144 | 142 | 142 | 172 | 139 | 141 |
| RH Spray Water | | 183 | 182 | 174 | 173 | 177 | 181 | 173 | 172 |
| Cold RH Ext Stm to G1&G2 HTR | | 329 | 329 | 326 | 327 | 328 | 327 | 327 | 328 |
| FW into HP HTR G1 | | 207 | 206 | 197 | 197 | 198 | 206 | 195 | 195 |
| FW into HP HTR G2 | | 206 | 206 | 197 | 196 | 197 | 205 | 194 | 194 |
| FW Out of HP HTR G1 | | 247 | 246 | 239 | 238 | 240 | 246 | 237 | 238 |
| FW Out of HP HTR G2 | | 247 | 246 | 238 | 238 | 239 | 246 | 238 | 237 |
| Stm Drain From HP HTR G1 | | 211 | 211 | 202 | 202 | 202 | 212 | 202 | 201 |
| Stm Drain From HP HTR G2 | | 208 | 208 | 198 | 197 | 196 | 209 | 197 | 196 |
| **Air & Gas** | | | | | | | | | |
| Pri Air AH Air Inlet | L | 3 | 8 | 9 | 16 | 11 | 23 | 14 | 16 |
| Pri Air AH Air Inlet | R | 1 | 2 | 17 | 17 | 14 | 23 | 17 | 18 |
| Sec Air AH Air Inlet | L | 18 | 15 | 13 | 11 | 11 | 26 | 15 | 18 |
| Sec Air AH Air Inlet | R | 17 | 14 | 16 | 16 | 15 | 26 | 17 | 21 |
| Pri Air AH Air Outlet | L | 376 | 381 | 368 | 373 | 366 | 346 | 354 | 359 |
| Pri Air AH Air Outlet | R | 383 | 389 | 378 | 388 | 377 | 357 | 363 | 369 |
| Sec Air AH Air Outlet | L | 367 | 372 | 359 | 365 | 357 | 369 | 347 | 352 |
| Sec Air AH Air Outlet | R | 371 | 377 | 367 | 377 | 367 | 346 | 353 | 359 |
| Economizer Gas Outlet | L | 431 | 437 | 421 | 426 | 422 | 399 | 408 | 412 |
| Economizer Gas Outlet | R | 438 | 444 | 433 | 443 | 433 | 408 | 418 | 423 |
| AH Gas Inlet | L | 406 | 406 | 396 | 402 | 397 | 373 | 382 | 387 |
| AH Gas Inlet | R | 415 | 421 | 410 | 419 | 409 | 387 | 394 | 401 |
| AH Gas Outlet | L | 122 | 122 | 118 | 119 | 113 | 123 | 115 | 118 |
| AH Gas Outlet | R | 119 | 120 | 112 | 116 | 113 | 118 | 109 | 112 |

# OVERFIRE AIR OPERATION STUDY

## TEST DATA

| TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| DATE | 1976 | 3/24 | 3/24 | 3/24 | 6/24 | 6/24 | 6/24 | 3/24 | 6/30 |
| UNIT LOAD | MW | 476 | 473 | 472 | 524 | 525 | 523 | 511 | 526 |
| FLOWS | KG/S | | | | | | | | |
| FEEDWATER | | 380.51 | 372.83 | 366.53 | 426.88 | 421.34 | 424.11 | 401.43 | 415.79 |
| PRESSURES | MPA | | | | | | | | |
| ECONOMIZER INLET | | 18.354 | 18.264 | 18.237 | 18.788 | 18.747 | 18.712 | 18.547 | 18.726 |
| DRUM | | 18.030 | 17.938 | 17.892 | 18.347 | 18.374 | 18.381 | 18.181 | 18.333 |
| SH OUTLET | | 16.864 | 16.816 | 16.796 | 16.892 | 16.947 | 16.947 | 16.877 | 16.891 |
| TURBINE 1ST STAGE | | 9.977 | 9.777 | 9.728 | 11.383 | 11.362 | 11.369 | 10.825 | 11.411 |
| RH INLET | | 3.282 | 3.227 | 3.234 | 3.661 | 3.661 | 3.627 | 3.558 | 3.661 |
| RH OUTLET | | 3.103 | 3.048 | 3.048 | 3.427 | 3.440 | 3.406 | 3.372 | 3.440 |
| SH SPRAY WATER | | 18.864 | 18.699 | 18.374 | 20.133 | 19.960 | 20.091 | 19.616 | 19.754 |
| RH SPRAY WATER | | 9.825 | 9.832 | 9.805 | 10.336 | 10.329 | 10.349 | 10.018 | 10.315 |
| HP HTR's G1&G2 STM IN | | 3.220 | 3.165 | 3.172 | 3.716 | 3.716 | 3.709 | 3.496 | NA |
| TEMPERATURES | °C | | | | | | | | |
| WATER & STEAM | | | | | | | | | |
| ECONOMIZER INLET | | 236 | 237 | 235 | 243 | 244 | 244 | 239 | 244 |
| ECONOMIZER OUTLET | L | 327 | 326 | 323 | 340 | 345 | 341 | 315 | 342 |
| ECONOMIZER OUTLET | LC | 324 | 324 | 319 | 342 | 345 | 342 | 315 | 346 |
| ECONOMIZER OUTLET | RC | 327 | 328 | 327 | 346 | 349 | 343 | 319 | 346 |
| ECONOMIZER OUTLET | R | 332 | 331 | 326 | 352 | 354 | 351 | 323 | 345 |
| SH PEND DIV INLET LINK | L | 368 | 368 | 369 | 385 | 388 | 387 | 363 | 388 |
| SH PEND DIV INLET LINK | R | 376 | 377 | 373 | 391 | 394 | 389 | 368 | 389 |
| SH DESH OUTLET LINK | L | 397 | 399 | 402 | 429 | 435 | 429 | 394 | 422 |
| SH DESH OUTLET LINK | R | 398 | 399 | 392 | 420 | 427 | 419 | 391 | 419 |
| SH PEND SPCD FRONT IN LINK | L | 489 | 488 | 483 | 507 | 514 | 507 | 482 | 510 |
| SH PEND SPCD FRONT IN LINK | R | 479 | 478 | 471 | 490 | 498 | 499 | 475 | 498 |
| SH OUTLET LEADS | L | 539 | 539 | 535 | 542 | 548 | 544 | 531 | 552 |
| SH OUTLET LEADS | R | 537 | 539 | 532 | 539 | 548 | 545 | 534 | 545 |
| RH DESH INLET COMB. LINE | | 292 | 287 | 285 | 325 | 334 | 329 | 292 | 333 |
| RH RADIANT WALL FRONT IN HDR | L | 246 | 240 | 226 | 281 | 287 | 301 | 229 | 298 |
| RH RADIANT WALL FRONT IN HDR | L | 242 | 237 | 224 | 290 | 282 | 291 | 233 | 237 |
| RH PEND SPCD FRONT IN LINKS | L | 283 | 284 | 272 | 331 | 322 | 331 | 273 | 326 |
| RH PEND SPCD FRONT IN LINKS | LC | 287 | 284 | 271 | 327 | 321 | 326 | 277 | 329 |
| RH PEND SPCD FRONT IN LINKS | RC | 282 | 281 | 278 | 326 | 324 | 326 | 283 | 331 |
| RH PEND SPCD FRONT IN LINKS | R | 275 | 269 | 262 | 319 | 316 | 323 | 274 | 320 |
| RH OUTLET LEADS | L | 535 | 536 | 526 | 532 | 529 | 538 | 520 | 543 |
| RH OUTLET LEADS | R | 544 | 544 | 551 | 562 | 563 | 554 | 551 | 547 |
| SH SPRAY WATER | | 142 | 142 | 139 | 71 | 69 | 74 | 143 | 79 |
| RH SPRAY WATER | | 171 | 171 | 169 | 186 | 186 | 185 | 172 | 186 |
| COLD RH EXT STM TO G1&G2 HTR | | 318 | 317 | 316 | 328 | 336 | 331 | 327 | 335 |
| FW INTO HP HTR G1 | | 193 | 193 | 192 | 57 | 57 | 59 | 196 | 39 |
| FW INTO HP HTR G2 | | 193 | 193 | 192 | 205 | 204 | 204 | 195 | 205 |
| FW OUT OF HP HTR G1 | | 233 | 234 | 233 | 95 | 95 | 95 | 238 | 85 |
| FW OUT OF HP HTR G2 | | 233 | 233 | 233 | 244 | 244 | 243 | 237 | 244 |
| STM DRAIN FROM HP HTR G1 | | 198 | 197 | 197 | 98 | 98 | 97 | 201 | 43 |
| STM DRAIN FROM HP HTR G2 | | 194 | 193 | 192 | 209 | 209 | 208 | 195 | 210 |
| AIR & GAS | | | | | | | | | |
| PRI AIR AH AIR INLET | L | 12 | 10 | 10 | 29 | 31 | 27 | 15 | 28 |
| PRI AIR AH AIR INLET | R | 14 | 14 | 15 | 26 | 29 | 26 | 14 | 25 |
| SEC AIR AH AIR INLET | L | 16 | 11 | 10 | 31 | 32 | 29 | 11 | 29 |
| SEC AIR AH AIR INLET | R | 14 | 14 | 14 | 30 | 32 | 28 | 16 | 28 |
| PRI AIR AH AIR OUTLET | L | 367 | 371 | 371 | 357 | 362 | 341 | 367 | 353 |
| PRI AIR AH AIR OUTLET | R | 375 | 378 | 382 | 369 | 376 | 364 | 380 | 362 |
| SEC AIR AH AIR OUTLET | L | 358 | 362 | 364 | 339 | 322 | 346 | 361 | 314 |
| SEC AIR AH AIR OUTLET | R | 364 | 367 | 371 | 341 | 332 | 341 | 369 | 349 |
| ECONOMIZER GAS OUTLET | L | 423 | 427 | 426 | 398 | 403 | 402 | 424 | 397 |
| ECONOMIZER GAS OUTLET | R | 431 | 432 | 435 | 421 | 428 | 399 | 435 | 407 |
| AH GAS INLET | L | 399 | 403 | 402 | 386 | 390 | 384 | 399 | 387 |
| AH GAS INLET | R | 408 | 411 | 412 | 397 | 404 | 393 | 411 | 393 |
| AH GAS OUTLET | L | 120 | 121 | 121 | 133 | 137 | 131 | 120 | 128 |
| AH GAS OUTLET | R | 112 | 114 | 115 | 131 | 137 | 132 | 120 | 125 |

# OVERFIRE AIR OPERATION STUDY

## TEST DATA

| TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|
| Date | 1976 | 6/25 | 6/30 | 6/29 | 6/25 | 6/26 | 6/25 | 6/27 | 6/29 |
| Unit Load | MW | 524 | 526 | 524 | 521 | 419 | 422 | 316 | 322 |
| **FLOWS** | kg/s | | | | | | | | |
| Feedwater | | 410.12 | 418.56 | 418.56 | 412.90 | 341.71 | 322.43 | 262.45 | 244.06 |
| **PRESSURES** | MPa | | | | | | | | |
| Economizer Inlet | | 18.678 | 18.740 | 18.726 | 18.795 | 18.037 | 17.982 | 17.526 | 17.437 |
| Drum | | 18.333 | 18.388 | 18.340 | 18.374 | 17.809 | 17.706 | 17.306 | 17.258 |
| SH Outlet | | 16.940 | 16.906 | 16.906 | 16.954 | 16.816 | 16.802 | 16.685 | 16.678 |
| Turbine 1st Stage | | 11.328 | 11.473 | 11.411 | 11.287 | 8.825 | 8.749 | 6.578 | 6.502 |
| RH Inlet | | 3.627 | 3.661 | 3.661 | 3.627 | 2.792 | 3.565 | 2.055 | 2.075 |
| RH Outlet | | 3.420 | 3.399 | 3.427 | 3.413 | 2.614 | 2.648 | 1.917 | 1.938 |
| SH Spray Water | | 19.112 | 19.822 | 19.884 | 19.767 | 19.671 | 18.864 | 19.133 | 18.581 |
| RH Spray Water | | 10.315 | 10.370 | 10.343 | 10.308 | 9.881 | 9.791 | 9.343 | 9.377 |
| HP HTR's G1&G2 Stm In | | 3.716 | NA | NA | NA | NA | NA | NA | NA |
| **TEMPERATURES** | °C | | | | | | | | |
| **Water & Steam** | | | | | | | | | |
| Economizer Inlet | | 243 | 244 | 245 | 243 | 231 | 232 | 216 | 218 |
| Economizer Outlet | L | 346 | 343 | 343 | 345 | 326 | 337 | 306 | 323 |
| Economizer Outlet | LC | 345 | 347 | 343 | 344 | 327 | 338 | 306 | 320 |
| Economizer Outlet | RC | 347 | 348 | 343 | 349 | 329 | 342 | 303 | 323 |
| Economizer Outlet | R | 354 | 343 | 348 | 351 | 332 | 346 | 308 | 328 |
| SH Pend Div Inlet Link | L | 388 | 388 | 388 | 391 | 383 | 391 | 380 | 384 |
| SH Pend Div Inlet Link | R | 393 | 389 | 391 | 394 | 386 | 394 | 379 | 387 |
| SH Desh Outlet Link | L | 422 | 422 | 424 | 425 | 431 | 426 | 427 | 423 |
| SH Desh Outlet Link | R | 415 | 418 | 421 | 422 | 428 | 422 | 443 | 418 |
| SH Pend Spcd Front In Link | L | 502 | 509 | 506 | 504 | 508 | 506 | 509 | 512 |
| SH Pend Spcd Front In Link | R | 503 | 498 | 497 | 494 | 506 | 496 | 511 | 508 |
| SH Outlet Leads | L | 542 | 551 | 548 | 551 | 545 | 550 | 537 | 546 |
| SH Outlet Leads | R | 553 | 545 | 545 | 546 | 548 | 546 | 538 | 547 |
| RH Desh Inlet Comb. Line | | 330 | 331 | 331 | 331 | 304 | 308 | 274 | 284 |
| RH Radiant Wall Front In HDR | L | 291 | 304 | 294 | 283 | 304 | 289 | 289 | 282 |
| RH Radiant Wall Front In HDR | R | 283 | 300 | 294 | 274 | 305 | 276 | 272 | 284 |
| RH Pend Spcd Front In Links | L | 322 | 329 | 323 | 314 | 329 | 329 | 301 | 312 |
| RH Pend Spcd Front In Links | LC | 322 | 333 | 324 | 314 | 328 | 316 | 296 | 309 |
| RH Pend Spcd Front In Links | RC | 326 | 334 | 330 | 319 | 332 | 313 | 292 | 313 |
| RH Pend Spcd Front In Links | R | 315 | 322 | 321 | 309 | 325 | 306 | 294 | 304 |
| RH Outlet Leads | L | 531 | 546 | 538 | 532 | 530 | 538 | 503 | 526 |
| RH Outlet Leads | R | 563 | 538 | 557 | 552 | 554 | 553 | 496 | 541 |
| SH Spray Water | | 72 | 80 | 79 | 63 | 55 | 51 | 32 | 43 |
| RH Spray Water | | 185 | 186 | 186 | 184 | 132 | 174 | 78 | 159 |
| Cold RH Ext Stm to G1&G2 HTR | | 333 | 334 | 334 | 333 | 309 | 312 | 278 | 289 |
| FW into HP HTR G1 | | 43 | 39 | 46 | 42 | 43 | 42 | 64 | 48 |
| FW into HP HTR G2 | | 204 | 205 | 205 | 204 | 192 | 194 | 180 | 182 |
| FW Out of HP HTR G1 | | 94 | 86 | 86 | 94 | 94 | 94 | 88 | 86 |
| FW Out of HP HTR G2 | | 244 | 244 | 244 | 243 | 230 | 232 | 216 | 217 |
| Stm Drain From HP HTR G1 | | 92 | 43 | 51 | 96 | 47 | 96 | 44 | 72 |
| Stm Drain From HP HTR G2 | | 209 | 209 | 209 | 208 | 197 | 197 | 183 | 184 |
| **Air & Gas** | | | | | | | | | |
| Pri Air AH Air Inlet | L | 33 | 27 | 26 | 35 | 36 | 36 | 36 | 31 |
| Pri Air AH Air Inlet | R | 28 | 24 | 23 | 32 | 35 | 34 | 32 | 28 |
| Sec Air AH Air Inlet | L | 33 | 28 | 28 | 36 | 37 | 37 | 36 | 33 |
| Sec Air AH Air Inlet | R | 31 | 27 | 27 | 34 | 36 | 36 | 36 | 32 |
| Pri Air AH Air Outlet | L | 351 | 348 | 358 | 358 | 322 | 323 | 287 | 296 |
| Pri Air AH Air Outlet | R | 372 | 353 | 368 | 379 | 334 | 356 | 292 | 312 |
| Sec Air AH Air Outlet | L | 319 | 308 | 318 | 316 | 271 | 281 | 221 | 247 |
| Sec Air AH Air Outlet | R | 304 | 340 | 354 | 361 | 323 | 346 | 230 | 304 |
| Economizer Gas Outlet | L | 398 | 401 | 398 | 418 | 376 | 393 | 337 | 354 |
| Economizer Gas Outlet | R | 424 | 406 | 411 | 430 | 373 | 387 | 324 | 341 |
| AH Gas Inlet | L | 393 | 376 | 389 | 395 | 351 | 368 | 309 | 327 |
| AH Gas Inlet | R | 402 | 385 | 398 | 407 | 358 | 379 | 313 | 332 |
| AH Gas Outlet | L | 133 | 126 | 128 | 136 | 118 | 127 | 100 | 103 |
| AH Gas Outlet | R | 133 | 124 | 128 | 142 | 123 | 137 | 106 | 114 |

# BASELINE OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1976 | 3/10 | 3/08 | 3/15 | 3/13 | 5/23 | 5/23 | 5/23 | 3/10 | 3/09 | 3/10 | 5/21 | 5/25 | 3/12 | 3/09 | 3/10 | 3/13 | 5/25 | 5/25 | 5/25 |
| UNIT LOAD | MW | 524 | 524 | 485 | 399 | 324 | 323 | 322 | 514 | 515 | 482 | 321 | 321 | 524 | 513 | 484 | 401 | 322 | 325 | 322 |
| **FLOWS** | KG/S | | | | | | | | | | | | | | | | | | | |
| FEEDWATER (MEASURED) | | 412 | 431 | 381 | 324 | 262 | 265 | 262 | 397 | 406 | 371 | 237 | 249 | 403 | 409 | 371 | 322 | 246 | 246 | 244 |
| SH SPRAY (PLANT FLOW NOZZLE) | | 30 | 11 | 19 | 9 | 4 | 4 | 6 | 30 | 26 | 23 | 26 | 16 | 29 | 18 | 26 | 7 | 17 | 20 | 19 |
| MAIN STEAM (CALCULATED) | | 441 | 442 | 400 | 334 | 267 | 269 | 268 | 427 | 432 | 394 | 263 | 265 | 432 | 426 | 397 | 329 | 264 | 267 | 263 |
| TURB. LEAK. (TURB. HT. BAL.) | | 7 | 7 | 6 | 5 | 4 | 4 | 4 | 6 | 6 | 6 | 4 | 4 | 7 | 6 | 6 | 5 | 4 | 4 | 4 |
| HP HTR. EXT. (HEAT BAL.) | | 36 | 38 | 32 | 25 | 18 | 18 | 18 | 35 | 36 | 31 | 17 | 17 | 35 | 36 | 31 | 25 | 17 | 17 | 17 |
| RH SPRAY (PLANT FLOW NOZZLE) | | 17 | 12 | 14 | 1 | 0 | 0 | 0 | 19 | 17 | 12 | 6 | 2 | 21 | 17 | 14 | 1 | 5 | 4 | 3 |
| RH STEAM (CALCULATED) | | 416 | 410 | 375 | 304 | 244 | 246 | 246 | 404 | 407 | 369 | 248 | 246 | 411 | 401 | 374 | 300 | 247 | 250 | 245 |
| **UNIT ABSORPTION** | MJ/S | | | | | | | | | | | | | | | | | | | |
| ECONOMIZER | | 224 | 212 | 212 | 170 | 125 | 135 | 135 | 219 | 221 | 215 | 134 | 153 | 224 | 225 | 213 | 164 | 133 | 148 | 157 |
| FURNACE | | 362 | 401 | 341 | 327 | 293 | 286 | 282 | 349 | 359 | 325 | 243 | 244 | 348 | 360 | 327 | 328 | 259 | 243 | 232 |
| DRUM - SH DESH | | 261 | 253 | 230 | 189 | 146 | 145 | 147 | 254 | 252 | 238 | 162 | 159 | 260 | 249 | 235 | 192 | 158 | 163 | 160 |
| SH DESH - SH OUTLET | | 184 | 165 | 164 | 122 | 98 | 97 | 101 | 181 | 181 | 154 | 117 | 104 | 183 | 165 | 164 | 111 | 106 | 109 | 107 |
| REHEATER | | 274 | 253 | 244 | 167 | 132 | 134 | 131 | 277 | 271 | 239 | 164 | 147 | 285 | 266 | 249 | 167 | 153 | 157 | 151 |
| TOTAL | | 1304 | 1284 | 1191 | 975 | 793 | 797 | 797 | 1279 | 1284 | 1171 | 820 | 806 | 1301 | 1266 | 1189 | 962 | 809 | 820 | 807 |
| **UNIT EFFICIENCY** | % | | | | | | | | | | | | | | | | | | | |
| DRY GAS LOSS | | 4.55 | 4.29 | 4.99 | 4.16 | 3.72 | 3.93 | 4.10 | 4.48 | 4.69 | 4.75 | 4.16 | 5.07 | 4.80 | 4.97 | 4.84 | 4.55 | 4.09 | 4.42 | 5.00 |
| MOISTURE IN FUEL LOSS | | 7.55 | 7.21 | 7.42 | 7.03 | 7.13 | 7.57 | 7.15 | 7.48 | 7.41 | 7.49 | 7.24 | 7.28 | 7.55 | 7.29 | 7.49 | 7.57 | 7.19 | 7.16 | 7.23 |
| MOISTURE IN AIR LOSS | | 0.11 | 0.10 | 0.12 | 0.10 | 0.09 | 0.09 | 0.10 | 0.10 | 0.11 | 0.11 | 0.10 | 0.12 | 0.11 | 0.12 | 0.11 | 0.11 | 0.10 | 0.10 | 0.12 |
| RADIATION LOSS | | 0.17 | 0.18 | 0.19 | 0.23 | 0.28 | 0.28 | 0.28 | 0.18 | 0.18 | 0.19 | 0.27 | 0.28 | 0.17 | 0.18 | 0.19 | 0.23 | 0.28 | 0.27 | 0.28 |
| ASH PIT LOSS | | 0.37 | 0.36 | 0.36 | 0.37 | 0.32 | 0.32 | 0.31 | 0.36 | 0.36 | 0.37 | 0.39 | 0.39 | 0.37 | 0.35 | 0.37 | 0.37 | 0.39 | 0.40 | 0.39 |
| HEAT IN FLY ASH LOSS | | 0.04 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 |
| PYRITE REJECTION LOSS | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CARBON LOSS | | 0.02 | 0.03 | 0.02 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.11 | 0.01 | 0.02 | 0.30 | 0.01 | 0.19 | 0.04 | 0.02 | 0.02 | 0.02 |
| ELECTROSTATIC PRECIP. LOSS | | 0.23 | 0.30 | 0.58 | 0.69 | 0.45 | 0.69 | 0.78 | 0.27 | 0.35 | 0.54 | 0.54 | 0.39 | 0.08 | 0.19 | 0.56 | 1.55 | 0.26 | 0.45 | 0.71 |
| TOTAL LOSSES | | 13.05 | 12.51 | 13.72 | 12.65 | 12.06 | 12.95 | 12.77 | 12.96 | 13.15 | 13.61 | 12.74 | 13.59 | 13.43 | 13.15 | 13.80 | 14.44 | 12.35 | 12.85 | 13.77 |
| EFFICIENCY | | 86.95 | 87.49 | 86.28 | 87.35 | 87.94 | 87.05 | 87.23 | 87.04 | 86.85 | 86.93 | 87.26 | 86.41 | 86.57 | 86.85 | 86.20 | 85.56 | 87.65 | 87.15 | 86.23 |
| **HEAT INPUT** | MJ/S | | | | | | | | | | | | | | | | | | | |
| HEAT INPUT FROM FUEL | | 1500 | 1468 | 1380 | 1116 | 902 | 916 | 914 | 1469 | 1478 | 1347 | 940 | 933 | 1503 | 1458 | 1379 | 1124 | 923 | 941 | 936 |
| **EXCESS AIR** | % | | | | | | | | | | | | | | | | | | | |
| ELECTROSTATIC PRECIP. INLET | | 20.7 | 21.8 | 34.7 | 35.6 | 27.7 | 37.5 | 43.2 | 19.4 | 23.7 | 30.6 | 20.4 | 52.5 | 17.1 | 22.6 | 32.2 | 35.7 | 26.1 | 39.5 | 54.8 |
| AIR HEATER INLET | | 25.1 | 25.8 | 36.5 | 36.8 | 30.0 | 39.3 | 44.2 | 23.2 | 26.9 | 32.7 | 21.0 | 55.9 | 19.5 | 27.5 | 35.0 | 39.1 | 29.2 | 42.3 | 57.1 |
| AIR HEATER OUTLET | | 26.7 | 33.3 | 47.0 | 55.8 | 51.6 | 55.8 | 61.9 | 24.9 | 35.9 | 35.7 | 37.6 | 81.5 | 30.2 | 35.4 | 40.1 | 54.0 | 45.3 | 52.7 | 83.2 |

# BASELINE OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1976 | 3/10 | 3/08 | 3/15 | 3/13 | 5/23 | 5/23 | 5/23 | 3/10 | 3/09 | 3/10 | 5/21 | 5/25 | 3/12 | 3/09 | 3/10 | 3/13 | 5/25 | 5/25 | 5/25 |
| UNIT LOAD | MW | 524 | 524 | 485 | 399 | 324 | 323 | 322 | 514 | 515 | 482 | 321 | 321 | 524 | 513 | 484 | 401 | 322 | 325 | 322 |
| **PRODUCTS OF COMBUSTION** | mg/J | | | | | | | | | | | | | | | | | | | |
| **ELECTROSTATIC PRECIPITATOR INLET** | | | | | | | | | | | | | | | | | | | | |
| DRY PRODUCTS | | 403 | 409 | 457 | 449 | 421 | 472 | 482 | 398 | 417 | 434 | 408 | 510 | 396 | 413 | 439 | 480 | 426 | 469 | 519 |
| WET PRODUCTS | | 436 | 442 | 491 | 481 | 454 | 507 | 516 | 432 | 450 | 467 | 441 | 545 | 430 | 446 | 472 | 515 | 459 | 503 | 554 |
| **AIR HEATER INLET** | | | | | | | | | | | | | | | | | | | | |
| DRY AIR | | 391 | 415 | 473 | 491 | 470 | 509 | 522 | 386 | 428 | 425 | 445 | 576 | 413 | 420 | 437 | 511 | 459 | 499 | 586 |
| WET AIR | | 396 | 421 | 479 | 497 | 476 | 516 | 529 | 391 | 434 | 431 | 450 | 584 | 418 | 425 | 443 | 518 | 465 | 506 | 594 |
| DRY PRODUCTS | | 417 | 422 | 463 | 452 | 428 | 478 | 485 | 410 | 427 | 440 | 411 | 522 | 404 | 429 | 448 | 492 | 436 | 479 | 527 |
| WET PRODUCTS | | 451 | 455 | 497 | 485 | 461 | 513 | 519 | 444 | 460 | 474 | 444 | 556 | 438 | 461 | 481 | 527 | 469 | 512 | 561 |
| **AIR HEATER OUTLET** | | | | | | | | | | | | | | | | | | | | |
| DRY AIR | | 386 | 391 | 439 | 430 | 402 | 455 | 465 | 380 | 400 | 416 | 391 | 493 | 378 | 394 | 421 | 461 | 407 | 451 | 501 |
| WET AIR | | 391 | 396 | 444 | 436 | 407 | 461 | 471 | 385 | 405 | 421 | 396 | 500 | 383 | 400 | 426 | 467 | 412 | 457 | 508 |
| DRY PRODUCTS | | 422 | 446 | 497 | 513 | 496 | 532 | 543 | 416 | 456 | 450 | 464 | 604 | 439 | 454 | 464 | 542 | 487 | 527 | 611 |
| WET PRODUCTS | | 456 | 479 | 531 | 546 | 530 | 568 | 578 | 449 | 490 | 484 | 498 | 640 | 473 | 487 | 498 | 578 | 521 | 561 | 647 |
| **GAS AND AIR FLOWS** | KG/S | | | | | | | | | | | | | | | | | | | |
| GAS ENTERING PRECIPITATOR | | 655 | 649 | 677 | 537 | 409 | 465 | 472 | 634 | 655 | 629 | 415 | 509 | 646 | 650 | 651 | 579 | 424 | 473 | 518 |
| GAS ENTERING AIR HEATER | | 676 | 668 | 685 | 541 | 416 | 470 | 475 | 652 | 681 | 639 | 417 | 519 | 658 | 673 | 664 | 592 | 433 | 482 | 526 |
| GAS LEAVING AIR HEATER | | 684 | 704 | 733 | 610 | 478 | 521 | 528 | 660 | 724 | 652 | 468 | 597 | 711 | 710 | 686 | 650 | 481 | 528 | 606 |
| AIR ENTERING AIR HEATER | | 594 | 618 | 661 | 555 | 429 | 472 | 484 | 574 | 642 | 580 | 423 | 544 | 629 | 620 | 611 | 582 | 429 | 476 | 556 |
| AIR LEAVING AIR HEATER | | 586 | 582 | 613 | 486 | 368 | 422 | 430 | 566 | 598 | 568 | 372 | 466 | 576 | 583 | 588 | 525 | 381 | 430 | 475 |
| AIR HEATER LEAKAGE | | 8 | 36 | 48 | 68 | 62 | 51 | 53 | 8 | 43 | 13 | 51 | 78 | 53 | 38 | 23 | 57 | 48 | 46 | 80 |
| **AIR HEATER PERFORMANCE** | | | | | | | | | | | | | | | | | | | | |
| AIR HEATER LEAKAGE | % | 1.1 | 5.4 | 7.0 | 12.6 | 14.9 | 10.8 | 11.2 | 1.2 | 6.4 | 2.0 | 12.3 | 15.1 | 8.0 | 5.6 | 3.4 | 9.7 | 11.2 | 9.5 | 15.2 |
| GAS SIDE EFFICIENCY | % | 72.1 | 72.7 | 71.9 | 72.6 | 70.6 | 72.4 | 72.0 | 72.1 | 71.8 | 72.2 | 67.8 | 70.1 | 70.4 | 71.1 | 72.0 | 72.6 | 69.8 | 71.1 | 70.9 |
| GAS DROP | C | 264 | 250 | 256 | 221 | 187 | 195 | 196 | 264 | 258 | 261 | 191 | 205 | 261 | 266 | 258 | 224 | 196 | 206 | 209 |
| AIR RISE | C | 254 | 238 | 244 | 209 | 185 | 184 | 187 | 256 | 250 | 253 | 199 | 201 | 262 | 261 | 251 | 214 | 196 | 200 | 201 |
| TEMPERATURE HEAD | C | 373 | 351 | 363 | 312 | 272 | 276 | 279 | 373 | 367 | 368 | 291 | 301 | 378 | 381 | 366 | 316 | 288 | 297 | 302 |
| **FUEL ANALYSIS** | | | | | | | | | | | | | | | | | | | | |
| CARBON | % | 48.6 | 50.3 | 49.8 | 49.4 | 48.9 | 49.7 | 51.3 | 49.0 | 50.0 | 48.8 | 51.1 | 50.6 | 49.2 | 50.6 | 48.8 | 49.9 | 50.5 | 50.6 | 50.6 |
| HYDROGEN | % | 3.4 | 3.4 | 3.4 | 3.3 | 3.3 | 3.7 | 3.6 | 3.4 | 3.5 | 3.4 | 3.6 | 3.6 | 3.4 | 3.4 | 3.4 | 3.4 | 3.4 | 3.4 | 3.5 |
| NITROGEN | % | .6 | .6 | .7 | .7 | .7 | .7 | .8 | .8 | .4 | .7 | .8 | .9 | .7 | .9 | .7 | .7 | .8 | .8 | .8 |
| OXYGEN | % | 11.6 | 12.3 | 12.3 | 12.2 | 12.6 | 11.7 | 11.9 | 12.7 | 11.8 | 12.2 | 11.9 | 11.7 | 12.3 | 12.7 | 12.2 | 12.5 | 12.3 | 11.9 | 12.0 |
| SULFUR | % | 1.0 | .8 | .7 | .8 | .8 | .9 | .6 | .7 | 1.0 | .8 | .7 | .7 | .8 | .7 | .8 | .7 | .6 | .6 | .6 |
| MOISTURE | % | 25.1 | 24.4 | 24.4 | 24.4 | 25.5 | 25.1 | 24.7 | 24.7 | 24.5 | 24.9 | 24.5 | 25.0 | 24.6 | 24.2 | 24.9 | 24.2 | 25.2 | 25.1 | 25.1 |
| ASH | % | 9.7 | 8.2 | 8.7 | 9.2 | 8.2 | 8.2 | 7.1 | 8.7 | 8.8 | 9.2 | 7.4 | 7.5 | 9.0 | 7.5 | 9.2 | 8.6 | 7.2 | 7.6 | 7.4 |
| HHV | KJ/KG | 19724 | 20108 | 19648 | 19934 | 19841 | 19724 | 20492 | 19748 | 20097 | 19736 | 20422 | 20353 | 19562 | 20120 | 19736 | 18841 | 20050 | 20097 | 20166 |

# BIASED FIRING OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1976 | 5/19 | 5/19 | 3/14 | 5/19 | 5/12 | 5/12 | 5/16 | 5/21 | 6/27 | 5/23 | 5/19 | 5/10 | 3/16 | 5/12 | 3/13 | 5/16 | 5/21 | 5/23 |
| UNIT LOAD | MW | 505 | 506 | 525 | 506 | 422 | 422 | 421 | 320 | 314 | 324 | 491 | 497 | 523 | 423 | 400 | 422 | 320 | 323 |
| FLOWS | KG/S | | | | | | | | | | | | | | | | | | |
| FEEDWATER (MEASURED) | | 406 | 412 | 404 | 404 | 349 | 345 | 342 | 237 | 256 | 260 | 391 | 384 | 407 | 349 | 321 | 345 | 234 | 254 |
| SH SPRAY (PLANT FLOW NOZZLE) | | 21 | 17 | 29 | 26 | 4 | 7 | 3 | 27 | 3 | 7 | 26 | 33 | 31 | 5 | 4 | 5 | 27 | 11 |
| MAIN STEAM (CALCULATED) | | 426 | 428 | 433 | 431 | 352 | 352 | 344 | 263 | 258 | 268 | 417 | 417 | 438 | 353 | 325 | 350 | 261 | 264 |
| TURB. LEAK. (TURB. HEAT BAL.) | | 6 | 6 | 7 | 7 | 5 | 5 | 5 | 4 | 4 | 4 | 6 | 6 | 7 | 5 | 5 | 5 | 4 | 4 |
| HP HTR. EXT. (HEAT BALANCE) | | 35 | 35 | 35 | 34 | 28 | 27 | 27 | 16 | 18 | 18 | 32 | 30 | 35 | 27 | 25 | 26 | 16 | 18 |
| RH SPRAY (PLANT FLOW NOZZLE) | | 13 | 16 | 21 | 12 | 2 | 1 | 1 | 4 | 0 | 0 | 13 | 18 | 18 | 2 | 1 | 1 | 3 | 0 |
| RH STEAM (CALCULATED) | | 398 | 404 | 412 | 402 | 321 | 321 | 314 | 247 | 236 | 245 | 392 | 399 | 415 | 323 | 296 | 320 | 244 | 242 |
| UNIT ABSORPTION | MJ/S | | | | | | | | | | | | | | | | | | |
| ECONOMIZER | | 222 | 224 | 228 | 222 | 178 | 168 | 174 | 132 | 119 | 127 | 227 | 227 | 223 | 190 | 161 | 190 | 142 | 130 |
| FURNACE | | 356 | 363 | 347 | 354 | 345 | 351 | 340 | 245 | 292 | 287 | 335 | 319 | 366 | 333 | 329 | 328 | 232 | 273 |
| DRUM - SH DESH | | 244 | 242 | 264 | 245 | 187 | 193 | 196 | 160 | 142 | 148 | 242 | 250 | 249 | 195 | 183 | 201 | 157 | 147 |
| SH DESH - SH OUTLET | | 182 | 180 | 181 | 192 | 134 | 133 | 117 | 120 | 90 | 102 | 185 | 190 | 191 | 131 | 112 | 122 | 122 | 104 |
| REHEATER | | 248 | 263 | 284 | 248 | 176 | 177 | 173 | 160 | 120 | 135 | 250 | 269 | 279 | 179 | 163 | 178 | 152 | 134 |
| TOTAL | | 1252 | 1272 | 1304 | 1262 | 1021 | 1022 | 1001 | 817 | 763 | 799 | 1239 | 1256 | 1308 | 1027 | 949 | 1020 | 805 | 788 |
| UNIT EFFICIENCY | % | | | | | | | | | | | | | | | | | | |
| DRY GAS LOSS | | 5.33 | 5.31 | 5.31 | 5.20 | 4.63 | 4.25 | 4.54 | 4.38 | 3.84 | 4.16 | 5.45 | 5.22 | 4.86 | 4.73 | 4.76 | 5.23 | 5.03 | 3.89 |
| MOISTURE IN FUEL LOSS | | 7.24 | 7.29 | 7.55 | 7.25 | 7.26 | 7.82 | 7.72 | 7.23 | 7.11 | 7.17 | 7.30 | 7.36 | 7.63 | 7.01 | 7.29 | 7.13 | 7.16 | 7.53 |
| MOISTURE IN AIR LOSS | | 0.13 | 0.12 | 0.12 | 0.12 | 0.11 | 0.10 | 0.11 | 0.10 | 0.09 | 0.10 | 0.13 | 0.12 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | 0.09 |
| RADIATION LOSS | | 0.18 | 0.18 | 0.17 | 0.18 | 0.22 | 0.22 | 0.23 | 0.27 | 0.29 | 0.28 | 0.17 | 0.18 | 0.17 | 0.22 | 0.24 | 0.22 | 0.28 | 0.28 |
| ASH PIT LOSS | | 0.37 | 0.35 | 0.36 | 0.34 | 0.37 | 0.37 | 0.36 | 0.39 | 0.35 | 0.33 | 0.35 | 0.35 | 0.36 | 0.38 | 0.36 | 0.35 | 0.40 | 0.33 |
| HEAT IN FLY ASH LOSS | | 0.03 | 0.03 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | 0.02 | 0.03 | 0.02 |
| PYRITE REJECTION LOSS | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CARBON LOSS | | 0.02 | 0.03 | 0.35 | 0.02 | 0.03 | 0.02 | 0.02 | 0.01 | 0.02 | 0.04 | 0.02 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.04 |
| ELECTROSTATIC PRECIP. LOSS | | 0.50 | 0.15 | 0.53 | 0.34 | 0.60 | 0.48 | 0.70 | 0.42 | 0.30 | 0.52 | 0.82 | 0.21 | 0.10 | 0.57 | 0.81 | 0.78 | 0.32 | 1.14 |
| TOTAL LOSSES | | 13.81 | 13.46 | 14.44 | 13.48 | 13.24 | 13.29 | 13.70 | 12.83 | 12.03 | 12.63 | 14.27 | 13.51 | 13.31 | 13.08 | 13.63 | 13.89 | 13.38 | 13.33 |
| EFFICIENCY | | 86.19 | 86.54 | 85.56 | 86.52 | 86.76 | 86.71 | 86.30 | 87.17 | 87.97 | 87.37 | 85.73 | 86.49 | 86.69 | 86.92 | 86.37 | 86.11 | 86.62 | 86.67 |
| HEAT INPUT | MJ/S | | | | | | | | | | | | | | | | | | |
| HEAT INPUT FROM FUEL | | 1453 | 1470 | 1524 | 1459 | 1177 | 1179 | 1160 | 937 | 867 | 915 | 1445 | 1452 | 1509 | 1182 | 1099 | 1185 | 929 | 909 |
| EXCESS AIR | % | | | | | | | | | | | | | | | | | | |
| ELECTROSTATIC PRECIP. INLET | | 20.4 | 18.4 | 15.2 | 19.0 | 26.1 | 21.7 | 30.7 | 19.7 | 34.2 | 29.2 | 23.1 | 24.6 | 18.4 | 34.1 | 35.8 | 41.3 | 35.9 | 36.6 |
| AIR HEATER INLET | | 23.2 | 23.2 | 18.4 | 23.2 | 28.4 | 24.5 | 32.3 | 21.1 | 35.9 | 32.4 | 23.9 | 29.2 | 25.4 | 36.7 | 36.7 | 43.2 | 37.6 | 38.4 |
| AIR HEATER OUTLET | | 42.3 | 41.3 | 28.4 | 40.4 | 47.1 | 38.4 | 45.1 | 39.5 | 56.1 | 48.2 | 46.2 | 41.3 | 36.8 | 50.4 | 54.8 | 65.8 | 56.0 | 58.2 |

# BIASED FIRING OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1976 | 5/19 | 5/19 | 3/14 | 5/19 | 5/12 | 5/12 | 5/16 | 5/21 | 6/27 | 5/23 | 5/19 | 5/10 | 3/16 | 5/12 | 3/13 | 5/16 | 5/21 | 5/23 |
| Unit Load | MW | 505 | 506 | 525 | 506 | 422 | 422 | 421 | 320 | 314 | 324 | 491 | 497 | 523 | 423 | 400 | 422 | 320 | 323 |
| **PRODUCTS OF COMBUSTION** | µg/J | | | | | | | | | | | | | | | | | | |
| **Electrostatic Precipitator Inlet** | | | | | | | | | | | | | | | | | | | |
| Dry Products | | 405 | 404 | 393 | 398 | 437 | 420 | 451 | 400 | 429 | 440 | 421 | 422 | 402 | 451 | 455 | 471 | 450 | 461 |
| Wet Products | | 437 | 436 | 425 | 431 | 471 | 455 | 485 | 433 | 462 | 473 | 454 | 455 | 435 | 484 | 489 | 504 | 483 | 496 |
| **Air Heater Inlet** | | | | | | | | | | | | | | | | | | | |
| Dry Air | | 448 | 444 | 407 | 435 | 482 | 449 | 475 | 441 | 473 | 474 | 476 | 442 | 420 | 477 | 496 | 526 | 490 | 508 |
| Wet Air | | 453 | 450 | 412 | 440 | 489 | 455 | 481 | 446 | 479 | 480 | 482 | 448 | 425 | 483 | 503 | 533 | 497 | 515 |
| Dry Products | | 414 | 419 | 403 | 411 | 445 | 429 | 455 | 404 | 435 | 451 | 423 | 436 | 424 | 460 | 458 | 477 | 455 | 467 |
| Wet Products | | 446 | 452 | 436 | 444 | 478 | 465 | 491 | 437 | 468 | 484 | 456 | 470 | 458 | 492 | 492 | 510 | 488 | 502 |
| **Air Heater Outlet** | | | | | | | | | | | | | | | | | | | |
| Dry Air | | 386 | 385 | 374 | 380 | 420 | 403 | 431 | 382 | 411 | 422 | 403 | 403 | 383 | 433 | 438 | 453 | 432 | 444 |
| Wet Air | | 391 | 390 | 379 | 385 | 425 | 409 | 439 | 387 | 416 | 428 | 408 | 408 | 388 | 439 | 443 | 459 | 438 | 450 |
| Dry Products | | 475 | 478 | 436 | 466 | 508 | 475 | 497 | 463 | 497 | 502 | 496 | 476 | 461 | 504 | 516 | 550 | 514 | 534 |
| Wet Products | | 509 | 512 | 469 | 500 | 542 | 511 | 533 | 497 | 531 | 536 | 530 | 509 | 495 | 537 | 551 | 584 | 548 | 567 |
| **GAS AND AIR FLOWS** | kg/s | | | | | | | | | | | | | | | | | | |
| Gas Entering Precipitator | | 635 | 641 | 648 | 629 | 554 | 536 | 563 | 406 | 401 | 433 | 656 | 661 | 656 | 572 | 537 | 597 | 449 | 451 |
| Gas Entering Air Heater | | 648 | 664 | 664 | 648 | 563 | 548 | 570 | 409 | 406 | 443 | 659 | 682 | 691 | 582 | 541 | 604 | 453 | 456 |
| Gas Leaving Air Heater | | 740 | 753 | 715 | 730 | 638 | 602 | 618 | 466 | 460 | 490 | 766 | 739 | 747 | 635 | 606 | 692 | 509 | 515 |
| Air Entering Air Heater | | 658 | 662 | 628 | 642 | 576 | 536 | 558 | 418 | 415 | 439 | 697 | 650 | 641 | 571 | 553 | 632 | 462 | 468 |
| Air Leaving Air Heater | | 568 | 573 | 578 | 562 | 500 | 482 | 509 | 363 | 361 | 392 | 590 | 592 | 585 | 519 | 487 | 544 | 407 | 409 |
| Air Heater Leakage | | 92 | 89 | 51 | 82 | 75 | 54 | 48 | 57 | 54 | 47 | 107 | 57 | 56 | 53 | 65 | 88 | 56 | 59 |
| **AIR HEATER PERFORMANCE** | | | | | | | | | | | | | | | | | | | |
| Air Heater Leakage | % | 13.9 | 13.2 | 7.6 | 12.5 | 13.2 | 10.0 | 8.7 | 13.6 | 13.4 | 10.8 | 16.2 | 8.5 | 8.1 | 9.1 | 12.0 | 14.4 | 12.1 | 13.0 |
| Gas Side Efficiency | % | 66.0 | 66.3 | 67.6 | 66.4 | 69.9 | 70.6 | 70.6 | 65.9 | 69.4 | 68.6 | 66.2 | 69.4 | 71.0 | 70.9 | 69.4 | 68.9 | 66.2 | 71.0 |
| Gas Drop | C | 227 | 226 | 254 | 226 | 219 | 216 | 218 | 187 | 178 | 180 | 227 | 249 | 259 | 230 | 214 | 220 | 195 | 183 |
| Air Rise | C | 319 | 314 | 347 | 315 | 287 | 282 | 284 | 271 | 239 | 247 | 317 | 329 | 333 | 296 | 284 | 292 | 279 | 236 |
| Temperature Head | C | 352 | 349 | 384 | 350 | 321 | 313 | 317 | 293 | 265 | 271 | 353 | 367 | 372 | 331 | 317 | 328 | 303 | 265 |
| **FUEL ANALYSIS** | | | | | | | | | | | | | | | | | | | |
| Carbon | % | 50.4 | 51.0 | 49.8 | 50.2 | 52.4 | 50.3 | 50.1 | 50.4 | 48.5 | 50.1 | 51.5 | 50.5 | 48.8 | 51.2 | 50.2 | 51.0 | 49.7 | 48.9 |
| Hydrogen | % | 3.4 | 3.4 | 3.4 | 3.4 | 3.7 | 3.8 | 3.7 | 3.4 | 3.3 | 3.5 | 3.6 | 3.4 | 3.3 | 3.5 | 3.5 | 3.5 | 3.4 | 3.6 |
| Nitrogen | % | .7 | .7 | .7 | .8 | .8 | .7 | .7 | .7 | .6 | .7 | .7 | .7 | .7 | .7 | .8 | .7 | .8 | .6 |
| Oxygen | % | 12.5 | 12.2 | 12.3 | 12.5 | 11.6 | 11.7 | 11.8 | 12.5 | 13.6 | 11.6 | 11.3 | 12.2 | 12.2 | 12.1 | 11.8 | 12.1 | 11.8 | 11.5 |
| Sulfur | % | .5 | .6 | .7 | .7 | .6 | .6 | .5 | .6 | .5 | 1.0 | .8 | .6 | .7 | .9 | .7 | .6 | .8 | 1.0 |
| Moisture | % | 24.7 | 25.0 | 24.4 | 24.7 | 23.9 | 25.9 | 25.3 | 25.4 | 25.9 | 23.9 | 24.2 | 25.1 | 25.6 | 23.5 | 24.7 | 24.4 | 24.6 | 25.8 |
| Ash | % | 7.7 | 7.1 | 8.7 | 7.7 | 7.0 | 7.0 | 7.9 | 7.0 | 7.6 | 9.2 | 7.5 | 7.5 | 8.7 | 8.1 | 8.3 | 7.7 | 8.9 | 8.6 |
| HHV | kJ/kg | 20097 | 20027 | 19648 | 20166 | 20422 | 19957 | 19771 | 20036 | 20273 | 19911 | 20399 | 20027 | 19329 | 20469 | 20166 | 20492 | 20166 | 19724 |

# OVERFIRE AIR OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1976 | 3/17 | 3/17 | 3/20 | 3/20 | 3/22 | 3/20 | 3/20 | 3/20 | 3/24 | 3/24 | 3/24 | 6/24 |
| Unit Load | MW | 517 | 512 | 524 | 525 | 526 | 521 | 522 | 522 | 476 | 473 | 472 | 524 |
| FLOWS | kg/s | | | | | | | | | | | | |
| Feedwater (Measured) | | 399 | 400 | 432 | 432 | 420 | 444 | 438 | 435 | 381 | 373 | 367 | 427 |
| SH Spray (Plant Flow Nozzle) | | 26 | 26 | 7 | 12 | 24 | 2 | 3 | 4 | 17 | 17 | 22 | 19 |
| Main Steam (Calculated) | | 425 | 426 | 439 | 445 | 444 | 446 | 441 | 439 | 398 | 390 | 389 | 446 |
| Turbine Leakage (Turbine Heat Balance) | | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 6 | 6 | 6 |
| HP Htr. Extraction (Heat Balance) | | 34 | 34 | 38 | 37 | 36 | 38 | 39 | 38 | 31 | 31 | 30 | 35 |
| RH Spray (Plant Flow Nozzle) | | 20 | 20 | 14 | 15 | 15 | 3 | 12 | 13 | 13 | 14 | 16 | 11 |
| RH Steam (Calculated) | | 404 | 405 | 409 | 416 | 416 | 404 | 407 | 407 | 374 | 367 | 368 | 415 |
| UNIT ABSORPTION | MJ/s | | | | | | | | | | | | |
| Economizer | | 227 | 230 | 160 | 167 | 159 | 200 | 151 | 151 | 178 | 174 | 165 | 237 |
| Furnace | | 341 | 340 | 467 | 459 | 449 | 432 | 485 | 479 | 387 | 380 | 383 | 376 |
| Drum - SH DESH | | 246 | 247 | 246 | 255 | 257 | 236 | 245 | 241 | 225 | 223 | 225 | 258 |
| SH DESH - SH Outlet | | 185 | 183 | 156 | 163 | 180 | 175 | 150 | 153 | 159 | 155 | 154 | 187 |
| Reheater | | 281 | 285 | 287 | 294 | 298 | 227 | 278 | 284 | 272 | 264 | 264 | 261 |
| Total | | 1280 | 1286 | 1315 | 1338 | 1342 | 1269 | 1310 | 1309 | 1221 | 1196 | 1191 | 1319 |
| UNIT EFFICIENCY | % | | | | | | | | | | | | |
| Dry Gas Loss | | 4.69 | 4.86 | 4.54 | 4.55 | 4.36 | 4.05 | 4.20 | 4.08 | 5.09 | 5.23 | 5.02 | 4.61 |
| Moisture in Fuel Loss | | 7.94 | 7.61 | 7.46 | 7.36 | 7.28 | 7.39 | 7.34 | 7.32 | 7.37 | 7.29 | 7.34 | 7.07 |
| Moisture in Air Loss | | 0.11 | 0.11 | 0.11 | 0.11 | 0.10 | 0.09 | 0.10 | 0.10 | 0.12 | 0.12 | 0.12 | 0.11 |
| Radiation Loss | | 0.18 | 0.18 | 0.17 | 0.17 | 0.17 | 0.18 | 0.17 | 0.17 | 0.19 | 0.19 | 0.19 | 0.17 |
| Ash Pit Loss | | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.35 | 0.36 | 0.36 | 0.35 | 0.36 | 0.33 | 0.35 |
| Heat in Fly Ash Loss | | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 |
| Pyrite Rejection Loss | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Carbon Loss | | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.03 | 0.04 | 0.03 | 0.01 | 0.02 | 0.01 | 0.02 |
| Electrostatic Precipitator Loss | | 0.79 | 0.07 | 0.80 | 0.60 | 0.51 | 0.25 | 0.32 | 0.33 | 0.96 | 0.80 | 0.90 | 0.44 |
| Total Losses | | 14.12 | 13.25 | 13.50 | 13.20 | 12.84 | 12.37 | 12.57 | 12.43 | 14.13 | 14.05 | 13.94 | 12.80 |
| Efficiency | | 85.88 | 86.75 | 86.50 | 86.80 | 87.16 | 87.63 | 87.43 | 87.57 | 85.87 | 85.95 | 86.06 | 87.20 |
| HEAT INPUT | MJ/s | | | | | | | | | | | | |
| Heat Input from Fuel | | 1490 | 1482 | 1520 | 1541 | 1540 | 1448 | 1498 | 1495 | 1422 | 1392 | 1384 | 1513 |
| EXCESS AIR | % | | | | | | | | | | | | |
| Electrostatic Precipitator Inlet | | 23.9 | 23.2 | 21.8 | 19.7 | 20.4 | 13.3 | 13.9 | 15.1 | 36.8 | 35.8 | 30.0 | 23.9 |
| Air Heater Inlet | | 25.4 | 30.8 | 23.2 | 22.5 | 23.9 | 18.4 | 19.0 | 19.7 | 37.7 | 37.6 | 30.8 | 26.1 |
| Air Heater Outlet | | 33.3 | 34.2 | 33.3 | 31.6 | 30.8 | 26.9 | 30.8 | 26.9 | 49.4 | 49.3 | 40.4 | 35.8 |

# OVERFIRE AIR OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1976 | 6/24 | 6/24 | 3/25 | 6/30 | 6/25 | 6/30 | 6/29 | 6/25 | 6/26 | 6/25 | 6/27 | 5/29 |
| UNIT LOAD | MW | 525 | 523 | 511 | 526 | 524 | 526 | 524 | 521 | 419 | 422 | 316 | 322 |
| **FLOWS** | kg/s | | | | | | | | | | | | |
| FEEDWATER (MEASURED) | | 421 | 424 | 401 | 416 | 410 | 419 | 419 | 413 | 342 | 322 | 262 | 244 |
| SH SPRAY (PLANT FLOW NOZZLE) | | 22 | 19 | 23 | 23 | 30 | 23 | 22 | 25 | 9 | 20 | 1 | 15 |
| MAIN STEAM (CALCULATED) | | 444 | 443 | 425 | 438 | 440 | 441 | 441 | 438 | 350 | 342 | 263 | 259 |
| TURBINE LEAKAGE (TURBINE HEAT BALANCE) | | 7 | 7 | 6 | 7 | 7 | 7 | 7 | 7 | 5 | 5 | 4 | 4 |
| HP HTR. EXTRACTION (HEAT BALANCE) | | 35 | 35 | 34 | 34 | 34 | 35 | 35 | 34 | 27 | 25 | 19 | 17 |
| RH SPRAY (PLANT FLOW NOZZLE) | | 16 | 8 | 18 | 12 | 14 | 10 | 12 | 17 | 0 | 5 | 0 | 0 |
| RH STEAM (CALCULATED) | | 418 | 408 | 402 | 409 | 413 | 409 | 412 | 414 | 318 | 316 | 240 | 238 |
| **UNIT ABSORPTION** | MJ/s | | | | | | | | | | | | |
| ECONOMIZER | | 243 | 233 | 159 | 227 | 237 | 233 | 228 | 240 | 173 | 186 | 115 | 129 |
| FURNACE | | 360 | 375 | 428 | 368 | 353 | 366 | 371 | 354 | 346 | 302 | 306 | 261 |
| DRUM - SH DESH | | 265 | 253 | 245 | 253 | 260 | 254 | 256 | 261 | 194 | 202 | 144 | 148 |
| SH DESH - SH OUTLET | | 195 | 196 | 171 | 203 | 213 | 204 | 199 | 202 | 141 | 152 | 82 | 114 |
| REHEATER | | 263 | 243 | 284 | 243 | 257 | 233 | 249 | 263 | 173 | 202 | 123 | 133 |
| TOTAL | | 1326 | 1300 | 1286 | 1295 | 1320 | 1289 | 1302 | 1320 | 1027 | 1044 | 770 | 785 |
| **UNIT EFFICIENCY** | % | | | | | | | | | | | | |
| DRY GAS LOSS | | 4.80 | 4.62 | 4.74 | 4.42 | 4.66 | 4.26 | 4.21 | 4.75 | 4.22 | 4.43 | 3.25 | 3.73 |
| MOISTURE IN FUEL LOSS | | 7.05 | 7.03 | 7.38 | 7.12 | 7.48 | 7.18 | 7.12 | 7.27 | 6.92 | 6.97 | 6.91 | 6.94 |
| MOISTURE IN AIR LOSS | | 0.11 | 0.11 | 0.11 | 0.10 | 0.11 | 0.10 | 0.10 | 0.11 | 0.10 | 0.10 | 0.08 | 0.09 |
| RADIATION LOSS | | 0.17 | 0.17 | 0.18 | 0.18 | 0.17 | 0.18 | 0.17 | 0.17 | 0.22 | 0.22 | 0.29 | 0.28 |
| ASH PIT LOSS | | 0.35 | 0.35 | 0.37 | 0.35 | 0.36 | 0.35 | 0.34 | 0.35 | 0.37 | 0.34 | 0.35 | 0.36 |
| HEAT IN FLY ASH LOSS | | 0.03 | 0.02 | 0.03 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| PYRITE REJECTION LOSS | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CARBON LOSS | | 0.02 | 0.02 | 0.01 | 0.06 | 0.05 | 0.05 | 0.03 | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 |
| ELECTROSTATIC PRECIPITATOR LOSS | | 0.56 | 0.39 | 0.74 | 0.29 | 0.25 | 0.72 | 0.34 | 0.66 | 0.59 | 0.50 | 0.59 | 0.77 |
| TOTAL LOSSES | | 13.10 | 12.72 | 13.57 | 12.55 | 13.12 | 12.87 | 12.34 | 13.37 | 12.47 | 12.61 | 11.53 | 12.22 |
| EFFICIENCY | | 86.90 | 87.28 | 86.43 | 87.45 | 86.88 | 87.13 | 87.66 | 86.63 | 87.53 | 87.39 | 88.47 | 87.78 |
| **HEAT INPUT** | MJ/s | | | | | | | | | | | | |
| HEAT INPUT FROM FUEL | | 1526 | 1489 | 1488 | 1481 | 1519 | 1479 | 1485 | 1524 | 1173 | 1195 | 870 | 894 |
| **EXCESS AIR** | % | | | | | | | | | | | | |
| ELECTROSTATIC PRECIPITATOR INLET | | 26.9 | 26.9 | 18.3 | 24.6 | 26.2 | 23.2 | 19.1 | 25.4 | 30.0 | 28.5 | 32.5 | 34.2 |
| AIR HEATER INLET | | 28.5 | 27.7 | 20.4 | 26.1 | 28.5 | 24.7 | 19.8 | 27.7 | 32.4 | 30.1 | 35.1 | 34.2 |
| AIR HEATER OUTLET | | 41.4 | 38.6 | 30.8 | 36.8 | 40.5 | 37.7 | 30.9 | 39.5 | 48.3 | 42.4 | 51.6 | 50.5 |

Wisconsin Power & Light Co.
Columbia #1

C-E Power Systems
Field Testing and
Performance Results

# OVERFIRE AIR OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1976 | 3/17 | 3/17 | 3/20 | 3/20 | 3/22 | 3/20 | 3/20 | 3/20 | 3/24 | 3/24 | 3/24 | 6/24 |
| Unit Load | MW | 517 | 512 | 524 | 525 | 526 | 521 | 522 | 522 | 476 | 473 | 472 | 524 |
| **PRODUCTS OF COMBUSTION** | μg/J | | | | | | | | | | | | |
| **Electrostatic Precipitator Inlet** | | | | | | | | | | | | | |
| Dry Products | | 413 | 414 | 412 | 400 | 401 | 383 | 384 | 387 | 461 | 453 | 443 | 412 |
| Wet Products | | 448 | 447 | 446 | 433 | 434 | 416 | 416 | 419 | 494 | 486 | 476 | 444 |
| **Air Heater Inlet** | | | | | | | | | | | | | |
| Dry Air | | 420 | 406 | 427 | 412 | 406 | 393 | 403 | 392 | 480 | 473 | 455 | 425 |
| Wet Air | | 425 | 411 | 433 | 417 | 411 | 398 | 409 | 397 | 486 | 479 | 461 | 430 |
| Dry Products | | 417 | 438 | 417 | 409 | 412 | 399 | 400 | 401 | 463 | 459 | 445 | 419 |
| Wet Products | | 452 | 472 | 450 | 442 | 445 | 432 | 433 | 434 | 497 | 492 | 478 | 451 |
| **Air Heater Outlet** | | | | | | | | | | | | | |
| Dry Air | | 394 | 395 | 394 | 382 | 384 | 365 | 366 | 369 | 442 | 436 | 424 | 394 |
| Wet Air | | 400 | 400 | 400 | 387 | 389 | 370 | 370 | 374 | 448 | 441 | 429 | 399 |
| Dry Products | | 443 | 449 | 450 | 438 | 434 | 427 | 438 | 424 | 501 | 496 | 476 | 450 |
| Wet Products | | 478 | 483 | 483 | 471 | 467 | 460 | 471 | 457 | 535 | 530 | 510 | 482 |
| **GAS AND AIR FLOWS** | kg/s | | | | | | | | | | | | |
| Gas Entering Precipitator | | 668 | 662 | 678 | 667 | 668 | 602 | 623 | 626 | 702 | 676 | 659 | 672 |
| Gas Entering Air Heater | | 673 | 700 | 684 | 681 | 685 | 626 | 649 | 649 | 707 | 685 | 662 | 682 |
| Gas Leaving Air Heater | | 712 | 716 | 734 | 726 | 719 | 666 | 706 | 683 | 761 | 738 | 706 | 729 |
| Air Entering Air Heater | | 633 | 609 | 658 | 642 | 633 | 576 | 613 | 594 | 691 | 667 | 638 | 650 |
| Air Leaving Air Heater | | 596 | 593 | 608 | 596 | 599 | 536 | 554 | 559 | 637 | 614 | 594 | 604 |
| Air Heater Leakage | | 39 | 16 | 50 | 45 | 34 | 40 | 57 | 34 | 54 | 53 | 44 | 47 |
| **AIR HEATER PERFORMANCE** | | | | | | | | | | | | | |
| Air Heater Leakage | % | 5.6 | 2.3 | 7.4 | 6.7 | 5.0 | 6.4 | 8.8 | 5.4 | 7.7 | 7.7 | 6.6 | 7.0 |
| Gas Side Efficiency | % | 71.9 | 72.4 | 72.3 | 72.2 | 73.1 | 71.7 | 72.1 | 73.1 | 72.0 | 71.4 | 71.7 | 70.0 |
| Gas Drop | C | 267 | 272 | 264 | 268 | 268 | 237 | 250 | 256 | 262 | 264 | 265 | 235 |
| Air Rise | C | 339 | 346 | 333 | 341 | 333 | 313 | 318 | 321 | 331 | 337 | 339 | 297 |
| Temperature Head | C | 379 | 382 | 372 | 378 | 373 | 337 | 354 | 357 | 371 | 377 | 377 | 344 |
| **FUEL ANALYSIS** | | | | | | | | | | | | | |
| Carbon | % | 47.30 | 48.80 | 50.30 | 49.80 | 50.00 | 50.20 | 49.80 | 49.70 | 50.40 | 50.20 | 52.30 | 51.50 |
| Hydrogen | % | 3.20 | 3.30 | 3.50 | 4.40 | 3.50 | 3.50 | 3.40 | 3.40 | 3.50 | 3.50 | 3.60 | 3.60 |
| Nitrogen | % | 0.70 | 0.70 | 0.80 | 0.80 | 0.80 | 0.80 | 0.70 | 0.60 | 0.80 | 0.80 | 0.80 | 0.80 |
| Oxygen | % | 11.80 | 12.10 | 12.00 | 11.80 | 11.80 | 12.00 | 12.00 | 12.00 | 13.10 | 11.90 | 13.60 | 12.70 |
| Sulfur | % | 0.70 | 0.60 | 0.60 | 0.70 | 0.70 | 0.60 | 0.80 | 0.90 | 0.70 | 0.90 | 0.50 | 0.50 |
| Moisture | % | 27.90 | 25.80 | 24.80 | 24.90 | 24.10 | 25.20 | 24.90 | 24.90 | 24.00 | 23.90 | 24.00 | 23.80 |
| Ash | % | 8.40 | 8.70 | 8.00 | 8.60 | 9.10 | 7.70 | 8.40 | 8.50 | 7.50 | 8.80 | 5.20 | 7.10 |
| HHV | kJ/kg | 19050 | 19492 | 20050 | 20097 | 20306 | 20120 | 19980 | 20004 | 20004 | 20283 | 20515 | 20864 |

# OVERFIRE AIR OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1976 | 6/24 | 6/24 | 3/25 | 6/30 | 6/25 | 6/30 | 6/29 | 6/25 | 6/26 | 6/25 | 6/27 | 5/29 |
| UNIT LOAD | MW | 525 | 523 | 511 | 526 | 524 | 526 | 524 | 521 | 419 | 422 | 316 | 322 |
| **PRODUCTS OF COMBUSTION** | µg/J | | | | | | | | | | | | |
| **ELECTROSTATIC PRECIPITATOR INLET** | | | | | | | | | | | | | |
| DRY PRODUCTS | | 409 | 412 | 404 | 411 | 413 | 391 | 380 | 409 | 440 | 417 | 421 | 433 |
| WET PRODUCTS | | 441 | 444 | 437 | 443 | 442 | 423 | 412 | 442 | 472 | 449 | 454 | 466 |
| **AIR HEATER INLET** | | | | | | | | | | | | | |
| DRY AIR | | 431 | 428 | 421 | 426 | 432 | 412 | 396 | 428 | 473 | 436 | 454 | 465 |
| WET AIR | | 436 | 433 | 426 | 432 | 437 | 418 | 401 | 434 | 479 | 442 | 459 | 471 |
| DRY PRODUCTS | | 414 | 415 | 411 | 415 | 420 | 395 | 382 | 416 | 448 | 422 | 429 | 433 |
| WET PRODUCTS | | 446 | 446 | 444 | 448 | 454 | 428 | 414 | 449 | 480 | 454 | 462 | 466 |
| **AIR HEATER OUTLET** | | | | | | | | | | | | | |
| DRY AIR | | 391 | 394 | 387 | 393 | 394 | 373 | 362 | 391 | 422 | 398 | 403 | 415 |
| WET AIR | | 396 | 399 | 392 | 398 | 400 | 378 | 366 | 396 | 427 | 403 | 408 | 420 |
| DRY PRODUCTS | | 454 | 448 | 445 | 449 | 458 | 435 | 416 | 453 | 499 | 460 | 479 | 484 |
| WET PRODUCTS | | 486 | 481 | 478 | 482 | 492 | 468 | 448 | 487 | 532 | 492 | 513 | 517 |
| **GAS AND AIR FLOWS** | kg/s | | | | | | | | | | | | |
| GAS ENTERING PRECIPITATOR | | 673 | 661 | 650 | 656 | 671 | 626 | 612 | 674 | 554 | 536 | 395 | 417 |
| GAS ENTERING AIR HEATER | | 680 | 664 | 661 | 663 | 690 | 633 | 615 | 684 | 563 | 542 | 402 | 417 |
| GAS LEAVING AIR HEATER | | 742 | 716 | 711 | 714 | 747 | 692 | 665 | 742 | 624 | 588 | 446 | 462 |
| AIR ENTERING AIR HEATER | | 665 | 645 | 634 | 640 | 664 | 618 | 595 | 661 | 562 | 528 | 399 | 421 |
| AIR LEAVING AIR HEATER | | 604 | 594 | 583 | 589 | 608 | 559 | 544 | 604 | 501 | 482 | 355 | 375 |
| AIR HEATER LEAKAGE | | 62 | 52 | 50 | 51 | 57 | 59 | 50 | 58 | 61 | 46 | 44 | 45 |
| **AIR HEATER PERFORMANCE** | | | | | | | | | | | | | |
| AIR HEATER LEAKAGE | % | 9.0 | 7.7 | 7.8 | 7.6 | 8.4 | 9.3 | 8.3 | 8.3 | 10.8 | 8.5 | 11.1 | 11.0 |
| GAS SIDE EFFICIENCY | % | 68.8 | 69.5 | 70.9 | 71.0 | 70.1 | 70.0 | 70.4 | 69.4 | 70.9 | 69.3 | 73.0 | 71.5 |
| GAS DROP | C | 234 | 233 | 260 | 239 | 239 | 230 | 240 | 237 | 208 | 216 | 183 | 195 |
| AIR RISE | C | 286 | 299 | 336 | 291 | 272 | 284 | 297 | 292 | 249 | 266 | 207 | 232 |
| TEMPERATURE HEAD | C | 348 | 343 | 374 | 344 | 348 | 336 | 349 | 349 | 301 | 319 | 258 | 280 |
| **FUEL ANALYSIS** | | | | | | | | | | | | | |
| CARBON | % | 49.90 | 50.10 | 50.20 | 50.80 | 47.80 | 48.90 | 49.40 | 49.40 | 51.90 | 50.40 | 49.30 | 49.20 |
| HYDROGEN | % | 3.40 | 3.40 | 3.50 | 3.50 | 3.30 | 3.40 | 3.40 | 3.40 | 3.60 | 3.50 | 3.40 | 3.40 |
| NITROGEN | % | 0.60 | 0.60 | 0.70 | 0.80 | 0.70 | 0.80 | 0.70 | 0.60 | 0.60 | 0.70 | 0.60 | 0.70 |
| OXYGEN | % | 13.80 | 13.80 | 11.90 | 12.70 | 13.70 | 14.10 | 14.40 | 13.80 | 12.90 | 14.60 | 14.30 | 13.60 |
| SULFUR | % | 0.40 | 0.50 | 0.90 | 0.50 | 0.50 | 0.50 | 0.40 | 0.40 | 0.60 | 0.70 | 0.40 | 0.70 |
| MOISTURE | % | 24.60 | 24.20 | 23.50 | 24.70 | 25.70 | 25.60 | 25.10 | 25.30 | 22.90 | 23.90 | 25.10 | 24.10 |
| ASH | % | 7.30 | 7.40 | 9.30 | 7.10 | 8.60 | 6.70 | 6.60 | 7.10 | 7.50 | 6.20 | 6.90 | 8.30 |
| HHV | kJ/kg | 20562 | 20492 | 19911 | 20678 | 19399 | 20515 | 20562 | 20120 | 20585 | 20655 | 20515 | 20283 |

# BASELINE OPERATION STUDY

## WATERWALL ABSORPTION RATES, $kW/m^2$

| TEST<br>T/C # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 45.55 | 23.36 | 50.03 | 32.32 | 23.26 | 32.03 | 2.90 | 120.87 | 0.0 | 2.81 | 23.25 | 2.28 | 29.37 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 100.11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 52.43 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 18.75 | 191.56 | 8.33 | 128.47 | 55.78 | 59.41 | 73.78 | 22.42 | 166.53 | 28.88 | 28.03 | 195.36 | 29.76 | 79.38 | 31.64 |
| 5 | 3.10 | 80.54 | 55.98 | 52.75 | 29.62 | 31.33 | 27.53 | 13.87 | 8.40 | 102.61 | 12.05 | 17.02 | 40.62 | 0.0 | 32.84 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 15.17 | 110.49 | 4.93 | 82.82 | 3.39 | 3.58 | 0.0 | 150.68 | 140.97 | 83.43 | 0.0 | 73.05 | 18.99 | 35.70 | 127.62 |
| 8 | 18.02 | 19.37 | 24.47 | 3.50 | 75.31 | 85.24 | 94.16 | 28.01 | 62.63 | 31.81 | 70.96 | 61.54 | 51.71 | 50.41 | 31.26 |
| 9 | 16.24 | 3.79 | 32.58 | 54.85 | 65.29 | 80.68 | 75.01 | 33.06 | 8.59 | 31.81 | 47.32 | 51.54 | 40.81 | 7.36 | 33.67 |
| 10 | 110.75 | 120.53 | 72.57 | 125.10 | 75.31 | 80.68 | 82.30 | 107.40 | 100.05 | 101.91 | 60.95 | 63.36 | 54.43 | 94.18 | 93.13 |
| 11 | 91.57 | 45.56 | 57.10 | 74.88 | 63.47 | 70.65 | 57.71 | 97.90 | 90.91 | 96.43 | 76.43 | 66.09 | 53.53 | 67.71 | 102.87 |
| 12 | 22.49 | 78.16 | 53.45 | 53.04 | 56.19 | 55.19 | 53.16 | 41.76 | 69.01 | 43.57 | 62.77 | 50.63 | 96.39 | 55.87 | 43.33 |
| 13 | 56.00 | 51.18 | 55.26 | 56.67 | 50.74 | 56.09 | 45.90 | 60.67 | 58.08 | 59.03 | 44.60 | 48.82 | 73.57 | 56.77 | 65.15 |
| 14 | 95.22 | 80.55 | 105.35 | 58.49 | 0.0 | 0.0 | 0.0 | 83.29 | 53.53 | 109.21 | 0.0 | 0.0 | 47.16 | 44.05 | 90.70 |
| 15 | 15.29 | 47.85 | 29.82 | 115.05 | 87.20 | 86.20 | 97.86 | 106.24 | 33.49 | 5.23 | 38.33 | 20.07 | 70.76 | 88.62 | 10.43 |
| 16 | 8.28 | 82.09 | 76.16 | 109.57 | 34.49 | 33.50 | 27.90 | 16.14 | 96.32 | 20.09 | 71.93 | 58.87 | 18.22 | 90.45 | 17.48 |
| 17 | 61.39 | 50.74 | 51.57 | 161.63 | 157.51 | 154.67 | 161.77 | 66.80 | 41.64 | 63.54 | 108.42 | 92.58 | 88.10 | 110.54 | 62.08 |
| 18 | 44.10 | 92.32 | 111.77 | 77.63 | 126.46 | 119.06 | 116.12 | 58.06 | 85.36 | 61.71 | 92.90 | 106.27 | 48.91 | 79.49 | 57.22 |
| 19 | 73.24 | 93.78 | 105.38 | 50.32 | 110.94 | 101.71 | 103.33 | 64.62 | 89.02 | 72.65 | 0.0 | 97.14 | 54.37 | 84.06 | 74.23 |
| 20 | 50.46 | 74.06 | 69.78 | 82.19 | 109.11 | 97.15 | 93.29 | 56.60 | 48.91 | 60.81 | 53.73 | 56.14 | 68.94 | 53.06 | 63.29 |
| 21 | 5.71 | 56.55 | 47.95 | 24.15 | 64.42 | 56.14 | 59.57 | 11.90 | 8.53 | 14.76 | 83.78 | 64.32 | 23.58 | 12.52 | 15.12 |
| 22 | 131.73 | 113.74 | 143.80 | 102.36 | 0.0 | 0.0 | 0.0 | 132.05 | 124.69 | 130.24 | 0.0 | 0.0 | 153.91 | 123.38 | 136.09 |
| 23 | 118.94 | 121.78 | 37.11 | 144.37 | 161.28 | 155.71 | 162.80 | 58.29 | 146.61 | 45.41 | 103.06 | 77.20 | 38.07 | 97.81 | 36.42 |
| 24 | 76.05 | 79.40 | 174.84 | 62.23 | 257.88 | 261.42 | 263.95 | 94.05 | 100.03 | 94.62 | 137.76 | 200.41 | 134.74 | 97.81 | 95.90 |
| 25 | 60.53 | 108.62 | 83.53 | 47.69 | 141.19 | 135.62 | 138.15 | 72.15 | 106.42 | 75.45 | 74.78 | 112.79 | 71.73 | 101.46 | 76.43 |
| 26 | 53.24 | 26.33 | 107.27 | 0.0 | 164.93 | 152.97 | 155.50 | 89.67 | 116.47 | 0.0 | 100.33 | 122.83 | 78.72 | 0.0 | 74.61 |
| 27 | 40.53 | 70.54 | 102.70 | 33.21 | 159.45 | 126.48 | 140.89 | 80.91 | 75.07 | 83.67 | 103.97 | 100.31 | 100.94 | 64.96 | 47.29 |
| 28 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 97.72 | 33.34 | 36.92 | 98.53 | 122.76 | 114.45 | 106.94 | 77.96 | 100.73 | 75.26 | 59.15 | 80.68 | 41.79 | 32.05 | 69.85 |
| 30 | 36.69 | 51.67 | 47.80 | 165.19 | 150.16 | 147.32 | 138.90 | 52.45 | 64.23 | 58.85 | 84.65 | 108.06 | 86.12 | 65.66 | 48.01 |
| 31 | 91.33 | 93.93 | 102.50 | 70.25 | 192.14 | 200.25 | 198.22 | 118.14 | 97.99 | 128.21 | 109.29 | 131.80 | 103.47 | 91.20 | 119.75 |
| 32 | 65.78 | 126.86 | 86.98 | 69.34 | 150.16 | 155.54 | 123.37 | 94.03 | 50.57 | 83.47 | 91.04 | 137.28 | 119.00 | 51.09 | 85.66 |
| 33 | 64.87 | 111.52 | 102.50 | 52.96 | 140.11 | 146.41 | 137.07 | 93.30 | 73.34 | 84.38 | 91.95 | 106.23 | 89.77 | 70.22 | 82.01 |
| 34 | 64.87 | 116.63 | 94.28 | 51.15 | 130.07 | 127.23 | 116.98 | 74.31 | 62.40 | 68.87 | 57.33 | 100.75 | 72.43 | 62.92 | 71.06 |
| 35 | 28.56 | 86.67 | 73.76 | 19.59 | 101.76 | 98.01 | 95.07 | 40.10 | 30.63 | 36.16 | 128.47 | 83.42 | 56.94 | 26.64 | 37.13 |
| 36 | 44.26 | 76.95 | 54.51 | 206.61 | 185.24 | 166.89 | 159.39 | 78.47 | 44.53 | 58.28 | 102.40 | 66.51 | 71.84 | 52.32 | 55.32 |
| 37 | 87.09 | 28.24 | 82.75 | 157.35 | 158.77 | 145.89 | 130.17 | 107.69 | 58.17 | 89.28 | 86.89 | 90.21 | 86.44 | 57.78 | 84.48 |
| 38 | 89.82 | 148.54 | 135.48 | 56.06 | 198.00 | 185.14 | 156.65 | 86.50 | 68.19 | 84.72 | 108.79 | 79.27 | 115.67 | 60.51 | 85.70 |
| 39 | 44.26 | 29.44 | 55.40 | 40.64 | 137.77 | 128.55 | 124.69 | 74.09 | 81.88 | 46.46 | 74.12 | 103.90 | 91.00 | 61.42 | 71.11 |
| 40 | 71.57 | 91.55 | 99.05 | 51.52 | 146.90 | 145.89 | 132.91 | 109.15 | 85.53 | 106.63 | 72.30 | 99.34 | 100.14 | 84.22 | 93.00 |
| 41 | 84.35 | 113.47 | 57.06 | 67.71 | 144.16 | 141.33 | 135.64 | 89.42 | 99.22 | 85.63 | 85.06 | 108.47 | 83.70 | 98.83 | 91.78 |
| 42 | 71.57 | 100.32 | 111.05 | 52.43 | 0.0 | 0.0 | 0.0 | 135.91 | 70.93 | 116.68 | 0.0 | 0.0 | 102.88 | 71.45 | 107.61 |
| 43 | 158.64 | 190.37 | 51.17 | 152.25 | 179.25 | 156.34 | 147.92 | 119.15 | 81.29 | 107.89 | 92.77 | 100.66 | 66.69 | 54.46 | 78.44 |
| 44 | 69.25 | 135.39 | 77.61 | 172.33 | 192.02 | 172.77 | 164.35 | 76.79 | 122.38 | 75.93 | 100.07 | 111.61 | 71.25 | 121.99 | 68.71 |
| 45 | 93.80 | 105.93 | 133.17 | 177.51 | 200.23 | 178.25 | 169.83 | 99.43 | 115.99 | 89.62 | 126.55 | 106.14 | 156.17 | 125.64 | 94.26 |

# BASELINE OPERATION STUDY

## WATERWALL ABSORPTION RATES, $kW/m^2$

| TEST | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T/C # | 46 | 68.24 | 86.21 | 52.17 | 31.93 | 47.00 | 38.77 | 25.97 | 67.31 | 72.16 | 76.24 | 60.88 | 83.32 | 79.46 | 74.51 | 0.0 |
| | 47 | 76.45 | [illegible] | [illegible] | 59.17 | 131.78 | 134.43 | 123.26 | 81.90 | 80.37 | 65.91 | 83.65 | 93.36 | 99.55 | 79.98 | 78.44 |
| | 48 | 87.40 | 101.55 | 97.69 | 63.72 | 139.08 | 137.17 | 128.74 | 92.85 | 96.81 | 93.27 | 69.98 | 98.83 | 107.77 | 94.59 | 83.31 |
| | 49 | 66.12 | 119.32 | 133.31 | 42.52 | 37.05 | 48.42 | 43.99 | 81.90 | 100.16 | 67.73 | 54.52 | 88.80 | 93.15 | 91.84 | 82.09 |
| | 50 | 146.44 | 108.77 | 141.22 | 15.91 | 158.03 | 148.81 | 134.91 | 143.31 | 135.76 | 115.80 | 134.56 | 122.35 | 98.31 | 142.67 | 77.54 |
| | 51 | 119.96 | 126.43 | 92.81 | 116.38 | 49.50 | 90.38 | 117.56 | 112.63 | 56.36 | 96.63 | 84.35 | 96.79 | 76.40 | 81.48 | 93.36 |
| | 52 | 113.56 | 137.59 | 100.51 | 23.67 | 165.33 | 149.73 | 147.70 | 119.20 | 131.19 | 101.19 | 109.90 | 92.23 | 124.80 | 104.31 | 103.10 |
| | 53 | 54.26 | 79.07 | 65.45 | 53.46 | 93.20 | 84.91 | 87.44 | 62.25 | 65.46 | 54.69 | 57.04 | 46.72 | 107.44 | 69.62 | 50.83 |
| | 54 | 90.73 | 27.33 | 53.16 | 88.99 | 45.88 | 83.08 | 118.47 | 87.79 | 24.66 | 73.81 | 61.58 | 83.11 | 83.70 | 96.09 | 73.89 |
| | 55 | 103.52 | 43.24 | 97.33 | 23.14 | 119.55 | 104.98 | 100.21 | 108.97 | 19.30 | 101.19 | 128.16 | 92.23 | 129.36 | 100.65 | 97.01 |
| | 56 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 57 | 0.0 | 0.0 | 0.0 | 0.0 | 36.84 | 50.33 | 48.31 | 0.0 | 0.0 | 0.0 | 151.87 | 121.42 | 0.0 | 0.0 | 0.0 |
| | 58 | 135.23 | 138.99 | 130.02 | 70.05 | 39.55 | 47.60 | 47.40 | 165.29 | 137.31 | 161.97 | 116.26 | 128.73 | 169.26 | 127.79 | 179.96 |
| | 59 | 86.82 | 84.92 | 84.23 | 33.72 | 30.52 | 35.84 | 32.03 | 92.23 | 72.47 | 87.99 | 104.38 | 83.08 | 93.47 | 112.26 | 97.17 |
| | 60 | 31.49 | 46.07 | 33.48 | 3.23 | 78.96 | 81.59 | 81.39 | 38.13 | 17.39 | 46.30 | 60.95 | 41.57 | 53.53 | 20.58 | 50.59 |
| | 61 | 27.88 | 9.40 | 30.20 | 0.0 | 57.10 | 58.82 | 55.89 | 77.45 | 14.73 | 66.31 | 56.40 | 49.73 | 29.95 | 47.68 | 59.08 |
| | 62 | 190.17 | 31.59 | 58.90 | 17.87 | 108.16 | 98.02 | 92.34 | 138.09 | 69.01 | 128.39 | 95.59 | 77.03 | 71.75 | 79.57 | 133.32 |
| | 63 | 44.17 | 101.53 | 131.92 | 66.68 | 90.81 | 76.12 | 63.17 | 57.03 | 115.57 | 53.57 | 61.86 | 52.45 | 64.45 | 79.57 | 60.29 |
| | 64 | 77.87 | 140.25 | 117.51 | 36.71 | 7.84 | 8.61 | 7.57 | 82.56 | 101.87 | 77.26 | 76.43 | 135.45 | 48.98 | 103.31 | 82.18 |
| | 65 | 70.50 | 98.89 | 25.32 | 131.49 | 94.50 | 86.20 | 86.90 | 21.13 | 37.11 | 88.16 | 41.04 | 35.30 | 50.73 | 48.52 | 34.23 |
| | 66 | 25.11 | 92.32 | 37.05 | 102.27 | 107.29 | 99.88 | 89.64 | 34.09 | 38.92 | 31.77 | 85.60 | 58.87 | 38.02 | 42.16 | 31.82 |
| | 67 | 41.38 | 142.01 | 75.25 | 115.05 | 128.29 | 118.15 | 105.16 | 47.14 | 59.83 | 49.89 | 72.84 | 65.23 | 73.50 | 52.15 | 54.79 |
| | 68 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 69 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 70 | 150.91 | 163.41 | 172.10 | 102.36 | 0.0 | 0.0 | 0.0 | 133.51 | 92.72 | 132.07 | 0.0 | 0.0 | 160.30 | 150.78 | 161.65 |
| | 71 | 97.93 | 110.08 | 59.82 | 99.53 | 135.71 | 123.74 | 113.49 | 65.58 | 50.78 | 51.77 | 82.08 | 44.47 | 58.06 | 66.78 | 54.56 |
| | 72 | 96.11 | 123.24 | 166.62 | 138.89 | 184.09 | 179.44 | 169.19 | 107.20 | 129.26 | 105.58 | 228.98 | 62.62 | 113.73 | 115.16 | 100.77 |
| | 73 | 86.06 | 142.96 | 151.02 | 123.37 | 171.31 | 159.36 | 145.46 | 99.17 | 127.43 | 98.27 | 104.89 | 107.31 | 134.74 | 93.24 | 97.12 |
| | 74 | 28.77 | 58.98 | 29.89 | 108.76 | 118.36 | 110.05 | 98.88 | 32.88 | 32.64 | 31.83 | 151.46 | 56.26 | 100.94 | 38.59 | 29.19 |
| | 75 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 76 | 60.32 | 36.42 | 81.50 | 31.23 | 140.11 | 135.45 | 130.68 | 69.21 | 86.12 | 66.14 | 91.95 | 140.02 | 78.82 | 108.56 | 69.85 |
| | 77 | 0.0 | 0.0 | 0.0 | 0.0 | 152.89 | 149.15 | 142.55 | 0.0 | 0.0 | 0.0 | 186.90 | 60.65 | 0.0 | 0.0 | 0.0 |
| | 78 | 71.25 | 64.73 | 110.72 | 37.55 | 125.50 | 117.19 | 107.85 | 83.07 | 87.03 | 79.82 | 85.57 | 96.19 | 85.21 | 60.19 | 156.28 |
| | 79 | 35.79 | 132.71 | 91.54 | 97.62 | 94.45 | 116.27 | 106.02 | 45.18 | 51.48 | 42.50 | 66.43 | 109.88 | 67.87 | 51.09 | 41.96 |
| | 80 | 56.08 | 68.92 | 110.14 | 51.52 | 207.12 | 197.00 | 173.08 | 73.36 | 39.09 | 80.16 | 111.53 | 89.30 | 80.05 | 45.96 | 74.75 |
| | 81 | 120.88 | 169.72 | [illegible] | 69.71 | 228.99 | 229.81 | 166.69 | 120.11 | 126.63 | 114.85 | 111.53 | 130.38 | 113.84 | 140.85 | 122.23 |
| | 82 | 113.57 | 145.62 | 99.95 | 57.89 | 152.38 | 147.72 | 144.78 | 139.11 | 103.79 | 122.16 | 82.33 | 104.82 | 125.71 | 119.84 | 112.48 |
| | 83 | 95.30 | [illegible] | 131.15 | 133.51 | 132.29 | 123.98 | 121.95 | 107.69 | 105.62 | 111.20 | 95.10 | 70.16 | 117.49 | 102.48 | 118.57 |
| | 84 | 76.13 | 83.52 | 102.83 | 113.08 | 0.0 | 0.0 | 0.0 | 82.12 | 78.23 | 73.77 | 0.0 | 0.0 | 94.66 | 79.66 | 77.18 |
| | 85 | 70.98 | 54.84 | 79.43 | 71.92 | 150.95 | 156.34 | 148.83 | 104.54 | 41.23 | 97.84 | 96.42 | 103.40 | 102.29 | 89.11 | 96.70 |
| | 86 | 82.84 | 105.20 | 100.82 | 137.64 | 120.82 | 129.86 | 121.44 | 104.54 | 78.55 | 105.15 | 77.27 | 109.79 | 109.59 | 65.39 | 88.17 |
| | 87 | 99.28 | 139.54 | 123.55 | 65.54 | 136.34 | 144.47 | 150.66 | 103.19 | 108.68 | 106.97 | 81.83 | 102.49 | 111.42 | 96.41 | 102.79 |
| | 88 | 87.40 | 112.51 | 102.25 | 111.15 | 120.82 | 122.56 | 126.00 | 91.39 | 105.02 | 89.62 | 69.98 | 62.37 | 101.37 | 110.11 | 85.74 |
| | 89 | 142.20 | 124.20 | [illegible] | 21.23 | 115.25 | 107.95 | 112.30 | 133.04 | 74.90 | 115.19 | 100.07 | 112.53 | 157.08 | 83.63 | 108.87 |
| | 90 | 66.10 | [illegible] | 53.16 | 133.31 | 131.55 | 134.20 | 138.50 | 117.93 | 23.76 | 89.32 | 81.61 | 90.40 | 150.37 | 101.56 | 79.97 |

# BASELINE OPERATION STUDY

## WATERWALL ABSORPTION RATES, kW/m$^2$

| TEST | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T/C # | 91 | 115.39 | 105.[illegible] | 7[illegible].00 | 115.47 | 121.51 | 123.24 | 135.82 | 115.55 | 92.83 | 99.37 | 108.99 | 84.93 | 102.88 | 96.09 | 95.79 |
| | 92 | 120.87 | 108.16 | 91.90 | 114.55 | 109.64 | 114.11 | 123.95 | 122.86 | 92.83 | 110.33 | 113.55 | 53.98 | 106.53 | 97.91 | 97.01 |
| | 93 | 148.27 | 138.11 | 122.04 | 120.94 | 131.55 | 133.29 | 140.39 | 174.71 | 79.14 | 146.86 | 152.82 | 106.83 | 162.24 | 61.42 | 139.63 |
| | 94 | 144.62 | 87.70 | 35.47 | 138.30 | 95.94 | 104.07 | 141.30 | 139.66 | 98.31 | 70.17 | 119.95 | 73.08 | 60.91 | 83.30 | 59.31 |
| | 95 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 96 | 202.02 | 75.24 | 57.08 | 84.92 | 101.77 | 95.28 | 90.51 | 152.70 | 116.49 | 141.18 | 111.11 | 77.94 | 138.41 | 201.89 | 111.40 |
| | 97 | 82.28 | 102.55 | 95.33 | 144.28 | 116.42 | 120.89 | 119.77 | 92.35 | 112.76 | 90.90 | 86.51 | 94.41 | 96.32 | 114.20 | 93.70 |
| | 98 | 104.33 | 106.43 | 0.0 | 67.70 | 0.0 | 0.0 | 0.0 | 113.05 | 144.78 | 111.97 | 0.0 | 0.0 | 100.94 | 120.64 | 112.95 |
| | 99 | 73.08 | 131.97 | 116.20 | 71.17 | 154.72 | 144.58 | 134.33 | 78.69 | 86.12 | 77.99 | 90.13 | 88.89 | 91.60 | 86.64 | 77.15 |
| | 100 | 81.61 | 118.57 | 102.33 | 66.07 | 187.06 | 182.41 | 156.65 | 93.80 | 107.44 | 87.46 | 102.40 | 66.51 | 117.49 | 100.66 | 84.48 |
| | 101 | 141.29 | 108.85 | 87.64 | 125.68 | 171.04 | 159.08 | 144.27 | 142.54 | 107.77 | 123.41 | 122.90 | 110.70 | 108.68 | 98.24 | 118.61 |
| | 102 | 135.13 | 91.93 | 84.60 | 20.76 | 31.73 | 29.19 | 37.76 | 123.11 | 103.40 | 104.14 | 92.62 | 34.81 | 114.05 | 98.74 | 98.55 |
| | 103 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 104 | 109.47 | 80.95 | 59.53 | 68.34 | 14.41 | 18.65 | 16.05 | 90.54 | 84.60 | 89.10 | 80.08 | 21.77 | 99.64 | 78.06 | 67.64 |
| | 105 | 157.00 | 110.52 | 96.51 | 105.18 | 36.09 | 33.54 | 43.38 | 161.61 | 124.69 | 142.31 | 98.26 | 42.30 | 146.57 | 101.25 | 146.95 |
| | 106 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 107 | 170.11 | 130.05 | 104.65 | 113.35 | 36.71 | 32.29 | 43.38 | 181.08 | 95.88 | 157.31 | 103.90 | 78.60 | 110.92 | 91.22 | 184.40 |
| | 108 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 109 | 46.72 | 55.74 | 64.16 | 31.92 | 26.93 | 30.43 | 32.03 | 19.56 | 59.71 | 60.63 | 96.17 | 74.88 | 84.34 | 58.41 | 31.64 |
| | 110 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 111 | 45.01 | 67.49 | 50.66 | 116.71 | 101.80 | 107.19 | 115.20 | 52.96 | 51.64 | 48.98 | 101.11 | 62.50 | 48.00 | 27.69 | 47.52 |
| | 112 | 71.47 | 126.16 | 108.18 | 177.24 | 0.0 | 0.0 | 0.0 | 89.67 | 79.94 | 88.23 | 0.0 | 0.0 | 82.68 | 64.96 | 94.68 |
| | 113 | 85.85 | 138.59 | 44.17 | 83.93 | 57.09 | 52.46 | 47.72 | 77.96 | 40.59 | 73.43 | 94.69 | 101.67 | 59.67 | 49.27 | 67.42 |
| | 114 | 55.17 | 121.51 | 49.04 | 131.78 | 166.99 | 147.72 | 135.64 | 86.50 | 59.08 | 81.98 | 70.48 | 102.99 | 96.48 | 51.41 | 78.40 |
| | 115 | 111.15 | 56.30 | 60.29 | 122.12 | 125.39 | 112.51 | 105.00 | 125.73 | 54.85 | 118.85 | 56.34 | 81.50 | 91.33 | 107.37 | 110.09 |
| | 116 | 99.86 | 100.12 | 70.08 | 95.38 | 109.64 | 104.98 | 98.39 | 106.05 | 88.27 | 92.97 | 60.67 | 81.29 | 110.18 | 90.61 | 101.88 |

# BASELINE OPERATION STUDY

## WATERWALL ABSORPTION RATES, $kW/m^2$

| TEST T/C # | 16 | 17 | 18 | 19 |
|---|---|---|---|---|
| 1 | 58.31 | 4.35 | 0.0 | 11.55 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 124.74 | 110.35 | [illegible] | 213.39 |
| 5 | 45.95 | 81.15 | 43.09 | 15.94 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 79.45 | 79.35 | 73.72 | 71.03 |
| 8 | 0.0 | 52.34 | 53.05 | 55.79 |
| 9 | 116.61 | 46.90 | 44.88 | 43.62 |
| 10 | 117.33 | 59.61 | 50.32 | 64.98 |
| 11 | 72.79 | 62.34 | 63.96 | 69.62 |
| 12 | 54.58 | 52.34 | 53.95 | 54.06 |
| 13 | 56.03 | 50.55 | 51.23 | 50.43 |
| 14 | 58.22 | 0.0 | 0.0 | 0.0 |
| 15 | 133.77 | 21.73 | 24.21 | 19.87 |
| 16 | 82.64 | 59.66 | 63.09 | 60.48 |
| 17 | 130.12 | 97.94 | 96.83 | 93.29 |
| 18 | 91.40 | 119.86 | 114.17 | 106.07 |
| 19 | 36.80 | 109.81 | 109.48 | 93.29 |
| 20 | 78.99 | 69.67 | 55.73 | 54.12 |
| 21 | 42.60 | 66.94 | 56.73 | 61.39 |
| 22 | 117.97 | 0.0 | 0.0 | 0.0 |
| 23 | 153.77 | 87.11 | 89.65 | 0.0 |
| 24 | 47.95 | 187.53 | 190.98 | 192.91 |
| 25 | 33.47 | 104.45 | 105.16 | 108.93 |
| 26 | 18.59 | 131.85 | 120.69 | 115.23 |
| 27 | 29.86 | 109.02 | 0.0 | 0.0 |
| 28 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 105.55 | 51.44 | 52.15 | 63.17 |
| 30 | 170.57 | 86.75 | 92.22 | 98.72 |
| 31 | 61.04 | 133.52 | 132.40 | 134.34 |
| 32 | 64.68 | 132.60 | 135.05 | 132.51 |
| 33 | 45.05 | 109.77 | 109.57 | 106.94 |
| 34 | 47.96 | 107.03 | 90.40 | 91.42 |
| 35 | 20.55 | 96.99 | 75.80 | 77.74 |
| 36 | 159.44 | 68.22 | 68.01 | 66.31 |
| 37 | 155.79 | 90.09 | 86.24 | 87.27 |
| 38 | 52.14 | 84.62 | 85.33 | 82.71 |
| 39 | 47.78 | 109.26 | 97.19 | 100.04 |
| 40 | 45.60 | 108.35 | 100.34 | 99.13 |
| 41 | 59.41 | 109.25 | 102.67 | 99.13 |
| 42 | 26.10 | 0.0 | 0.0 | 0.0 |
| 43 | 149.04 | 133.41 | 93.95 | 101.37 |
| 44 | 165.11 | 146.20 | 105.81 | 106.84 |
| 45 | 151.25 | 130.57 | 93.51 | 95.80 |
| 46 | 31.69 | 109.67 | 65.91 | 69.45 |
| 47 | 54.88 | 135.24 | 63.47 | 34.94 |
| 48 | 64.34 | 116.05 | 130.33 | 100.45 |
| 49 | 25.94 | 89.59 | 75.71 | 85.85 |
| 50 | 19.62 | 153.28 | 117.46 | 117.58 |
| 51 | 114.80 | 121.52 | 92.81 | 90.20 |
| 52 | 17.49 | 87.55 | 60.92 | 71.96 |
| 53 | 61.53 | 55.67 | 49.11 | 46.52 |
| 54 | 97.27 | 112.19 | 54.60 | 79.25 |
| 55 | 20.33 | 123.15 | 90.08 | 85.64 |
| 56 | 0.0 | 0.0 | 0.0 | 0.0 |
| 57 | 0.0 | 121.32 | 120.20 | 123.05 |
| 58 | 65.60 | 128.62 | 133.25 | 130.35 |
| 59 | 30.03 | 88.45 | 85.51 | 81.06 |
| 60 | 8.66 | 36.04 | 40.35 | 41.37 |
| 61 | 73.52 | 47.80 | 49.41 | 49.52 |
| 62 | 106.37 | 76.91 | 75.80 | 75.91 |
| 63 | 67.69 | 54.16 | 50.32 | 50.43 |
| 64 | 38.61 | 152.69 | 150.14 | 125.20 |
| 65 | 123.54 | 26.20 | 27.78 | 30.60 |
| 66 | 111.85 | 67.85 | 67.65 | 56.84 |
| 67 | 108.20 | 70.59 | 70.38 | 62.30 |
| 68 | 0.0 | 0.0 | 0.0 | 0.0 |
| 69 | 0.0 | 0.0 | 0.0 | 0.0 |
| 70 | 101.90 | 0.0 | 0.0 | 0.0 |
| 71 | 81.45 | 52.51 | 49.58 | 46.98 |
| 72 | 147.93 | 74.35 | 72.32 | 66.04 |
| 73 | 109.21 | 122.72 | 117.03 | 101.62 |
| 74 | 109.94 | 73.44 | 67.77 | 55.15 |
| 75 | 0.0 | 0.0 | 0.0 | 0.0 |
| 76 | 112.86 | 161.82 | 132.40 | 105.12 |
| 77 | 0.0 | 65.99 | 56.69 | 56.81 |
| 78 | 61.04 | 123.47 | 101.35 | 91.42 |
| 79 | 108.47 | 145.39 | 108.65 | 89.60 |
| 80 | 213.44 | 85.55 | 80.77 | 79.97 |
| 81 | 217.81 | 145.79 | 126.41 | 124.70 |
| 82 | 144.83 | 120.22 | 101.75 | 100.04 |
| 83 | 119.99 | 86.45 | 72.57 | 67.22 |
| 84 | 124.37 | 0.0 | 0.0 | 0.0 |
| 85 | 44.71 | 111.50 | 97.60 | 95.89 |
| 86 | 119.08 | 119.71 | 112.20 | 108.67 |
| 87 | 50.51 | 114.24 | 103.07 | 102.28 |
| 88 | 111.78 | 71.36 | 64.78 | 57.62 |
| 89 | 98.63 | 135.24 | 114.03 | 105.93 |
| 90 | 134.53 | 85.72 | 59.10 | 77.43 |
| 91 | 122.11 | 79.34 | 82.78 | 84.72 |
| 92 | 111.88 | 58.40 | 56.38 | 58.32 |
| 93 | 121.38 | 127.71 | 124.77 | 112.10 |
| 94 | 124.30 | 71.14 | 79.13 | 80.17 |
| 95 | 0.0 | 0.0 | 0.0 | 0.0 |
| 96 | 134.14 | 75.09 | 74.89 | 76.82 |
| 97 | 143.27 | 97.94 | 100.48 | 92.37 |
| 98 | 60.31 | 0.0 | 0.0 | 0.0 |
| 99 | 69.06 | 105.20 | 101.35 | 86.86 |
| 100 | 66.70 | 77.33 | 74.39 | 63.58 |
| 101 | 96.44 | 0.0 | 0.0 | 108.67 |
| 102 | 11.22 | 43.46 | 37.08 | 32.80 |
| 103 | 0.0 | 0.0 | 0.0 | 0.0 |
| 104 | 58.99 | 34.10 | 28.36 | 23.48 |
| 105 | 109.11 | 53.46 | 46.44 | 40.90 |
| 106 | 0.0 | 0.0 | 0.0 | 0.0 |
| 107 | 112.62 | 91.05 | 74.62 | 69.69 |
| 108 | 0.0 | 0.0 | 0.0 | 0.0 |
| 109 | 34.36 | 79.33 | 86.42 | 81.06 |
| 110 | 0.0 | 0.0 | 0.0 | 0.0 |
| 111 | 76.80 | 66.03 | 65.83 | 62.30 |
| 112 | 127.47 | 0.0 | 0.0 | 0.0 |
| 113 | 78.54 | 107.03 | 97.70 | 96.90 |
| 114 | 111.95 | 131.18 | 86.24 | 83.62 |
| 115 | 105.93 | 96.89 | 83.00 | 74.92 |
| 116 | 92.16 | 108.54 | 104.68 | 78.34 |

# BIASED FIRING OPERATION STUDY

## WATERWALL ABSORPTION RATES, $kW/m^2$

| TEST / T/C # | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 74.10 | 126.55 | 7.17 | 86.79 | 97.15 | 121.79 | 46.10 | 0.0 | 0.0 | 20.46 | 104.12 | 121.39 | 79.91 | 13.98 | 71.66 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 52.71 | 0.0 | 29.43 | 43.82 | 54.27 | 0.0 | 0.0 | 0.0 | 0.0 | 85.85 | 0.0 | 152.97 | 143.05 | 0.0 |
| 4 | 95.10 | 233.55 | 35.70 | 147.07 | 47.00 | 193.90 | 77.05 | 27.54 | 0.0 | 51.11 | 67.60 | 83.95 | 195.84 | 154.92 | 152.01 |
| 5 | 30.47 | 121.67 | 112.26 | 56.72 | 56.09 | 99.87 | 34.32 | 14.20 | 64.16 | 26.71 | 137.00 | 89.43 | 79.91 | 110.17 | 58.91 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 125.35 | 20.67 | 69.45 | 18.17 | 104.43 | 15.51 | 0.0 | 80.56 | 8.19 | 135.78 | 125.96 | 105.48 | 130.27 | 93.56 |
| 8 | 96.20 | 159.52 | 53.14 | 129.00 | 31.87 | 39.10 | 114.74 | 65.00 | 0.0 | 61.43 | 85.44 | 34.08 | 6.13 | 31.21 | 0.0 |
| 9 | 77.94 | 81.97 | 45.14 | 62.35 | 32.77 | 23.68 | 80.95 | 43.20 | 122.87 | 50.53 | 76.92 | 54.04 | 17.52 | 36.63 | 115.74 |
| 10 | 111.73 | 138.30 | 58.60 | 35.10 | 44.54 | 38.20 | 93.73 | 53.18 | 23.76 | 56.89 | 106.14 | 58.60 | 22.87 | 49.33 | 111.17 |
| 11 | 75.20 | 70.12 | 58.60 | 24.27 | 47.26 | 49.08 | 65.45 | 68.64 | 25.55 | 45.99 | 75.71 | 117.01 | 26.47 | 66.61 | 75.57 |
| 12 | 45.15 | 94.45 | 91.43 | 53.25 | 61.81 | 38.20 | 58.17 | 64.09 | 39.96 | 39.65 | 40.51 | 60.42 | 37.31 | 71.17 | 71.01 |
| 13 | 82.50 | 45.84 | 72.27 | 34.19 | 56.35 | 47.26 | 53.62 | 36.87 | 90.00 | 37.85 | 87.87 | 73.18 | 28.27 | 64.79 | 62.81 |
| 14 | 49.69 | 57.97 | 44.95 | 39.62 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 52.62 | 75.01 | 83.74 | 0.0 | 0.0 |
| 15 | 107.08 | 91.34 | 30.39 | 92.39 | 31.87 | 40.00 | 95.54 | 47.79 | 15.81 | 98.86 | 111.56 | 65.81 | 117.46 | 47.49 | 60.08 |
| 16 | 104.34 | 101.97 | 14.28 | 141.72 | 59.07 | 61.80 | 130.25 | 72.34 | 0.0 | 34.28 | 59.23 | 43.07 | 76.37 | 125.01 | 59.17 |
| 17 | 65.10 | 70.65 | 80.80 | 54.09 | 111.07 | 112.90 | 156.73 | 111.57 | 0.0 | 137.21 | 66.52 | 58.53 | 56.31 | 113.14 | 141.30 |
| 18 | 111.65 | 57.29 | 45.79 | 50.46 | 61.80 | 64.53 | 123.86 | 86.01 | 48.15 | 107.07 | 113.99 | 43.07 | 74.54 | 63.86 | 81.04 |
| 19 | 76.04 | 41.54 | 31.24 | 47.73 | 92.81 | 92.81 | 110.16 | 71.43 | 81.83 | 89.73 | 78.68 | 66.72 | 89.14 | 89.40 | 26.57 |
| 20 | 72.39 | 51.22 | 55.81 | 41.37 | 60.89 | 51.79 | 101.94 | 45.07 | 86.39 | 87.91 | 72.60 | 61.26 | 39.96 | 64.77 | 80.12 |
| 21 | 56.90 | 85.25 | 19.62 | 65.02 | 21.99 | 22.89 | 59.07 | 99.70 | 65.42 | 53.30 | 39.85 | 22.30 | 10.39 | 24.01 | 50.08 |
| 22 | 0.0 | 0.0 | 157.08 | 0.0 | 0.0 | 0.0 | 191.49 | 0.0 | 25.41 | 0.0 | 0.0 | 0.0 | 145.82 | 0.0 | 113.08 |
| 23 | 111.70 | 149.54 | 35.87 | 147.25 | 97.15 | 129.42 | 188.75 | 101.95 | 106.58 | 177.50 | 105.22 | 65.87 | 22.86 | 98.00 | 150.52 |
| 24 | 148.24 | 251.61 | 119.73 | 110.72 | 219.74 | 247.96 | 217.01 | 136.35 | 0.0 | 279.49 | 127.14 | 95.07 | 125.73 | 209.96 | 42.00 |
| 25 | 68.80 | 50.97 | 70.42 | 45.97 | 116.63 | 117.55 | 144.03 | 72.46 | 0.0 | 146.46 | 69.92 | 62.22 | 69.12 | 110.48 | 22.19 |
| 26 | 100.74 | 111.79 | 47.66 | 139.03 | 50.97 | 29.25 | 148.60 | 104.39 | 120.28 | 167.46 | 104.00 | 71.34 | 115.68 | 63.95 | 19.52 |
| 27 | 91.61 | 91.09 | 54.67 | 139.95 | 160.47 | 206.08 | 143.12 | 93.43 | 115.71 | 150.11 | 90.61 | 116.99 | 78.24 | 116.87 | 32.96 |
| 28 | 44.23 | 130.06 | 103.77 | 111.93 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 46.86 | 86.85 | 44.55 | 0.0 | 0.0 |
| 29 | 64.03 | 101.54 | 106.73 | 127.37 | 44.44 | 39.91 | 109.14 | 49.57 | 148.42 | 118.90 | 59.09 | 38.38 | 68.00 | 86.55 | 86.11 |
| 30 | 93.23 | 96.65 | 101.25 | 98.03 | 101.84 | 140.20 | 156.63 | 79.60 | 182.19 | 167.30 | 101.06 | 81.16 | 152.92 | 91.12 | 160.38 |
| 31 | 90.49 | 91.79 | 102.16 | 39.50 | 142.94 | 181.27 | 115.54 | 107.88 | 0.0 | 222.01 | 87.66 | 104.90 | 97.20 | 124.91 | 61.80 |
| 32 | 96.88 | 86.92 | 118.60 | 94.07 | 61.70 | 58.06 | 157.54 | 91.45 | 150.25 | 169.12 | 97.40 | 80.25 | 88.07 | 59.21 | 67.27 |
| 33 | 84.10 | 80.34 | 66.64 | 105.94 | 57.15 | 54.43 | 38.10 | 94.19 | 49.01 | 157.25 | 86.45 | 51.09 | 89.90 | 55.57 | 46.35 |
| 34 | 95.97 | 103.97 | 70.22 | 126.04 | 153.89 | 142.02 | 132.89 | 56.84 | 52.64 | 139.91 | 87.66 | 55.64 | 86.25 | 121.25 | 50.89 |
| 35 | 133.42 | 111.28 | 52.91 | 127.87 | 29.07 | 31.78 | 100.92 | 144.41 | 40.86 | 103.38 | 136.37 | 98.51 | 47.06 | 29.30 | 20.23 |
| 36 | 93.55 | 119.82 | 72.36 | 127.28 | 107.68 | 124.12 | 102.20 | 93.69 | 163.43 | 178.65 | 90.12 | 69.62 | 84.74 | 94.21 | 96.82 |
| 37 | 83.50 | 85.72 | 80.05 | 81.62 | 78.47 | 86.68 | 165.21 | 80.01 | 145.17 | 164.96 | 87.69 | 62.33 | 88.39 | 69.58 | 127.87 |
| 38 | 127.34 | 136.87 | 110.92 | 157.45 | 89.42 | 94.89 | 201.70 | 106.47 | 52.13 | 214.22 | 124.22 | 95.18 | 116.70 | 84.17 | 60.35 |
| 39 | 59.80 | 74.77 | 47.77 | 67.63 | 98.55 | 85.77 | 133.25 | 65.43 | 148.82 | 153.09 | 64.58 | 69.62 | 134.97 | 104.26 | 35.26 |
| 40 | 84.42 | 56.55 | 105.22 | 63.58 | 78.47 | 93.07 | 145.13 | 71.80 | 142.43 | 165.87 | 79.17 | 61.42 | 105.74 | 74.14 | 53.08 |
| 41 | 120.03 | 60.19 | 57.37 | 51.63 | 166.12 | 156.08 | 149.69 | 81.85 | 132.38 | 158.57 | 127.87 | 78.74 | 120.36 | 151.75 | 64.90 |
| 42 | 70.73 | 55.55 | 144.31 | 71.58 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 71.87 | 49.59 | 112.14 | 0.0 | 0.0 |
| 43 | 94.78 | 153.93 | 72.68 | 135.11 | 208.44 | 172.86 | 161.92 | 88.62 | 152.87 | 171.76 | 91.36 | 60.83 | 86.89 | 183.14 | 132.81 |
| 44 | 110.31 | 140.54 | 73.57 | 134.09 | 233.04 | 196.59 | 176.53 | 95.92 | 174.78 | 185.45 | 104.75 | 84.54 | 168.16 | 194.99 | 128.24 |
| 45 | 118.53 | 145.41 | 157.43 | 149.52 | 232.13 | 160.31 | 168.31 | 128.79 | 176.60 | 200.95 | 108.41 | 84.54 | 170.90 | 184.05 | 120.93 |

# BIASED FIRING OPERATION STUDY

## WATERWALL ABSORPTION RATES, $kW/m^2$

| TEST | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T/C # | 46 | 71.06 | 62.04 | 75.42 | 39.15 | 37.02 | 40.64 | 102.56 | 54.93 | 111.78 | 53.17 | 59.74 | 141.17 | 0.0 | 41.76 | 31.71 |
| | 47 | 88.39 | 33.51 | 111.02 | 105.68 | 177.44 | 159.18 | 169.23 | 84.98 | 130.04 | 150.76 | 81.62 | 62.65 | 76.85 | 155.76 | 48.60 |
| | 48 | 93.87 | 89.39 | 102.60 | 113.47 | 153.71 | 150.05 | 156.45 | 70.40 | 137.35 | 145.28 | 87.71 | 74.51 | 88.71 | 142.97 | 67.09 |
| | 49 | 105.74 | 66.23 | 37.23 | 104.77 | 139.10 | 123.57 | 124.48 | 54.93 | 103.56 | 45.91 | 95.01 | 70.86 | 128.90 | 126.54 | 33.52 |
| | 50 | 162.04 | 143.26 | 173.39 | 143.72 | 177.17 | 177.17 | 153.44 | 138.63 | 108.81 | 158.76 | 156.19 | 41.42 | 113.96 | 167.35 | 13.63 |
| | 51 | 144.09 | 202.37 | 88.05 | 53.38 | 152.52 | 142.48 | 29.54 | 82.03 | 112.46 | 49.32 | 137.93 | 123.49 | 113.96 | 141.79 | 107.88 |
| | 52 | 179.36 | 170.04 | 124.40 | 161.99 | 135.17 | 150.70 | 43.09 | 103.01 | 123.42 | 162.41 | 158.62 | 150.89 | 113.04 | 111.65 | 20.71 |
| | 53 | 57.06 | 79.95 | 113.22 | 80.72 | 40.37 | 48.53 | 19.70 | 56.54 | 86.91 | 88.46 | 50.33 | 86.96 | 79.26 | 27.95 | 40.49 |
| | 54 | 65.26 | 77.51 | 62.39 | 80.72 | 75.83 | 75.83 | 135.17 | 56.54 | 53.22 | 36.65 | 63.68 | 99.74 | 78.35 | 46.93 | 89.62 |
| | 55 | 105.42 | 89.08 | 123.95 | 115.41 | 131.52 | 127.87 | 137.91 | 121.27 | 93.29 | 107.62 | 90.44 | 82.39 | 124.92 | 123.52 | 24.28 |
| | 56 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 57 | 169.98 | 128.93 | 0.0 | 80.40 | 135.49 | 111.74 | 53.37 | 142.24 | 89.69 | 35.71 | 134.57 | 117.74 | 0.0 | 120.22 | 0.0 |
| | 58 | 194.61 | 143.60 | 149.70 | 105.88 | 148.27 | 129.09 | 53.37 | 129.45 | 96.08 | 42.04 | 177.16 | 143.31 | 129.22 | 141.23 | 88.08 |
| | 59 | 94.19 | 102.17 | 86.69 | 83.14 | 105.35 | 88.00 | 34.32 | 103.88 | 63.25 | 29.41 | 104.12 | 84.86 | 63.49 | 103.78 | 38.94 |
| | 60 | 90.72 | 64.04 | 53.60 | 26.07 | 70.01 | 67.27 | 86.43 | 54.08 | 35.44 | 63.25 | 84.23 | 29.56 | 66.41 | 68.43 | 6.32 |
| | 61 | 83.41 | 93.24 | 31.36 | 82.42 | 45.45 | 31.67 | 59.08 | 54.99 | 37.25 | 45.08 | 81.79 | 35.89 | 61.85 | 48.42 | 99.30 |
| | 62 | 108.07 | 99.35 | 74.09 | 86.07 | 189.59 | 215.11 | 92.82 | 90.52 | 0.0 | 75.09 | 96.40 | 72.27 | 111.14 | 164.30 | 151.35 |
| | 63 | 74.29 | 53.11 | 53.15 | 25.17 | 80.04 | 80.95 | 78.21 | 54.99 | 131.09 | 55.97 | 72.06 | 67.71 | 57.30 | 79.38 | 89.26 |
| | 64 | 91.63 | 95.08 | 48.59 | 91.55 | 163.13 | 141.22 | 66.37 | 60.82 | 111.00 | 10.23 | 87.87 | 92.35 | 95.61 | 126.86 | 47.36 |
| | 65 | 48.71 | 88.91 | 151.63 | 124.36 | 40.00 | 35.48 | 97.37 | 40.55 | 51.78 | 76.96 | 44.69 | 145.25 | 128.42 | 37.52 | 130.34 |
| | 66 | 67.83 | 97.45 | 53.10 | 98.79 | 136.64 | 103.76 | 127.51 | 84.19 | 102.82 | 83.35 | 62.88 | 46.70 | 14.79 | 123.18 | 114.81 |
| | 67 | 146.36 | 155.83 | 57.64 | 73.23 | 141.21 | 132.99 | 126.60 | 67.78 | 0.0 | 98.86 | 133.48 | 136.12 | 72.72 | 121.36 | 112.99 |
| | 68 | 0.0 | 0.0 | 71.28 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 69 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 70 | 73.36 | 127.62 | 111.51 | 155.47 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 69.92 | 135.26 | 154.04 | 0.0 | 0.0 |
| | 71 | 87.04 | 94.74 | 51.30 | 98.84 | 204.26 | 154.99 | 149.51 | 76.11 | 45.55 | 134.59 | 82.09 | 88.68 | 45.45 | 183.52 | 91.16 |
| | 72 | 149.15 | 170.23 | 107.83 | 162.77 | 90.15 | 93.80 | 210.64 | 105.30 | 69.18 | 180.24 | 133.23 | 108.77 | 128.47 | 83.09 | 181.55 |
| | 73 | 106.22 | 120.32 | 118.82 | 190.14 | 122.12 | 127.60 | 180.55 | 97.09 | 93.80 | 178.41 | 110.09 | 80.46 | 119.34 | 111.40 | 148.70 |
| | 74 | 52.40 | 54.61 | 35.94 | 145.42 | 108.41 | 64.62 | 127.60 | 153.70 | 69.18 | 119.98 | 52.92 | 18.78 | 42.73 | 89.48 | 107.60 |
| | 75 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 76 | 93.23 | 114.73 | 76.60 | 104.12 | 188.57 | 170.32 | 150.24 | 91.45 | 164.86 | 158.17 | 84.01 | 76.60 | 60.71 | 168.73 | 131.16 |
| | 77 | 82.27 | 94.23 | 0.0 | 105.03 | 211.36 | 150.24 | 168.50 | 84.16 | 58.10 | 160.00 | 81.58 | 0.0 | 0.0 | 193.37 | 0.0 |
| | 78 | 68.59 | 80.34 | 34.82 | 123.30 | 43.98 | 53.52 | 141.11 | 81.42 | 57.18 | 125.29 | 69.42 | 67.48 | 80.77 | 40.14 | 111.98 |
| | 79 | 44.02 | 59.57 | 55.60 | 45.63 | 76.28 | 75.37 | 116.45 | 62.29 | 32.73 | 43.29 | 45.15 | 32.05 | 58.89 | 57.39 | 93.72 |
| | 80 | 78.03 | 72.34 | 30.57 | 67.93 | 155.17 | 187.11 | 152.43 | 116.51 | 220.88 | 226.06 | 84.04 | 55.05 | 70.14 | 72.32 | 230.95 |
| | 81 | 128.26 | 106.42 | 110.70 | 173.84 | 287.22 | 253.60 | 206.26 | 114.68 | 233.64 | 257.01 | 130.31 | 225.66 | 166.93 | 262.92 | 206.36 |
| | 82 | 96.29 | 94.24 | 123.77 | 95.31 | 222.65 | 190.76 | 154.26 | 82.74 | 136.95 | 153.09 | 101.08 | 69.62 | 134.97 | 198.28 | 154.36 |
| | 83 | 104.51 | 103.99 | 120.75 | 76.14 | 177.98 | 158.82 | 151.52 | 92.78 | 162.52 | 125.70 | 104.73 | 184.65 | 166.93 | 164.53 | 127.87 |
| | 84 | 102.63 | 119.32 | 90.09 | 73.40 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 101.08 | 167.32 | 90.22 | 0.0 | 0.0 |
| | 85 | 129.49 | 142.77 | 74.57 | 134.91 | 169.23 | 170.14 | 129.05 | 89.54 | 154.70 | 159.89 | 118.15 | 71.77 | 133.47 | 149.37 | 47.09 |
| | 86 | 103.91 | 115.22 | 133.38 | 94.72 | 199.33 | 173.79 | 164.66 | 77.68 | 156.52 | 129.76 | 103.54 | 71.77 | 158.12 | 182.23 | 115.45 |
| | 87 | 104.83 | 91.83 | 113.76 | 31.94 | 213.91 | 197.50 | 168.31 | 73.13 | 168.39 | 141.63 | 109.63 | 99.15 | 126.16 | 194.08 | 51.63 |
| | 88 | 76.35 | 72.35 | 133.28 | 55.42 | 164.60 | 145.49 | 141.84 | 74.04 | 131.87 | 127.02 | 75.54 | 136.60 | 113.37 | 147.54 | 115.45 |
| | 89 | 58.32 | 82.17 | [illegible] | [illegible] | 143.23 | 129.05 | 120.83 | 97.75 | 102.65 | 121.54 | 65.82 | 149.38 | 122.51 | 129.28 | 103.58 |
| | 90 | 135.65 | 150.57 | [illegible] | [illegible] | 131.61 | [illegible] | 167.13 | 92.06 | 106.99 | 145.06 | 136.71 | 66.89 | 66.49 | 157.31 | 130.71 |

# BIASED FIRING OPERATION STUDY

## WATERWALL ABSORPTION RATES, kW/m$^2$

| TEST | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T/C # | 91 | 115.46 | 121.34 | 109.79 | 126.37 | 146.13 | 152.52 | 132.43 | 112.14 | 120.68 | 135.93 | 108.70 | 108.87 | 82.00 | 146.35 | 109.71 |
| | 92 | 93.54 | 105.51 | 107.05 | 140.99 | 134.26 | 147.05 | 140.65 | 133.14 | 123.42 | 124.97 | 84.35 | 87.87 | 122.18 | 137.22 | 103.32 |
| | 93 | 99.94 | 114.03 | 132.71 | 146.47 | 139.74 | 138.83 | 134.26 | 77.47 | 127.08 | 145.98 | 91.65 | 149.06 | 155.97 | 133.57 | 124.32 |
| | 94 | 78.94 | 87.25 | 92.33 | 122.72 | 111.43 | 129.69 | 130.61 | 54.72 | 103.33 | 103.06 | 74.62 | 79.66 | 101.17 | 124.43 | 145.32 |
| | 95 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 96 | 129.08 | 138.50 | 127.06 | 127.17 | 162.22 | 174.09 | 100.12 | 105.12 | 128.35 | 78.74 | 114.67 | 143.50 | 133.06 | 137.82 | 169.61 |
| | 97 | 211.12 | 64.58 | 93.19 | 97.73 | 148.52 | 167.68 | 174.99 | 86.92 | 71.80 | 101.60 | 140.78 | 66.72 | 103.76 | 124.10 | 132.17 |
| | 98 | 118.10 | 125.19 | 97.81 | 121.68 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 118.62 | 76.81 | 170.47 | 0.0 | 0.0 |
| | 99 | 100.53 | 103.97 | 88.46 | 129.69 | 96.36 | 101.84 | 194.96 | 86.89 | 61.73 | 153.60 | 101.06 | 72.04 | 75.29 | 96.59 | 67.27 |
| | 100 | 126.43 | 135.65 | 113.44 | 154.67 | 145.13 | 159.73 | 150.60 | 95.51 | 178.94 | 178.65 | 118.13 | 108.88 | 88.39 | 107.00 | 55.80 |
| | 101 | 0.0 | 141.75 | 111.94 | 78.29 | 130.88 | 145.49 | 87.04 | 0.0 | 143.74 | 151.68 | 121.80 | 133.86 | 95.10 | 104.62 | 47.09 |
| | 102 | 105.89 | 111.39 | 113.05 | 128.90 | 103.66 | 123.70 | 121.19 | 92.28 | 0.0 | 36.59 | 98.21 | 91.22 | 126.65 | 81.24 | 10.74 |
| | 103 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 104 | 88.86 | 103.54 | 89.97 | 102.61 | 86.11 | 99.90 | 83.60 | 77.86 | 65.54 | 21.68 | 82.34 | 114.40 | 99.72 | 59.94 | 51.73 |
| | 105 | 97.00 | 107.71 | 125.67 | 143.91 | 113.05 | 128.08 | 95.51 | 97.29 | 0.0 | 35.97 | 92.36 | 124.41 | 147.28 | 86.88 | 74.28 |
| | 106 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 107 | 85.09 | 89.33 | 94.36 | 119.51 | 96.14 | 116.81 | 82.35 | 100.42 | 0.0 | 34.72 | 82.34 | 123.16 | 170.38 | 83.12 | 71.78 |
| | 108 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 109 | 112.45 | 111.95 | 80.30 | 79.57 | 69.76 | 84.35 | 36.13 | 92.93 | 55.07 | 23.14 | 88.29 | 84.86 | 61.67 | 93.73 | 44.37 |
| | 110 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 84.52 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 111 | 87.91 | 90.12 | 44.88 | 51.42 | 123.86 | 123.86 | 57.25 | 108.83 | 60.87 | 104.33 | 115.21 | 107.80 | 36.33 | 116.79 | 49.17 |
| | 112 | 84.31 | 77.70 | 79.55 | 39.01 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 89.39 | 106.94 | 78.24 | 0.0 | 0.0 |
| | 113 | 103.27 | 105.19 | 59.28 | 148.87 | 62.62 | 56.24 | 158.46 | 88.72 | 0.0 | 59.62 | 96.18 | 170.65 | 38.90 | 67.40 | 66.36 |
| | 114 | 63.44 | 61.49 | 91.52 | 58.82 | 143.30 | 149.69 | 162.47 | 67.25 | 157.04 | 179.56 | 64.58 | 101.57 | 146.84 | 128.00 | 106.87 |
| | 115 | 59.21 | 52.93 | 87.28 | 52.73 | 151.88 | 108.05 | 116.26 | 51.30 | 126.39 | 124.28 | 56.10 | 56.28 | 127.07 | 120.14 | 85.33 |
| | 116 | 68.91 | 90.29 | 110.70 | 116.32 | 97.73 | 106.86 | 104.12 | 58.36 | 92.38 | 120.41 | 63.68 | 106.13 | 107.56 | 104.34 | 82.32 |

# BIASED FIRING OPERATION STUDY

## WATERWALL ABSORPTION RATES, $kW/m^2$

| TEST T/C # | 16 | 17 | 18 |
|---|---|---|---|
| 1 | 44.29 | 4.35 | 25.53 |
| 2 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 |
| 4 | 83.14 | 29.39 | 49.90 |
| 5 | 45.50 | 11.64 | 21.06 |
| 6 | 0.0 | 0.0 | 0.0 |
| 7 | 25.03 | 0.0 | 0.0 |
| 8 | 97.39 | 55.06 | 57.49 |
| 9 | 91.31 | 45.99 | 52.04 |
| 10 | 93.74 | 57.79 | 52.04 |
| 11 | 75.49 | 65.97 | 40.60 |
| 12 | 71.84 | 65.97 | 36.04 |
| 13 | 64.55 | 38.74 | 34.84 |
| 14 | 0.0 | 0.0 | 0.0 |
| 15 | 79.73 | 45.14 | 87.61 |
| 16 | 115.03 | 71.50 | 29.49 |
| 17 | 158.87 | 110.73 | 129.61 |
| 18 | 127.21 | 72.40 | 97.65 |
| 19 | 117.47 | 74.23 | 83.05 |
| 20 | 112.60 | 48.76 | 80.31 |
| 21 | 67.58 | 89.73 | 45.75 |
| 22 | 0.0 | 0.0 | 553.17 |
| 23 | 169.60 | 0.0 | 157.16 |
| 24 | 208.51 | 134.59 | 255.56 |
| 25 | 135.52 | 72.53 | 134.29 |
| 26 | 147.69 | 98.07 | 148.90 |
| 27 | 136.74 | 0.0 | 139.77 |
| 28 | 0.0 | 0.0 | 0.0 |
| 29 | 57.16 | 51.46 | 126.82 |
| 30 | 97.28 | 79.66 | 156.96 |
| 31 | 145.99 | 103.37 | 215.34 |
| 32 | 165.46 | 90.61 | 161.52 |
| 33 | 121.63 | 92.43 | 152.39 |
| 34 | 132.59 | 58.72 | 132.30 |
| 35 | 99.71 | 124.39 | 104.00 |
| 36 | 63.28 | 84.54 | 171.06 |
| 37 | 124.12 | 78.26 | 160.10 |
| 38 | 152.13 | 104.71 | 201.16 |
| 39 | 119.25 | 34.63 | 134.54 |
| 40 | 120.47 | 66.41 | 154.62 |
| 41 | 136.30 | 79.17 | 144.58 |
| 42 | 0.0 | 0.0 | 0.0 |
| 43 | 146.10 | 85.05 | 162.34 |
| 44 | 157.06 | 97.32 | 142.41 |
| 45 | 133.93 | 114.26 | [illegible] |
| 46 | 110.79 | 55.01 | 50.15 |
| 47 | 127.84 | 75.93 | 138.60 |
| 48 | 129.05 | 66.85 | 123.99 |
| 49 | 115.66 | 47.75 | 51.06 |
| 50 | 144.00 | 134.13 | 151.16 |
| 51 | 28.64 | 69.35 | 46.31 |
| 52 | 35.85 | 93.96 | 150.25 |
| 53 | 27.44 | 51.17 | 88.17 |
| 54 | 119.65 | 54.80 | 43.60 |
| 55 | 123.30 | 40.50 | 100.03 |
| 56 | 0.0 | 0.0 | 0.0 |
| 57 | 63.69 | 128.61 | 39.03 |
| 58 | 61.26 | 125.86 | 43.55 |
| 59 | 40.67 | 88.43 | 32.71 |
| 60 | 96.17 | 49.61 | 62.95 |
| 61 | 69.41 | 52.33 | 44.79 |
| 62 | 113.22 | 91.50 | 75.70 |
| 63 | 93.74 | 59.60 | 53.86 |
| 64 | 73.06 | 55.97 | 12.55 |
| 65 | 111.38 | 46.04 | 66.64 |
| 66 | 132.08 | 79.70 | 76.67 |
| 67 | 135.74 | 61.48 | 94.00 |
| 68 | 0.0 | 0.0 | 0.0 |
| 69 | 0.0 | 0.0 | 0.0 |
| 70 | 0.0 | 0.0 | 0.0 |
| 71 | 148.91 | 76.18 | 121.51 |
| 72 | 206.08 | 100.81 | 160.25 |
| 73 | 173.25 | 89.85 | 175.29 |
| 74 | 122.12 | 36.22 | 123.33 |
| 75 | 0.0 | 0.0 | 0.0 |
| 76 | 150.86 | 90.61 | 144.18 |
| 77 | 155.73 | 76.95 | 152.39 |
| 78 | 135.03 | 76.93 | 124.09 |
| 79 | 109.45 | 58.72 | 34.86 |
| 80 | 142.39 | 108.36 | 202.07 |
| 81 | 193.50 | 108.36 | 149.15 |
| 82 | 142.39 | 80.03 | 155.54 |
| 83 | 143.61 | 83.72 | 91.62 |
| 84 | 0.0 | 0.0 | 0.0 |
| 85 | 120.53 | 82.31 | 159.60 |
| 86 | 130.27 | 68.65 | 59.24 |
| 87 | 163.15 | 62.27 | 144.99 |
| 88 | 129.05 | 63.19 | 119.42 |
| 89 | 120.53 | 80.87 | 114.35 |
| 90 | 105.03 | [illegible] | [illegible] |
| 91 | 118.43 | 109.48 | 127.42 |
| 92 | 125.74 | 116.78 | 124.68 |
| 93 | 136.70 | 43.92 | 141.12 |
| 94 | 146.44 | 49.35 | 66.30 |
| 95 | 0.0 | 0.0 | 0.0 |
| 96 | 104.70 | 99.71 | 79.35 |
| 97 | 171.04 | 87.91 | 101.30 |
| 98 | 0.0 | 0.0 | 0.0 |
| 99 | 178.85 | 90.61 | 162.44 |
| 100 | 109.51 | 95.59 | 182.01 |
| 101 | 70.63 | 117.91 | 157.77 |
| 102 | 129.12 | 86.05 | 35.77 |
| 103 | 0.0 | 0.0 | 0.0 |
| 104 | 53.95 | 64.75 | 17.78 |
| 105 | 75.67 | 86.69 | 38.89 |
| 106 | 0.0 | 0.0 | 0.0 |
| 107 | 49.78 | 87.31 | 35.15 |
| 108 | 0.0 | 0.0 | 0.0 |
| 109 | 38.25 | 89.34 | 22.85 |
| 110 | 0.0 | 0.0 | 0.0 |
| 111 | 53.01 | 113.46 | 89.43 |
| 112 | 0.0 | 0.0 | 0.0 |
| 113 | 131.37 | 87.87 | 59.33 |
| 114 | 141.17 | 68.23 | 157.37 |
| 115 | 82.79 | 54.10 | 125.81 |
| 116 | 96.51 | 55.71 | 113.72 |

# OVERFIRE AIR OPERATION STUDY

## WATERWALL ABSORPTION RATES, $kW/m^2$

| T/C # \ TEST | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 72.87 | 70.26 | 0.0 | 7.74 | 6.58 | 74.77 | 28.41 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 114.87 | 129.93 | 0.0 | 11.22 | 0.0 | 41.08 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 129.64 | 127.80 | 103.85 | 84.77 |
| 4 | 141.36 | 41.15 | 100.75 | 77.27 | 124.43 | 163.35 | 133.22 | 114.46 | 4.58 | 6.01 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 82.90 | 92.13 | 43.05 | 55.10 | 44.15 | 74.77 | 46.53 | 33.34 | 0.0 | 0.0 | 0.0 | 87.99 | 91.26 | 93.80 | 62.87 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 115.78 | 115.32 | 0.0 | 11.22 | 8.30 | 100.33 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 123.80 | 119.57 | 120.29 | 29.29 |
| 8 | 94.96 | 92.98 | 0.0 | 2.39 | 0.0 | 53.06 | 51.24 | 25.40 | 34.64 | 38.27 | 28.59 | 0.0 | 0.0 | 0.0 | 20.50 |
| 9 | 29.43 | 29.87 | 6.14 | 0.0 | 84.41 | 75.85 | 43.97 | 21.81 | 31.92 | 18.48 | 15.48 | 61.52 | 58.58 | 80.27 | 6.44 |
| 10 | 24.93 | 29.09 | 37.33 | 29.26 | 88.07 | 132.47 | 105.07 | 51.67 | 84.68 | 82.86 | 55.17 | 155.02 | 127.96 | 123.20 | 34.00 |
| 11 | 81.26 | 83.24 | 2.83 | 0.0 | 28.03 | 93.19 | 65.81 | 18.23 | 72.82 | 67.36 | 60.02 | 54.96 | 47.66 | 43.83 | 85.87 |
| 12 | 20.46 | 19.12 | 57.32 | 61.03 | 47.96 | 89.54 | 56.70 | 60.77 | 80.12 | 91.08 | 74.60 | 100.22 | 99.64 | 107.67 | 26.78 |
| 13 | 87.65 | 91.76 | 68.26 | 52.83 | 74.38 | 79.49 | 53.97 | 55.31 | 74.64 | 71.92 | 72.17 | 86.34 | 66.78 | 110.41 | 109.62 |
| 14 | 77.61 | 95.41 | 54.59 | 53.74 | 65.26 | 78.58 | 58.52 | 47.12 | 72.82 | 78.30 | 58.81 | 117.02 | 115.17 | 107.67 | 40.34 |
| 15 | 130.51 | 142.24 | 122.04 | 102.01 | 107.17 | 131.46 | 112.28 | 120.02 | 70.95 | 63.68 | 42.42 | 28.41 | 24.05 | 26.56 | 14.22 |
| 16 | 6.33 | 10.22 | 105.60 | 102.92 | 0.0 | 132.38 | 95.84 | 63.42 | 56.37 | 52.75 | 55.75 | 0.0 | 0.0 | 0.0 | 36.65 |
| 17 | 59.31 | 64.32 | 79.12 | 70.97 | 26.16 | 134.20 | 115.02 | 96.27 | 71.86 | 67.32 | 56.96 | 136.30 | 175.34 | 50.11 | 52.99 |
| 18 | 43.05 | 52.19 | 27.31 | 63.68 | 40.62 | 94.93 | 62.08 | 37.06 | 30.08 | 36.42 | 29.16 | 132.45 | 185.95 | 111.23 | 44.81 |
| 19 | 89.41 | 93.52 | 70.91 | 89.23 | 56.07 | 82.14 | 75.75 | 67.98 | 68.21 | 62.77 | 58.17 | 95.38 | 185.03 | 91.14 | 76.68 |
| 20 | 69.33 | 74.05 | 73.21 | 77.36 | 108.99 | 107.71 | 94.01 | 92.62 | 83.72 | 92.87 | 73.96 | 101.96 | 185.03 | 85.66 | 91.28 |
| 21 | 28.47 | 38.87 | 51.78 | 44.57 | 50.61 | 72.11 | 50.24 | 37.06 | 61.83 | 37.33 | 27.96 | 36.36 | 31.26 | 30.16 | 30.32 |
| 22 | 148.83 | 156.60 | 122.09 | 116.67 | 128.22 | 150.68 | 122.37 | 114.59 | 128.54 | 138.60 | 134.61 | 0.0 | 184.20 | 0.0 | 93.17 |
| 23 | 19.55 | 26.58 | 179.61 | 111.19 | 7.03 | 127.85 | 145.20 | 156.60 | 4.58 | 7.71 | 0.0 | 197.85 | 188.16 | 172.45 | 33.09 |
| 24 | 138.78 | 146.86 | 137.62 | 81.06 | 76.17 | 211.79 | 178.97 | 146.55 | 74.66 | 79.25 | 68.87 | 0.0 | 0.0 | 0.0 | 113.26 |
| 25 | 50.26 | 56.73 | 65.49 | 53.71 | 52.48 | 125.11 | 97.71 | 70.76 | 38.28 | 43.75 | 37.37 | 0.0 | 0.0 | 0.0 | 17.83 |
| 26 | 0.0 | 88.41 | 0.0 | 0.0 | 0.0 | 112.63 | 0.0 | 0.0 | 73.45 | 70.13 | 0.0 | 137.99 | 139.79 | 133.20 | 0.0 |
| 27 | 59.36 | 52.15 | 0.0 | 0.0 | 0.0 | 128.46 | 0.0 | 58.00 | 0.0 | 64.66 | 44.01 | 138.73 | 137.96 | 134.11 | 350.71 |
| 28 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 19.35 | 23.09 | 246.19 | 109.76 | 104.26 | 105.71 | 132.20 | 86.06 | 22.17 | 9.54 | 21.28 | 112.39 | 96.64 | 136.64 | 0.0 |
| 30 | 55.51 | 59.93 | 102.69 | 143.86 | 128.92 | 115.76 | 92.92 | 82.41 | 47.45 | 56.27 | 55.63 | 186.15 | 114.91 | 227.83 | 78.36 |
| 31 | 108.43 | 103.72 | 107.26 | 94.54 | 82.35 | 180.58 | 160.51 | 110.72 | 79.02 | 73.58 | 75.67 | 195.64 | 173.35 | 216.91 | 86.57 |
| 32 | 111.17 | 115.93 | 134.66 | 129.25 | 62.28 | 153.20 | 130.57 | 138.12 | 52.60 | 57.18 | 56.24 | 56.90 | 60.15 | 59.95 | 73.80 |
| 33 | 91.08 | 97.65 | 109.09 | 113.29 | 73.22 | 117.59 | 97.49 | 111.63 | 67.17 | 68.11 | 63.52 | 53.26 | 96.64 | 59.04 | 44.66 |
| 34 | 142.23 | 139.04 | 113.22 | 110.98 | 111.57 | 117.59 | 104.80 | 120.77 | 73.55 | 77.23 | 76.89 | 78.05 | 76.56 | 94.62 | 90.22 |
| 35 | 101.12 | 95.20 | 77.13 | 51.63 | 62.28 | 104.80 | 98.40 | 103.24 | 34.46 | 35.40 | 32.06 | 62.73 | 49.22 | 74.54 | 74.71 |
| 36 | 63.12 | 64.30 | 65.53 | 45.63 | 48.04 | 121.55 | 98.71 | 65.39 | 47.49 | 46.62 | 46.59 | 135.53 | 58.63 | 220.86 | 44.99 |
| 37 | 77.71 | 80.61 | 32.00 | 50.17 | 98.18 | 117.89 | 112.41 | 89.11 | 56.58 | 58.44 | 57.49 | 82.20 | 56.81 | 122.33 | 66.83 |
| 38 | 95.05 | 96.44 | 143.67 | 142.35 | 175.80 | 189.10 | 183.62 | 150.30 | 135.06 | 119.57 | 87.88 | 205.61 | 181.86 | 229.96 | 98.76 |
| 39 | 110.58 | 114.70 | 66.62 | 72.03 | 0.0 | 114.24 | 0.0 | 0.0 | 29.39 | 56.62 | 62.35 | 83.66 | 83.25 | 73.93 | 48.62 |
| 40 | 73.15 | 72.10 | 127.43 | 133.21 | 94.53 | 139.81 | 134.33 | 91.85 | 100.36 | 89.44 | 95.18 | 93.15 | 97.86 | 89.45 | 51.65 |
| 41 | 91.40 | 95.22 | 116.10 | 130.48 | 110.36 | 134.33 | 121.85 | 135.69 | 62.95 | 64.81 | 68.42 | 120.92 | 118.87 | 106.80 | 48.62 |
| 42 | 107.84 | 108.61 | 88.39 | 100.33 | 55.61 | 118.81 | 92.32 | 131.13 | 66.60 | 69.36 | 67.21 | 111.42 | 97.86 | 110.46 | 93.29 |
| 43 | 57.93 | 56.33 | 143.51 | 149.77 | 0.0 | 120.94 | 63.43 | 131.74 | 81.53 | 88.87 | 74.55 | 189.33 | 182.18 | 175.59 | 34.45 |
| 44 | 81.68 | 33.15 | 133.59 | 168.22 | 168.81 | 184.84 | 114.55 | 133.26 | 108.00 | 107.13 | 98.28 | 213.39 | 167.58 | 233.91 | 54.40 |
| 45 | 110.29 | 101.33 | 33.23 | 102.47 | 107.94 | 191.23 | 151.08 | 146.96 | 94.30 | 99.82 | 100.10 | 181.31 | 161.19 | 191.10 | 72.62 |

# OVERFIRE AIR OPERATION STUDY

## WATERWALL ABSORPTION RATES, $kW/m^2$

| TEST | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T/C 4 | 46 | 61.62 | 53.77 | 51.40 | 77.34 | 64.13 | 104.50 | 98.11 | 0.0 | 46.31 | 40.62 | 59.97 | 138.95 | 115.53 | 135.43 | 73.53 |
| | 47 | 78.94 | 33.07 | 90.53 | 134.91 | 112.20 | 126.73 | 141.03 | 119.56 | 67.84 | 86.74 | 85.49 | 179.85 | 162.10 | 178.33 | 112.79 |
| | 48 | 116.33 | 119.66 | 117.93 | 117.09 | 135.95 | 128.25 | 146.51 | 121.39 | 93.39 | 87.96 | 83.06 | 184.95 | 176.70 | 182.89 | 107.31 |
| | 49 | 67.09 | 61.13 | 52.24 | 97.76 | 57.45 | 109.07 | 0.0 | 0.0 | 25.23 | 0.0 | 0.0 | 158.68 | 142.02 | 159.17 | 85.40 |
| | 50 | 39.49 | 40.87 | 91.11 | 122.24 | 134.71 | 165.34 | 145.26 | 157.59 | 39.37 | 30.39 | 0.0 | 184.26 | 190.96 | 172.52 | 18.87 |
| | 51 | 81.36 | 85.79 | [illegible] | 63.54 | 0.0 | 155.31 | 63.09 | 46.26 | 46.62 | 43.96 | 31.28 | 163.09 | 159.03 | 152.44 | 0.0 |
| | 52 | 90.49 | 91.63 | 55.77 | 0.0 | 0.0 | 175.38 | 74.03 | 53.53 | 73.01 | 53.03 | 38.50 | 138.98 | 101.49 | 111.34 | 15.90 |
| | 53 | 58.57 | 62.09 | 0.0 | 13.69 | 0.0 | 57.63 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 102.45 | 91.44 | 93.99 | 0.0 |
| | 54 | 61.39 | 66.33 | 15.18 | 20.35 | 0.0 | 129.73 | 41.27 | 20.98 | 24.04 | 22.32 | 19.92 | 127.29 | 106.06 | 136.92 | 18.87 |
| | 55 | 93.23 | 64.55 | 22.06 | 13.25 | 15.00 | 128.82 | 34.02 | 28.16 | 14.26 | 18.75 | 2.68 | 158.71 | 158.11 | 144.22 | 12.67 |
| | 56 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 57 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 109.91 | 115.92 | 0.0 | 0.0 |
| | 58 | 141.36 | 161.59 | 131.09 | 110.54 | 118.95 | 101.25 | 101.25 | 108.06 | 164.83 | 160.26 | 161.42 | 136.95 | 154.28 | 123.95 | 174.26 |
| | 59 | 73.78 | 78.79 | 61.70 | 58.12 | 60.52 | 52.90 | 47.44 | 46.95 | 94.51 | 106.38 | 94.45 | 87.26 | 96.74 | 77.37 | 84.77 |
| | 60 | 13.34 | 16.74 | 50.41 | 49.19 | 57.06 | 67.64 | 61.25 | 58.95 | 36.45 | 61.89 | 60.02 | 57.15 | 52.21 | 65.68 | 45.78 |
| | 61 | 78.53 | 74.75 | 77.58 | 77.44 | 92.63 | 75.85 | 71.28 | 63.50 | 18.46 | 14.93 | 11.96 | 76.11 | 72.25 | 105.84 | 22.29 |
| | 62 | 31.26 | 35.58 | 132.38 | 120.36 | 147.43 | 166.25 | 128.81 | 112.80 | 119.38 | 120.30 | 109.90 | 0.0 | 0.0 | 0.0 | 158.93 |
| | 63 | 32.14 | 31.09 | 120.30 | 109.40 | 117.29 | 106.89 | 92.28 | 91.79 | 143.13 | 144.96 | 126.95 | 133.83 | 117.00 | 145.12 | 64.89 |
| | 64 | 104.09 | 92.93 | 99.29 | 116.71 | 104.51 | 99.58 | 76.76 | 74.45 | 81.94 | 84.69 | 79.47 | 152.82 | 173.61 | 127.77 | 53.05 |
| | 65 | 145.12 | 65.54 | 135.01 | 129.42 | 161.05 | 136.03 | 127.81 | 139.20 | 145.82 | 102.91 | 111.69 | 26.96 | 30.36 | 19.39 | 72.12 |
| | 66 | 112.24 | 114.22 | 122.04 | 117.54 | 72.47 | 122.33 | 116.85 | 116.37 | 61.83 | 61.86 | 56.96 | 53.79 | 69.43 | 34.68 | 46.63 |
| | 67 | 52.03 | 59.47 | 135.74 | 134.89 | 41.53 | 117.76 | 123.24 | 132.81 | 112.94 | 119.35 | 109.26 | 0.0 | 0.0 | 0.0 | 58.45 |
| | 68 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 69 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 70 | 175.29 | 185.80 | 148.58 | 143.90 | 165.66 | 149.77 | 136.99 | 117.33 | 175.10 | 176.03 | 167.48 | 124.84 | 80.42 | 127.72 | 117.83 |
| | 71 | 52.08 | 50.75 | 115.69 | 63.75 | 75.26 | 178.97 | 156.16 | 115.50 | 44.62 | 45.56 | 47.04 | 81.74 | 64.00 | 155.11 | 63.06 |
| | 72 | 129.65 | 132.25 | 186.90 | 145.90 | 69.78 | 214.52 | 169.85 | 217.69 | 118.49 | 115.77 | 99.29 | 212.43 | 196.36 | 226.23 | 75.82 |
| | 73 | 97.68 | 104.23 | 178.69 | 155.03 | 78.91 | 201.77 | 178.97 | 181.23 | 96.57 | 102.98 | 91.99 | 109.50 | 116.04 | 89.36 | 56.69 |
| | 74 | 32.13 | 146.36 | 138.53 | 83.80 | 91.69 | 154.33 | 131.50 | 146.55 | 71.01 | 79.25 | 64.02 | 129.96 | 134.31 | 126.80 | 105.04 |
| | 75 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 76 | 80.13 | 81.81 | 74.59 | 68.07 | 118.88 | 160.51 | 75.58 | 82.41 | 103.67 | 91.85 | 89.05 | 113.12 | 102.12 | 118.37 | 56.48 |
| | 77 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 102.89 | 100.29 | 111.97 | 0.0 |
| | 78 | 90.17 | 95.20 | 79.87 | 68.07 | 99.69 | 139.51 | 111.19 | 92.45 | 48.97 | 50.82 | 44.12 | 115.31 | 105.78 | 113.80 | 51.93 |
| | 79 | 57.33 | 63.57 | 144.71 | 83.58 | 117.05 | 143.16 | 113.93 | 134.47 | 107.33 | 105.53 | 91.49 | 112.39 | 110.34 | 95.53 | 104.83 |
| | 80 | 90.49 | 89.13 | 150.89 | 70.21 | 117.36 | 213.70 | 136.16 | 98.24 | 67.51 | 62.99 | 47.80 | 94.61 | 109.74 | 93.10 | 52.26 |
| | 81 | 154.42 | 159.76 | 190.66 | 71.12 | 94.53 | 153.51 | 141.64 | 124.73 | 93.96 | 91.26 | 108.58 | 149.42 | 158.14 | 137.86 | 54.08 |
| | 82 | 85.01 | 84.25 | 28.56 | 36.56 | 18.26 | 116.98 | 37.67 | 62.65 | 22.21 | 17.79 | 11.89 | 180.81 | 159.96 | 185.32 | 13.52 |
| | 83 | 135.24 | 137.84 | 90.22 | 68.59 | 100.92 | 146.21 | 67.68 | 95.50 | 81.19 | 76.66 | 41.75 | 100.46 | 102.43 | 103.15 | 84.16 |
| | 84 | 103.27 | 104.95 | 35.59 | 26.65 | 72.62 | 134.33 | 45.23 | 43.55 | 58.40 | 52.98 | 27.30 | 80.01 | 79.60 | 78.49 | 74.12 |
| | 85 | 68.00 | 79.93 | 0.0 | 79.65 | 0.0 | 157.47 | 43.42 | 7.20 | 102.52 | 62.42 | 45.43 | 110.46 | 108.22 | 140.91 | 0.0 |
| | 86 | 112.73 | 111.07 | 40.79 | 35.97 | 0.0 | 162.03 | 67.99 | 63.88 | 64.20 | 52.42 | 51.48 | 148.45 | 109.13 | 188.36 | 69.89 |
| | 87 | 111.81 | 112.29 | 63.16 | 73.26 | 52.90 | 169.33 | 83.50 | 73.00 | 63.29 | 69.71 | 57.54 | 187.14 | 163.93 | 191.10 | 0.0 |
| | 88 | 101.77 | 106.54 | 52.24 | 40.59 | 64.73 | 142.86 | 53.41 | 71.17 | 34.24 | 29.78 | 21.39 | 109.73 | 110.05 | 109.85 | 59.87 |
| | 89 | 80.77 | 81.85 | 25.28 | 15.55 | 62.91 | 152.82 | 67.07 | 48.41 | 38.76 | 41.53 | 16.64 | 117.03 | 103.65 | 127.21 | 68.98 |
| | 90 | 55.84 | 56.62 | 11.42 | 63.82 | 0.0 | 177.21 | 56.72 | 0.0 | 0.0 | 0.0 | 0.0 | 177.69 | 167.24 | 168.87 | 0.0 |

# OVERFIRE AIR OPERATION STUDY

## WATERWALL ABSORPTION RATES, $kW/m^2$

| TEST | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T/C # | 91 | 129.76 | 129.03 | 33.77 | 50.16 | 0.0 | 144.35 | 47.62 | 37.19 | 7.30 | 0.0 | 51.80 | 174.77 | 160.85 | 180.73 | 27.82 |
| | 92 | 126.11 | 122.32 | 41.01 | 43.62 | 57.12 | 133.39 | 55.81 | 31.77 | 52.07 | 41.24 | 50.59 | 162.36 | 145.33 | 181.64 | 14.43 |
| | 93 | 155.33 | 145.46 | 0.0 | 0.0 | 93.60 | 43.99 | 0.0 | 0.0 | 83.05 | 79.45 | 94.34 | 198.12 | 175.45 | 206.26 | 0.0 |
| | 94 | 142.55 | 129.63 | 86.55 | 81.23 | 81.73 | 178.12 | 123.34 | 94.57 | 112.27 | 89.49 | 97.99 | 168.20 | 169.98 | 157.00 | 66.84 |
| | 95 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 96 | 117.79 | 116.12 | 120.30 | 101.18 | 112.73 | 149.82 | 127.90 | 99.10 | 90.16 | 91.99 | 101.38 | 163.05 | 146.23 | 151.51 | 51.23 |
| | 97 | 76.63 | 67.97 | 90.99 | 67.23 | 46.06 | 153.38 | 144.25 | 112.71 | 135.77 | 136.70 | 133.62 | 113.65 | 122.39 | 97.53 | 113.20 |
| | 98 | 319.88 | 104.84 | 59.11 | 287.05 | 0.0 | 70.02 | 93.14 | 58.00 | 141.32 | 145.00 | 151.65 | 223.36 | 222.78 | 111.28 | 538.57 |
| | 99 | 82.86 | 86.63 | 83.08 | 39.05 | 63.19 | 113.93 | 99.32 | 86.97 | 109.15 | 119.23 | 142.63 | 196.36 | 194.32 | 202.33 | 66.50 |
| | 100 | 98.70 | 106.13 | 131.32 | 129.56 | 149.33 | 158.07 | 144.38 | 143.91 | 155.15 | 117.74 | 106.14 | 236.20 | 253.81 | 226.32 | 76.85 |
| | 101 | 91.72 | 90.37 | 109.71 | 116.17 | 109.46 | 127.33 | 122.77 | 117.74 | 81.53 | 84.31 | 86.71 | 171.09 | 179.44 | 173.77 | 83.57 |
| | 102 | 153.72 | 148.42 | 52.09 | 37.13 | 76.98 | 139.32 | 76.08 | 70.75 | 27.23 | 25.41 | 0.0 | 0.0 | 0.0 | 0.0 | 19.90 |
| | 103 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 104 | 106.80 | 93.35 | 9.81 | 14.14 | 60.69 | 119.30 | 36.63 | 23.85 | 11.78 | 16.74 | 0.0 | 100.10 | 159.98 | 109.20 | 66.12 |
| | 105 | 134.34 | 165.91 | 53.34 | 109.16 | 105.80 | 138.69 | 81.71 | 57.59 | 91.68 | 71.04 | 44.94 | 0.0 | 0.0 | 0.0 | 23.00 |
| | 106 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 17.31 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 119.37 |
| | 107 | 141.85 | 171.73 | 64.62 | 128.35 | 113.32 | 144.94 | 99.89 | 58.22 | 97.95 | 61.64 | 29.13 | 0.0 | 0.0 | 0.0 | 54.85 |
| | 108 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 109 | 59.19 | 60.55 | 49.87 | 63.39 | 58.70 | 58.36 | 48.34 | 43.31 | 47.11 | 50.74 | 54.33 | 74.12 | 68.44 | 70.07 | 104.86 |
| | 110 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 126.52 | 121.57 | 91.23 | 0.0 |
| | 111 | 54.76 | 55.83 | 46.32 | 23.23 | 33.37 | 103.14 | 78.49 | 56.13 | 27.37 | 26.50 | 33.98 | 66.18 | 72.17 | 54.66 | 94.02 |
| | 112 | 62.10 | 62.86 | 77.17 | 91.10 | 107.21 | 106.84 | 90.40 | 77.15 | 68.28 | 69.22 | 59.16 | 107.30 | 103.25 | 99.40 | 104.13 |
| | 113 | 64.62 | 64.78 | 77.95 | 87.97 | 128.92 | 135.85 | 109.36 | 94.28 | 145.69 | 132.01 | 124.37 | 0.0 | 0.0 | 0.0 | 79.27 |
| | 114 | 54.02 | 52.57 | 139.54 | 124.03 | 75.36 | 149.86 | 143.47 | 144.82 | 88.49 | 80.31 | 67.21 | 159.64 | 147.18 | 190.79 | 86.90 |
| | 115 | 62.53 | 64.65 | 118.85 | 118.00 | 114.03 | 156.56 | 122.77 | 140.57 | 79.70 | 77.01 | 75.76 | 95.84 | 92.69 | 89.76 | 75.36 |
| | 116 | 111.49 | 116.25 | 112.12 | 110.36 | 113.69 | 116.03 | 110.55 | 121.06 | 35.75 | 60.31 | 55.44 | 122.18 | 122.50 | 114.99 | 106.08 |

# OVERFIRE AIR OPERATION STUDY

## WATERWALL ABSORPTION RATES, kW/m$^2$

| TEST T/C # | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 61.37 | 0.0 | 60.27 | 72.09 | 0.0 | 0.0 | 0.0 | 10.69 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 64.11 | 97.15 | 65.32 | 109.56 | 97.65 | 41.54 | 65.40 | 55.97 | 78.34 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 78.70 | 107.38 | 56.30 | 138.79 | 124.14 | 58.80 | 83.64 | 73.27 | 96.59 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 19.89 | 22.03 | 17.49 | 30.48 | 25.93 | 98.26 | 15.08 | 112.82 | 27.85 |
| 10 | 20.79 | 42.26 | 23.75 | 70.47 | 43.12 | 71.80 | 32.97 | 86.35 | 45.90 |
| 11 | 88.92 | 45.90 | 41.82 | 43.16 | 44.94 | 11.32 | 40.21 | 25.55 | 53.16 |
| 12 | 92.57 | 65.55 | 89.21 | 83.24 | 65.87 | 38.16 | 62.92 | 52.65 | 75.92 |
| 13 | 77.05 | 63.37 | 30.08 | 51.34 | 60.40 | 75.45 | 29.37 | 90.00 | 42.28 |
| 14 | 77.05 | 67.02 | 79.17 | 86.90 | 55.85 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 43.27 | 14.43 | 49.00 | 13.40 | 17.79 | 3.66 | 3.91 | 17.58 | 14.55 |
| 16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | 0.0 | 151.31 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | 46.00 | 101.62 | 44.46 | 159.88 | 99.55 | 39.04 | 101.22 | 53.60 | 114.29 |
| 19 | 79.71 | 100.16 | 82.73 | 134.40 | 134.26 | 90.94 | 108.53 | 105.55 | 121.59 |
| 20 | 85.18 | 100.16 | 102.62 | 51.26 | 107.77 | 106.46 | 84.79 | 121.08 | 97.86 |
| 21 | 97.97 | 53.45 | 90.74 | 71.30 | 54.85 | 70.87 | 79.32 | 85.47 | 92.38 |
| 22 | 0.0 | 154.46 | 0.0 | 0.0 | 106.30 | 16.68 | 224.50 | 31.09 | 237.56 |
| 23 | 145.51 | 142.04 | 179.56 | 138.01 | 105.99 | 122.06 | 151.54 | 136.72 | 164.63 |
| 24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 26 | 129.98 | 84.32 | 119.30 | 190.94 | 129.74 | 130.29 | 85.79 | 144.94 | 98.88 |
| 27 | 165.59 | 95.28 | 190.59 | 177.26 | 173.56 | 160.42 | 0.0 | 175.06 | 0.0 |
| 28 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 29 | 152.60 | 150.77 | 159.27 | 58.37 | 87.51 | 115.48 | 116.65 | 130.16 | 129.77 |
| 30 | 151.69 | 176.33 | 171.13 | 166.09 | -115.82 | 145.62 | 151.35 | 160.29 | 164.46 |
| 31 | 0.0 | 222.26 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 32 | 62.21 | 84.29 | 54.31 | 74.78 | 71.08 | 143.80 | 67.37 | 158.47 | 80.47 |
| 33 | 72.24 | 60.94 | 62.49 | 136.97 | 70.17 | 158.41 | 116.65 | 173.07 | 129.77 |
| 34 | 72.24 | 152.23 | 57.05 | 153.32 | 125.87 | 39.85 | 129.44 | 54.46 | 142.55 |
| 35 | 72.24 | 50.94 | 88.03 | 148.75 | 114.00 | 33.52 | 98.39 | 43.10 | 111.50 |
| 36 | 132.82 | 47.60 | 134.10 | 163.67 | 52.26 | 143.24 | 67.73 | 157.95 | 80.87 |
| 37 | 172.08 | 122.05 | 174.17 | 54.13 | 96.95 | 79.32 | 29.64 | 94.03 | 42.68 |
| 38 | 109.99 | 135.20 | 114.83 | 146.32 | 79.60 | 26.67 | 41.38 | 41.25 | 54.47 |
| 39 | 140.13 | 143.96 | 155.92 | 45.86 | 125.27 | 124.06 | 27.84 | 138.78 | 40.87 |
| 40 | 93.55 | 122.05 | 84.09 | 166.41 | 120.70 | 129.54 | 118.84 | 144.25 | 131.99 |
| 41 | 90.81 | 191.33 | 91.08 | 169.15 | 105.08 | 130.45 | 116.10 | 145.17 | 129.25 |
| 42 | 179.38 | 154.92 | 172.35 | 154.54 | 135.31 | 0.0 | 0.0 | 0.0 | 0.0 |
| 43 | 194.28 | 215.24 | 139.99 | 175.85 | 149.32 | 129.90 | 115.55 | 144.66 | 128.74 |
| 44 | 225.26 | 186.08 | 221.38 | 185.88 | 132.88 | 128.98 | 73.57 | 143.74 | 86.75 |
| 45 | 193.37 | 91.12 | 201.84 | 152.12 | 66.23 | 125.33 | 94.55 | 140.09 | 107.74 |

# OVERFIRE AIR OPERATION STUDY

## WATERWALL ABSORPTION RATES, kW/m²

| TEST | | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| T/C * | 46 | 168.74 | 147.38 | 161.71 | 141.16 | 111.87 | 79.68 | 78.13 | 94.43 | 91.31 |
| | 47 | 186.08 | 179.51 | 170.31 | 156.68 | 131.06 | 97.02 | 95.46 | 111.78 | 108.65 |
| | 48 | 197.02 | 184.62 | 193.64 | 158.51 | 169.40 | 120.76 | 111.90 | 135.52 | 125.09 |
| | 49 | 176.96 | 175.13 | 167.19 | 138.42 | 158.45 | 110.71 | 101.86 | 125.48 | 115.04 |
| | 50 | 168.41 | 181.73 | 155.89 | 140.83 | 181.84 | 94.91 | 53.27 | 109.72 | 66.48 |
| | 51 | 161.11 | 67.07 | 106.85 | 140.83 | 96.92 | 91.26 | 45.10 | 106.07 | 58.29 |
| | 52 | 188.48 | 162.75 | 182.36 | 109.77 | 177.27 | 97.65 | 46.01 | 112.46 | 59.20 |
| | 53 | 120.02 | 35.08 | 113.88 | 110.69 | 45.88 | 60.26 | 54.18 | 75.05 | 67.39 |
| | 54 | 133.72 | 47.41 | 129.41 | 152.70 | 46.78 | 74.84 | 95.19 | 89.64 | 108.43 |
| | 55 | 146.50 | 154.72 | 118.45 | 137.17 | 138.03 | 73.93 | 44.20 | 88.73 | 57.38 |
| | 56 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 57 | 78.70 | 98.61 | 74.44 | 107.73 | 105.87 | 75.20 | 73.60 | 89.69 | 66.55 |
| | 58 | 88.74 | 118.34 | 86.30 | 124.17 | 138.75 | 68.82 | 84.55 | 83.30 | 97.50 |
| | 59 | 63.20 | 80.35 | 60.76 | 83.07 | 97.65 | 43.35 | 52.66 | 57.79 | 65.58 |
| | 60 | 102.62 | 37.19 | 96.51 | 34.10 | 36.77 | 22.85 | 20.41 | 37.25 | 33.24 |
| | 61 | 30.67 | 40.09 | 30.06 | 43.16 | 37.68 | 15.72 | 30.27 | 30.03 | 43.18 |
| | 62 | 0.0 | 56.31 | 0.0 | 0.0 | 54.94 | 0.0 | 108.54 | 0.0 | 121.56 |
| | 63 | 120.89 | 59.75 | 104.73 | 96.05 | 59.49 | 113.79 | 71.12 | 128.35 | 84.12 |
| | 64 | 98.05 | 134.95 | 81.90 | 75.94 | 165.39 | 90.96 | 62.01 | 105.52 | 75.01 |
| | 65 | 50.54 | 29.51 | 50.82 | 27.70 | 27.65 | 22.83 | 13.32 | 37.29 | 26.11 |
| | 66 | 128.11 | 45.45 | 111.95 | 55.81 | 53.03 | 23.73 | 40.20 | 38.19 | 53.21 |
| | 67 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 68 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 69 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 70 | 162.86 | 119.39 | 149.44 | 63.14 | 117.87 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 71 | 98.93 | 48.59 | 127.52 | 40.75 | 157.13 | 36.41 | 30.35 | 50.99 | 43.35 |
| | 72 | 173.81 | 120.85 | 236.77 | 89.47 | 141.61 | 66.39 | 63.91 | 81.03 | 76.99 |
| | 73 | 194.78 | 104.04 | 242.41 | 86.86 | 114.21 | 166.81 | 75.76 | 181.45 | 86.85 |
| | 74 | 166.50 | 55.87 | 179.56 | 82.30 | 144.35 | 127.55 | 66.70 | 142.20 | 99.80 |
| | 75 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 76 | 190.01 | 63.65 | 188.46 | 146.93 | 96.64 | 137.40 | 144.96 | 152.06 | 158.07 |
| | 77 | 74.07 | 112.73 | 74.34 | 62.93 | 102.12 | 51.64 | 44.64 | 66.28 | 57.71 |
| | 78 | 199.13 | 128.13 | 199.40 | 64.75 | 113.08 | 46.19 | 47.36 | 60.82 | 60.44 |
| | 79 | 93.24 | 52.93 | 95.34 | 79.34 | 57.41 | 20.05 | 77.40 | 34.53 | 90.51 |
| | 80 | 264.96 | 57.06 | 278.86 | 260.23 | 64.10 | 197.99 | 130.71 | 212.68 | 143.86 |
| | 81 | 293.11 | 97.93 | 292.47 | 242.04 | 191.90 | 214.40 | 54.99 | 229.08 | 68.12 |
| | 82 | 129.17 | 95.01 | 131.27 | 209.27 | 134.40 | 144.15 | 145.33 | 158.86 | 158.47 |
| | 83 | 220.39 | 102.31 | 226.12 | 33.95 | 103.34 | 127.71 | 78.67 | 142.45 | 91.82 |
| | 84 | 182.11 | 127.16 | 191.50 | 130.80 | 130.75 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 85 | 191.55 | 63.37 | 212.77 | 163.07 | 59.85 | 150.90 | 133.82 | 165.65 | 147.01 |
| | 86 | 177.87 | 154.69 | 196.20 | 191.35 | 110.96 | 134.46 | 142.95 | 149.22 | 156.14 |
| | 87 | 112.13 | 167.83 | 110.57 | 207.75 | 138.56 | 150.90 | 146.60 | 165.65 | 159.79 |
| | 88 | 196.11 | 163.45 | 130.90 | 179.50 | 163.01 | 118.94 | 102.77 | 133.70 | 115.96 |
| | 89 | 191.55 | 155.42 | 186.34 | 153.51 | 177.61 | 88.80 | 77.21 | 103.56 | 90.40 |
| | 90 | 42.50 | 53.95 | 42.75 | 155.44 | 57.70 | 94.00 | 71.47 | 108.81 | 84.70 |

# OVERFIRE AIR OPERATION STUDY

## WATERWALL ABSORPTION RATES, $kW/m^2$

| TEST | | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| T/C # | 91 | 196.69 | 182.46 | 197.86 | 136.46 | 157.20 | 115.00 | 128.07 | 129.81 | 141.30 |
| | 92 | 162.02 | 160.40 | 173.23 | 186.46 | 144.42 | 113.17 | 118.02 | 127.99 | 131.26 |
| | 93 | 198.51 | 213.09 | 196.03 | 191.93 | 162.68 | 125.05 | 144.51 | 139.86 | 157.74 |
| | 94 | 170.24 | 77.28 | 185.09 | 171.87 | 153.55 | 98.57 | 112.54 | 113.38 | 125.78 |
| | 95 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 96 | 46.99 | 71.40 | 40.36 | 60.82 | 88.68 | 166.75 | 100.32 | 181.30 | 113.34 |
| | 97 | 167.37 | 81.90 | 161.27 | 139.79 | 83.12 | 148.47 | 106.70 | 163.08 | 119.77 |
| | 98 | 170.16 | 155.92 | 211.46 | 141.66 | 157.13 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 99 | 158.99 | 204.78 | 196.67 | 109.48 | 180.64 | 61.65 | 73.75 | 76.30 | 86.86 |
| | 100 | 242.24 | 126.45 | 207.00 | 190.13 | 117.04 | 152.37 | 81.41 | 167.08 | 94.56 |
| | 101 | 184.25 | 161.26 | 194.55 | 183.14 | 179.44 | 115.28 | 58.08 | 130.04 | 71.25 |
| | 102 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 103 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 104 | 147.05 | 103.37 | 136.40 | 175.63 | 189.29 | 53.47 | 59.93 | 63.66 | 69.64 |
| | 105 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 106 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 107 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 108 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 109 | 52.27 | 84.73 | 48.02 | 80.34 | 79.39 | 35.20 | 51.75 | 49.62 | 64.67 |
| | 110 | 112.67 | 78.63 | 101.99 | 125.26 | 68.61 | 100.09 | 68.39 | 114.65 | 81.39 |
| | 111 | 44.18 | 100.15 | 45.37 | 120.61 | 109.60 | 44.48 | 95.75 | 59.05 | 108.81 |
| | 112 | 199.24 | 109.87 | 174.39 | 116.09 | 116.04 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 113 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 114 | 192.15 | 186.31 | 211.55 | 70.53 | 194.63 | 135.02 | 57.72 | 149.73 | 70.85 |
| | 115 | 177.67 | 100.62 | 179.05 | 125.63 | 89.04 | 109.80 | 39.93 | 124.56 | 53.06 |
| | 116 | 141.94 | 116.73 | 132.15 | 131.69 | 117.93 | 84.87 | 89.72 | 97.68 | 102.95 |

# BASELINE OPERATION STUDY

## BOARD & COMPUTER DATA

| | Test No. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 3/10 | 3/08 | 3/15 | 3/13 | 5/23 | 5/23 | 5/23 | 3/10 | 3/09 | 3/10 |
| | Time | | 09:45 | 14:00 | 15:35 | 10:00 | 12:35 | 14:30 | 16:20 | 14:00 | 10:00 | 16:30 |
| *C | Load | MW | 524 | 524 | 483 | 399 | 324 | 323 | 322 | 514 | 515 | 482 |
| | **Flows - $10^3$ LB/HR** | | | | | | | | | | | |
| C | Feedwater | | 3170 | 3338 | 2996 | 2412 | 1974 | 1987 | 1967 | 3085 | 3134 | 2866 |
| C | Superheat Spray L | | 107 | 24 | 74 | 6 | 0 | 0 | 3 | 104 | 94 | 76 |
| C | Superheat Spray R | | 130 | 64 | 80 | 68 | 35 | 34 | 42 | 131 | 110 | 107 |
| C | Reheat Spray L | | 57 | 39 | 50 | 10 | 0 | 0 | 0 | 69 | 60 | 39 |
| C | Reheat Spray R | | 75 | 60 | 59 | 0 | 0 | 0 | 0 | 81 | 77 | 59 . |
| C | BFP Turb. Extr. Stm. Flow 1-A | | 0 | 0 | 0 | 0 | 44 | 44 | 44 | 0 | 0 | 0 |
| C | BFP Turb. Extr. Stm. Flow 1-B | | 0 | 0 | 0 | 0 | 34 | 34 | 34 | 0 | 0 | 0 |
| C | BFP Turb. Mn. Stm. Flow Combined | | 7.4 | 7.8 | 7.0 | 7.4 | 15.0 | 15.1 | 14.9 | 7.5 | 7.3 | 6.3 |
| C | Hot Air to Burners L Windbox | | 1626 | 1606 | 1612 | 1298 | 864 | 950 | 1017 | 1548 | 1630 | 1555 |
| C | Hot Air to Burners R Windbox | | 1585 | 1560 | 1593 | 1284 | 919 | 1023 | 1088 | 1506 | 1581 | 1516 |
| | **Pressures** | | | | | | | | | | | |
| | **Steam & Water - PSIG** | | | | | | | | | | | |
| C | Feedwater to Econ. | | 2735 | 2751 | 2698 | 2620 | 2566 | 2568 | 2573 | 2722 | 2734 | 2636 |
| C | Boiler Drum | | 2682 | 2691 | 2654 | 2586 | 2538 | 2541 | 2544 | 2668 | 2679 | 2637 |
| C | Turbine Throttle | | 2399 | 2400 | 2406 | 2399 | 2406 | 2405 | 2403 | 2400 | 2403 | 1446 |
| C | Turbine 1st Stage | | 1666 | 1682 | 1520 | 1242 | 987 | 987 | 985 | 1618 | 1634 | 1501 |
| C | HP Htr. 1-G1 & 1-G2 Steam In. | | 539 | 536 | 492 | 391 | 310 | 310 | 309 | 527 | 529 | 488 |
| | **Air & Gas - IN $H_2O$** | | | | | | | | | | | |
| C | FD Fan 1-A Discharge | | 5.67 | 5.63 | 5.87 | 4.35 | 8.70 | 9.35 | 9.77 | 5.43 | 5.82 | 5.47 |
| C | FD Fan 1-B Discharge | | 9.13 | 8.68 | 9.61 | 6.79 | 7.76 | 8.23 | 8.59 | 8.59 | 9.41 | 8.66 |
| C | Air Htr. 1-A Air In. | | 7.72 | 7.50 | 8.21 | 5.84 | 7.29 | 7.73 | 7.98 | 7.18 | 8.01 | 7.30 |
| C | Air Htr. 1-B Air In. | | 7.24 | 6.86 | 7.61 | 5.46 | 6.74 | 7.08 | 7.32 | 6.74 | 7.43 | 6.80 |
| C | Air Htr. 1-A Air Out. | | 3.68 | 3.51 | 3.93 | 3.04 | 5.66 | 5.67 | 5.85 | 3.49 | 3.74 | 3.54 |
| C | Air Htr. 1-B Air Out. | | 3.50 | 3.50 | 3.93 | 2.95 | 5.56 | 5.51 | 5.71 | 3.34 | 3.83 | 3.38 |
| C | Furn. Right Windbox | | 2.22 | 2.12 | 2.49 | 2.28 | 4.97 | 5.04 | 5.04 | 2.16 | 2.41 | 2.22 |
| C | Furn. Left Windbox | | 2.25 | 2.20 | 2.47 | 2.34 | 4.97 | 5.07 | 5.04 | 2.20 | 2.38 | 2.28 |
| C | Rt. WDBX to Furn. Diff. P | | 3.22 | 3.18 | 3.65 | 3.16 | 6.19 | 6.21 | 6.20 | 3.17 | 3.40 | 3.14 |
| C | Left WDBX to Furn. Diff. P | | 4.03 | 3.90 | 4.13 | 3.82 | 6.68 | 6.79 | 6.72 | 3.93 | 3.98 | 3.89 |
| C | Furnace | | -.51 | -.50 | -.60 | -.39 | -.66 | -.54 | -.57 | -.47 | -.48 | -.44 |
| C | Pri. SH Gas Out. | | -.83 | -.73 | -.64 | -.53 | -.51 | -.50 | -.53 | -.67 | -.72 | -.79 |
| C | Reheater Gas Out. | | -.66 | -.61 | -.56 | -.19 | -.78 | -.77 | -.84 | -.60 | -.56 | -.62 |
| C | Econ. Gas In. | | -2.58 | -2.34 | -2.49 | -1.79 | -1.20 | -1.29 | -1.35 | -2.54 | -2.45 | -2.54 |
| C | Econ. Gas Out. | | -6.46 | -6.34 | -6.42 | -4.49 | -2.70 | -3.00 | -3.15 | -6.04 | -6.39 | -6.00 |
| C | Air Htr. 1-A Gas In. | | -8.62 | -8.25 | -8.87 | -6.36 | -3.99 | -4.12 | -4.54 | -8.15 | -8.89 | -8.00 |
| C | Air Htr. 1-B Gas In. | | -8.56 | -8.43 | -8.65 | -6.24 | -4.13 | -4.25 | -4.63 | -8.12 | -8.37 | -8.00 |
| C | Air Htr. 1-A Gas Out. | | -15.5 | -15.3 | -15.6 | -11.2 | -6.76 | -7.30 | -7.94 | -14.7 | -15.4 | -14.6 |
| C | Air Htr. 1-B Gas Out. | | -14.2 | -14.0 | -14.6 | -10.2 | -6.41 | -6.98 | -7.34 | -13.1 | -14.1 | -13.3 |
| C | IDF 1-A Disch. | | -.51 | -.55 | -.48 | -1.07 | -.77 | -.66 | -.60 | -.51 | -.52 | -.54 |
| C | IDF 1-B Disch. | | -.46 | -.48 | -.47 | -2.15 | -.88 | -.76 | -.69 | -.50 | -.45 | -.49 |
| C | PAF 1-A Disch. Hdr. | | 32.92 | 32.87 | 32.64 | 32.47 | 31.56 | 31.54 | 31.64 | 32.76 | 32.74 | 32.89 |
| C | PAF 1-B Disch. Hdr. | | 32.67 | 32.77 | 32.52 | 32.29 | 32.28 | 32.23 | 32.30 | 32.56 | 32.64 | 32.55 |
| *B | Pri. Hot Air Duct | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | **Temperatures** | | | | | | | | | | | |
| | **Air & Gas - °F** | | | | | | | | | | | |
| C | 1-A FD Fan Disch. | | 51 | 41 | 46 | 41 | 77 | 77 | 76 | 55 | 46 | 52 |
| C | 1-B FD Fan Disch. | | 60 | 52 | 57 | 50 | 83 | 84 | 85 | 65 | 58 | 61 |
| C | 1-A AH Air In. | | 77 | 83 | 82 | 107 | 102 | 104 | 103 | 75 | 76 | 77 |
| C | 1-B AH Air In. | | 78 | 88 | 87 | 112 | 105 | 107 | 105 | 78 | 80 | 80 |
| C | 1-A AH Air Out. | | 696 | 668 | 684 | 627 | 565 | 573 | 576 | 698 | 689 | 693 |
| C | 1-B AH Air Out. | | 712 | 686 | 702 | 630 | 576 | 584 | 589 | 718 | 703 | 712 |
| C | 1-A AH Gas In. | | 760 | 730 | 750 | 682 | 612 | 622 | 624 | 763 | 753 | 757 |
| C | 1-B AH Gas In. | | 759 | 732 | 751 | 676 | 608 | 616 | 620 | 763 | 753 | 759 |
| C | 1-A AH Gas Out. | | 272 | 258 | 265 | 253 | 241 | 243 | 243 | 274 | 265 | 270 |
| C | 1-B AH Gas Out. | | 272 | 265 | 267 | 246 | 242 | 240 | 239 | 275 | 274 | 270 |

* C - Computer Data; B - Board Data; NA - Not Available.

# BASELINE OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1976 | 5/21 | 5/25 | 3/12 | 3/9 | 3/10 | 3/13 | 5/25 | 5/25 | 5/25 |
| | TIME | | 05:00 | 13:00 | 06:00 | 14:00 | 18:50 | 13:30 | 18:20 | 16:30 | 14:35 |
| *C | LOAD | MW | 321 | 321 | 525 | 512 | 484 | 400 | 322 | 325 | 322 |
| | FLOWS - $10^3$ LB/HR | | | | | | | | | | |
| C | FEEDWATER | | 1734 | 1824 | 3115 | 3179 | 2859 | 2444 | 1820 | 1818 | 1810 |
| C | SUPERHEAT SPRAY L | | 91 | 55 | 113 | 61 | 102 | 0 | 56 | 65 | 66 |
| C | SUPERHEAT SPRAY R | | 117 | 74 | 120 | 79 | 106 | 54 | 82 | 96 | 84 |
| C | REHEAT SPRAY L | | 14 | 0 | 81 | 58 | 44 | 10 | 10 | 8 | 4 |
| C | REHEAT SPRAY R | | 30 | 15 | 83 | 76 | 67 | 0 | 29 | 27 | 23 |
| C | BFP TURB. EXTR. STM. FLOW 1-A | | 39 | 39 | 0 | 0 | 0 | 0 | 44 | 42 | 39 |
| C | BFP TURB. EXTR. STM. FLOW 1-B | | 70 | 71 | 0 | 0 | 0 | 0 | 34 | 52 | 71 |
| C | BFP TURB. MN. STM. FLOW COMBINED | | 7.6 | 8.3 | 7.6 | 7.6 | 6.8 | 7.6 | 14.1 | 11.2 | 8.3 |
| C | HOT AIR TO BURNERS L WINDBOX | | 790 | 1190 | 1567 | 1622 | 1602 | 1302 | 896 | 1046 | 1210 |
| C | HOT AIR TO BURNERS R WINDBOX | | 810 | 1241 | 1504 | 1575 | 1558 | 1283 | 900 | 1099 | 1259 |
| | PRESSURES | | | | | | | | | | |
| | STEAM & WATER - PSIG | | | | | | | | | | |
| C | FEEDWATER TO ECON. | | 2547 | 2556 | 2726 | 2683 | 2686 | 2625 | 2559 | 2558 | 2558 |
| C | BOILER DRUM | | 2521 | 2529 | 2675 | 2676 | 2639 | 2589 | 2532 | 2531 | 2532 |
| C | TURBINE THROTTLE | | 2403 | 2405 | 2397 | 2402 | 2397 | 2404 | 2408 | 2407 | 2403 |
| C | TURBINE 1ST STAGE | | 966 | 969 | 1649 | 1623 | 1503 | 1245 | 958 | 969 | 968 |
| C | HP HTR. 1-G1 & 1-G2 STEAM IN. | | 313 | 311 | 539 | 526 | 490 | 393 | 312 | 316 | 313 |
| | AIR & GAS - IN $H_2O$ | | | | | | | | | | |
| C | FD FAN 1-A DISCHARGE | | 6.45 | 11.58 | 5.29 | 5.79 | 5.60 | 4.25 | 8.64 | 10.46 | 11.89 |
| C | FD FAN 1-B DISCHARGE | | 5.71 | 10.01 | 8.69 | 9.24 | 9.00 | 6.71 | 7.85 | 9.32 | 10.21 |
| C | AIR HTR. 1-A AIR IN. | | 5.36 | 9.08 | 7.28 | 7.96 | 7.47 | 5.84 | 7.30 | 8.54 | 9.17 |
| C | AIR HTR. 1-B AIR IN. | | 4.88 | 8.25 | 6.71 | 7.41 | 6.96 | 5.33 | 6.64 | 7.85 | 8.41 |
| C | AIR HTR. 1-A AIR OUT. | | 4.04 | 6.43 | 3.38 | 3.82 | 3.57 | 2.93 | 5.57 | 6.31 | 6.47 |
| C | AIR HTR. 1-B AIR OUT. | | 3.65 | 6.31 | 3.43 | 3.80 | 3.45 | 2.87 | 5.51 | 6.22 | 6.42 |
| C | FURN. RIGHT WINDBOX | | 3.62 | 5.40 | 2.10 | 2.32 | 2.20 | 2.30 | 5.00 | 5.47 | 5.37 |
| C | FURN. LEFT WINDBOX | | 3,57 | 6.12 | 2.11 | 2.35 | 2.21 | 2.37 | 4.94 | 5.49 | 5.45 |
| C | RT. WDBX TO FURN. DIFF. P | | 4.21 | 6.54 | 3.13 | 3.23 | 3.17 | 3.16 | 5.79 | 6.56 | 6.58 |
| C | LEFT WDBX TO FURN. DIFF. P | | 5.17 | 6.96 | 3.92 | 3.94 | 3.93 | 3.88 | 6.46 | 7.03 | 7.00 |
| C | FURNACE | | -.42 | -.61 | -.41 | -.68 | -.53 | -.40 | -.55 | -.61 | -.61 |
| C | PRI. SH GAS OUT. | | -.55 | -.58 | -.82 | -.77 | -.61 | -.54 | -.62 | -.63 | -.69 |
| C | REHEATER GAS OUT. | | -.73 | -.94 | -.84 | -.70 | -.47 | -.29 | -.90 | -.93 | -1.02 |
| C | ECON. GAS IN. | | -1.29 | -1.52 | -2.43 | -2.42 | -2.58 | -1.75 | -1.23 | -1.36 | -1.54 |
| C | ECON. GAS OUT. | | -2.48 | -3.72 | -6.39 | -6.49 | -6.12 | -4.39 | -2.65 | -3.23 | -3.83 |
| C | AIR HTR. 1-A GAS IN. | | -3.52 | -5.11 | -8.74 | -8.75 | -8.24 | -6.41 | -3.84 | -4.69 | -5.30 |
| C | AIR HTR. 1-B GAS IN. | | -3.74 | -5.20 | -8.09 | -8.34 | -8.18 | -6.18 | -3.90 | -4.75 | -5.50 |
| C | AIR HTR. 1-A GAS OUT. | | -6.29 | -9.15 | -15.0 | -15.4 | -14.9 | -11.3 | -6.74 | -8.13 | -9.50 |
| C | AIR HTR. 1-B GAS OUT. | | -5.90 | -8.52 | -13.5 | -14.3 | -13.6 | -10.3 | -6.23 | -7.35 | -8.72 |
| C | IDF 1-A DISCH. | | -.94 | -.39 | -.49 | -.43 | -.49 | -.94 | -.62 | -.45 | -.32 |
| C | IDF 1-B DISCH. | | -.91 | -.45 | -.41 | -.69 | -.43 | -.93 | -.62 | -.44 | -.38 |
| C | PAF 1-A DISCH. HDR. | | 31.66 | 31.66 | 32.85 | 32.64 | 32.81 | 32.69 | 31.63 | 31.74 | 31.76 |
| C | PAF 1-B DISCH. HDR. | | 32.72 | 32.52 | 32.77 | 32.44 | 32.63 | 32.29 | 32.53 | 32.77 | 32.64 |
| *B | PRI. HOT AIR DUCT | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | TEMPERATURES | | | | | | | | | | |
| | AIR & GAS - °F | | | | | | | | | | |
| C | 1-A FD FAN DISCH. | | 72 | 77 | 56 | 50 | 49 | 46 | 81 | 80 | 79 |
| C | 1-B FD FAN DISCH. | | 83 | 82 | 68 | 58 | 58 | 55 | 92 | 89 | 85 |
| C | 1-A AH AIR IN. | | 96 | 99 | 71 | 70 | 78 | 102 | 100 | 98 | 101 |
| C | 1-B AH AIR IN. | | 100 | 102 | 74 | 73 | 82 | 107 | 102 | 100 | 105 |
| C | 1-A AH AIR OUT. | | 590 | 604 | 710 | 705 | 688 | 631 | 591 | 603 | 607 |
| C | 1-B AH AIR OUT. | | 608 | 627 | 724 | 725 | 710 | 634 | 612 | 620 | 629 |
| C | 1-A AH GAS IN. | | 641 | 655 | 774 | 771 | 753 | 685 | 637 | 652 | 600 |
| C | 1-B AH GAS IN. | | 637 | 657 | 776 | 775 | 757 | 680 | 640 | 653 | 661 |
| C | 1-A AH GAS OUT. | | 247 | 244 | 276 | 270 | 267 | 253 | 244 | 245 | 245 |
| C | 1-B AH GAS OUT. | | 259 | 241 | 276 | 278 | 268 | 249 | 252 | 245 | 243 |

* C - COMPUTER DATA; B - BOARD DATA; NA - NOT AVAILABLE.

# BASELINE OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 3/10 | 3/08 | 3/15 | 3/13 | 5/23 | 5/23 | 5/23 | 3/10 | 3/09 | 3/10 |
| | Time | | 09:45 | 14:00 | 15:35 | 10:00 | 12:35 | 14:30 | 16:20 | 14:00 | 10:00 | 16:30 |
| *C | Load | MW | 524 | 524 | 483 | 399 | 324 | 323 | 322 | 514 | 515 | 482 |
| | **TEMPERATURES** | | | | | | | | | | | |
| | **Air & Gas - °F** | | | | | | | | | | | |
| C | Econ. N Gas Out. | | 788 | 750 | 780 | 710 | 638 | 651 | 655 | 794 | 775 | 782 |
| C | Econ. S Gas Out. | | 802 | 758 | 792 | 728 | 548 | 557 | 556 | [illegible] | 791 | 796 |
| C | 1-A PA Fan Disch. Hdr. | | 60 | 52 | 55 | 53 | 86 | 85 | 84 | 66 | 56 | 62 |
| C | 1-B PA Fan Disch. Hdr. | | 95 | 95 | 69 | 64 | *NA | NA | NA | 104 | 106 | 101 |
| C | 1-A AH Pri. Air Out. | | 708 | 681 | 697 | 639 | 579 | 586 | 588 | 712 | 701 | 707 |
| C | 1-B AH Pri. Air Out. | | 689 | 669 | 686 | 620 | 574 | 577 | 579 | 694 | 686 | 690 |
| | **Steam & Water - °F** | | | | | | | | | | | |
| C | Boiler Econ. In | | 480 | 477 | 471 | 448 | 424 | 424 | 424 | 477 | 477 | 468 |
| C | Downcomer 1 | | 677 | 675 | 675 | 673 | 666 | 666 | 666 | 676 | 674 | 674 |
| C | Downcomer 2 | | 678 | 676 | 677 | 674 | 668 | 668 | 668 | 678 | 676 | 676 |
| C | Downcomer 3 | | 679 | 677 | 677 | 674 | 669 | 669 | 669 | 678 | 676 | 676 |
| C | Downcomer 4 | | 682 | 681 | 676 | 676 | 673 | 673 | 673 | 682 | 680 | 680 |
| C | Downcomer 5 | | 680 | 679 | 676 | 676 | 670 | 670 | 670 | 679 | 678 | 677 |
| C | Blr. SH ATMP 1-A Stm. In. | | 851 | 830 | 838 | 850 | 844 | 837 | 839 | 860 | 848 | 865 |
| C | Blr. SH ATMP 1-B Stm. In. | | 856 | 829 | 846 | 827 | 813 | 813 | 822 | 855 | 848 | 858 |
| C | Blr. S SH Hdr. Out. | | 1008 | 1002 | 1006 | 1014 | 1008 | 1003 | 1009 | 1009 | 1006 | 1009 |
| C | Blr. N SH Hdr. Out. | | 1001 | 1011 | 1011 | 1012 | 1001 | 996 | 1008 | 999 | 1003 | 1003 |
| C | Turbine Throttle | | 1002 | 1000 | 1006 | 1009 | 1001 | 999 | 1006 | 1003 | 1002 | 1004 |
| C | Blr. S RH ATMP Stm. Out. A | | 478 | 480 | 471 | 589 | 550 | 547 | 554 | 478 | 476 | 472 |
| C | Blr. N RH ATMP Stm. Out. B | | 479 | 480 | 471 | 588 | 550 | 546 | 553 | 479 | 477 | 471 |
| C | Blr. S RH Hdr. Out. A | | 991 | 989 | 1000 | 1019 | 966 | 957 | 952 | 990 | 989 | 1008 |
| C | Blr. N RH Hdr. Out. B | | 1015 | 1015 | 1012 | 992 | 963 | 964 | 966 | 1014 | 1020 | 1006 |
| C | HP Htr. 1-G1 & 1-G2 Extr. Stm. | | 618 | 620 | 610 | 581 | 543 | 538 | 547 | 620 | 619 | 607 |
| C | HP Htr. 1-F1 FW Out. | | 411 | 407 | 404 | 387 | 366 | 366 | 366 | 410 | 408 | 404 |
| C | HP Htr. 1-F2 FW Out. | | 410 | 407 | 403 | 386 | 366 | 365 | 365 | 410 | 407 | 403 |
| C | HP Htr. 1-G1 FW Out. | | 479 | 476 | 470 | 449 | 424 | 423 | 423 | 477 | 475 | 469 |
| C | HP Htr. 1-G2 FW Out. | | 479 | 476 | 469 | 449 | 424 | 423 | 423 | 477 | 475 | 469 |
| C | HP Htr. 1-G1 Drain | | 415 | 412 | 406 | 387 | 366 | 366 | 366 | 415 | 411 | 406 |
| C | HP Htr. 1-G2 Drain | | 382 | 377 | 374 | 357 | 335 | 335 | 335 | 381 | 376 | 376 |
| | **PULVERIZER DATA** | | | | | | | | | | | |
| C | PLV 1-A Bowl Lower P | IN. $H_2O$ | 21.36 | 21.52 | 20.23 | 18.51 | -.27 | -.28 | -.15 | 20.90 | 21.39 | 20.25 |
| C | PLV 1-B Bowl Lower P | IN. $H_2O$ | 22.68 | 22.37 | 21.29 | 19.49 | -1.18 | -1.17 | -1.10 | 22.38 | 22.51 | 21.69 |
| C | PLV 1-C Bowl Lower P | IN. $H_2O$ | .23 | .13 | .21 | .19 | 19.31 | 19.16 | 19.21 | .25 | .23 | .25 |
| C | PLV 1-D Bowl Lower P | IN. $H_2O$ | 22.89 | 23.09 | 22.04 | 19.64 | 19.36 | 19.34 | 19.38 | 22.54 | 22.87 | 21.78 |
| C | PLV 1-E Bowl Lower P | IN. $H_2O$ | 22.16 | 22.19 | 21.44 | 19.84 | 19.74 | 19.39 | 19.58 | 21.89 | 22.25 | 21.24 |
| C | PLV 1-F Bowl Lower P | IN. $H_2O$ | 22.81 | 21.51 | 19.83 | 17.78 | 18.15 | 18.06 | 18.52 | 20.28 | 21.10 | 19.39 |
| C | PLV 1-A Bowl Diff. P | IN. $H_2O$ | 7.61 | 7.67 | 7.14 | 6.66 | .45 | .45 | .45 | 7.53 | 7.67 | 7.12 |
| C | PLV 1-B Bowl Diff. P | IN. $H_2O$ | 7.80 | 7.74 | 7.41 | 6.79 | .20 | .20 | .20 | 7.74 | 7.77 | 7.47 |
| C | PLV 1-C Bowl Diff. P | IN. $H_2O$ | .06 | .00 | .03 | .02 | 6.39 | 6.41 | 6.38 | .06 | .05 | .07 |
| C | PLV 1-D Bowl Diff. P | IN. $H_2O$ | 7.95 | 8.00 | 7.72 | 6.82 | 6.46 | 6.44 | 6.46 | 7.66 | 7.98 | 7.58 |
| C | PLV 1-E Bowl Diff. P | IN. $H_2O$ | 7.12 | 7.10 | 6.99 | 6.46 | 6.18 | 6.20 | 6.14 | 7.02 | 7.13 | 6.88 |
| C | PLV 1-F Bowl Diff. P | IN. $H_2O$ | 7.17 | 7.32 | 6.93 | 6.21 | 6.05 | 6.13 | 6.21 | 7.08 | 7.21 | 6.83 |
| C | PLV 1-A Coal Air Out. P | IN. $H_2O$ | 9.84 | 10.17 | 9.41 | 8.43 | -1.11 | -.96 | -.95 | 9.68 | 10.06 | 9.32 |
| C | PLV 1-B Coal Air Out. P | IN. $H_2O$ | 11.36 | 11.15 | 10.71 | 9.74 | -1.23 | -1.15 | -1.16 | 11.24 | 11.37 | 10.89 |
| C | PLV 1-C Coal Air Out. P | IN. $H_2O$ | -.13 | -.35 | -.19 | -.22 | 9.32 | 9.35 | 9.25 | -.13 | -.23 | -.14 |
| C | PLV 1-D Coal Air Out. P | IN. $H_2O$ | 10.80 | 10.99 | 10.45 | 9.34 | 9.23 | 9.33 | 9.19 | 10.61 | 10.85 | 10.78 |
| C | PLV 1-E Coal Air Out. P | IN. $H_2O$ | 11.58 | 11.56 | 11.17 | 10.26 | 9.64 | 9.89 | 9.63 | 11.29 | 11.66 | 10.03 |
| C | PLV 1-F Coal Air Out. P | IN. $H_2O$ | 10.26 | 10.67 | 9.55 | 8.58 | 8.83 | 9.03 | 8.93 | 9.88 | 10.41 | 9.44 |
| C | PLV 1-A Pri. Air In. Flow | 0-125% | 126.1 | 125.1 | 125.8 | 125.7 | 0.0 | 0.0 | 0.0 | 125.9 | 125.6 | 125.3 |
| C | PLV 1-B Pri. Air In. Flow | 0-125% | 127.8 | 128.3 | 128.6 | 128.4 | 30.8 | 30.2 | 29.7 | 128.4 | 128.6 | 128.4 |
| C | PLV 1-C Pri. Air In. Flow | 0-125% | 37.2 | 0.0 | 0.0 | 0.0 | 131.2 | 131.4 | 131.4 | 45.9 | 46.9 | 47.3 |
| C | PLV 1-D Pri. Air In. Flow | 0-125% | 125.2 | 125.4 | 126.0 | 125.6 | 126.2 | 125.9 | 126.3 | 124.9 | 125.3 | 124.8 |
| C | PLV 1-E Pri. Air In. Flow | 0-125% | 127.8 | 127.7 | 127.9 | 128.5 | 126.3 | 129.2 | 129.4 | 127.9 | 127.9 | 127.9 |
| C | PLV 1-F Pri. Air In. Flow | 0-125% | 125.2 | 125.1 | 125.0 | 125.3 | 126.2 | 125.3 | 124.0 | 124.5 | 124.7 | 125.4 |
| C | PLV 1-A Coal Air Disch. Temp. | °F | 144 | 139 | 142 | 144 | 87 | 88 | 88 | 142 | 141 | 143 |

* C - Computer Data; B - Board Data; NA - Not Available.

# BASELINE OPERATION STUDY

## BOARD & COMPUTER DATA

| | Test No. | | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 5/21 | 5/25 | 3/12 | 3/9 | 3/10 | 3/13 | 5/25 | 5/25 | 5/25 |
| | Time | | 05:00 | 13:00 | 06:00 | 14:00 | 18:50 | 13:30 | 18:20 | 16:30 | 14:35 |
| *C | Load | MW | 321 | 321 | 525 | 512 | 484 | 400 | 322 | 325 | 322 |
| | **Temperatures** | | | | | | | | | | |
| | Air & Gas - °F | | | | | | | | | | |
| C | Econ. N Gas Out. | | 662 | 693 | 817 | 794 | 780 | 707 | 663 | 687 | 702 |
| C | Econ. S Gas Out. | | 648 | 479 | 817 | 806 | 788 | 726 | 416 | 448 | 461 |
| C | 1-A PA Fan Disch. Hdr. | | 78 | 88 | 66 | 59 | 58 | 58 | 90 | 90 | 90 |
| C | 1-B PA Fan Disch. Hdr. | | *NA | NA | 104 | 106 | 93 | 75 | NA | NA | NA |
| C | 1-A AH Pri. Air Out. | | 605 | 616 | 723 | 718 | 702 | 645 | 602 | 614 | 619 |
| C | 1-B AH Pri. Air Out. | | 604 | 610 | 710 | 706 | 688 | 624 | 604 | 610 | 612 |
| | Steam & Water - °F | | | | | | | | | | |
| C | Boiler Econ. In. | | 425 | 424 | 478 | 476 | 469 | 448 | 424 | 426 | 425 |
| C | Downcomer 1 | | 666 | 666 | 676 | 674 | 674 | 673 | 666 | 666 | 664 |
| C | Downcomer 2 | | 667 | 668 | 678 | 676 | 676 | 674 | 668 | 668 | 668 |
| C | Downcomer 3 | | 668 | 668 | 678 | 679 | 676 | 674 | 668 | 668 | 668 |
| C | Downcomer 4 | | 667 | 672 | 682 | 680 | 680 | 679 | 673 | 673 | 673 |
| C | Downcomer 5 | | 667 | 670 | 680 | 678 | 678 | 676 | 670 | 669 | 670 |
| C | Blr. SH ATMP 1-A Stm. In. | | 917 | 882 | 860 | 841 | 864 | 842 | 892 | 904 | 891 |
| C | Blr. SH ATMP 1-B Stm. In. | | 878 | 862 | 862 | 842 | 853 | 847 | 857 | 865 | 871 |
| C | Blr. S SH Hdr. Out. | | 1011 | 1005 | 1013 | 1007 | 1011 | 1010 | 1010 | 1010 | 1006 |
| C | Blr. N SH Hdr. Out. | | 997 | 1005 | 1010 | 1005 | 1002 | 1012 | 998 | 1000 | 1003 |
| C | Turbine Throttle | | 1003 | 1003 | 1007 | 1004 | 1005 | 1008 | 1003 | 1002 | 1003 |
| C | Blr. S RH ATMP Stm. Out. A | | 427 | 454 | 479 | 476 | 472 | 588 | 427 | 427 | 428 |
| C | Blr. N RH ATMP Stm. Out. B | | 425 | 429 | 482 | 477 | 470 | 587 | 425 | 426 | 427 |
| C | Blr. S RH Hdr. Out. A | | 1005 | 970 | 1019 | 990 | 1006 | 1015 | 974 | 976 | 972 |
| C | Blr. N RH Hdr. Out. B | | 994 | 986 | 1012 | 1015 | 1007 | 994 | 975 | 982 | 984 |
| C | HP Htr. 1-G1 & 1-G2 Extr. Stm. | | 548 | 544 | 628 | 619 | 608 | 580 | 546 | 546 | 545 |
| C | HP Htr. 1-F1 FW Out. | | 368 | 366 | 412 | 409 | 404 | 387 | 367 | 368 | 367 |
| C | HP Htr. 1-F2 FW Out. | | 369 | 366 | 412 | 408 | 403 | 386 | 366 | 367 | 366 |
| C | HP Htr. 1-G1 FW Out. | | 424 | 424 | 479 | 476 | 469 | 449 | 424 | 424 | 424 |
| C | HP Htr. 1-G2 FW Out. | | 424 | 424 | 479 | 477 | 469 | 449 | 424 | 425 | 424 |
| C | HP Htr. 1-G1 Drain | | 367 | 366 | 415 | 413 | 406 | 387 | 366 | 367 | 366 |
| C | HP Htr. 1-G2 Drain | | 338 | 337 | 379 | 380 | 373 | 357 | 337 | 338 | 337 |
| | **Pulverizer Data** | | | | | | | | | | |
| C | PLV 1-A Bowl Lower P | IN. $H_2O$ | 18.56 | 18.42 | 21.65 | 20.97 | 20.25 | 18.64 | 18.21 | 18.43 | 18.39 |
| C | PLV 1-B Bowl Lower P | IN. $H_2O$ | 21.00 | 20.41 | 23.23 | 22.35 | 21.56 | 19.17 | 20.33 | 20.93 | 20.78 |
| C | PLV 1-C Bowl Lower P | IN. $H_2O$ | 19.96 | 19.60 | .24 | .24 | .23 | .19 | 19.18 | 12.62 | 19.52 |
| C | PLV 1-D Bowl Lower P | IN. $H_2O$ | 19.53 | 19.45 | 23.44 | 22.50 | 21.84 | 19.78 | 19.44 | 19.56 | 19.44 |
| C | PLV 1-E Bowl Lower P | IN. $H_2O$ | -.89 | 0.0 | 21.88 | 21.89 | 21.30 | 19.91 | -.01 | 0.0 | 0.0 |
| C | PLV 1-F Bowl Lower P | IN. $H_2O$ | -1.16 | -1.10 | 18.87 | 20.47 | 19.48 | 17.68 | -1.22 | -1.24 | -1.23 |
| C | PLV 1-A Bowl Diff. P | IN. $H_2O$ | 6.37 | 6.36 | 7.75 | 7.60 | 7.25 | 6.65 | 6.32 | 6.34 | 6.39 |
| C | PLV 1-B Bowl Diff. P | IN. $H_2O$ | 6.53 | 6.57 | 8.12 | 7.73 | 7.44 | 6.72 | 6.58 | 6.79 | 6.73 |
| C | PLV 1-C Bowl Diff. P | IN. $H_2O$ | 6.68 | 6.46 | .06 | .07 | .07 | .25 | 6.32 | 6.56 | 6.47 |
| C | PLV 1-D Bowl Diff. P | IN. $H_2O$ | 6.69 | 6.54 | 8.21 | 7.77 | 7.56 | 6.82 | 6.48 | 6.55 | 6.55 |
| C | PLV 1-E Bowl Diff. P | IN. $H_2O$ | .12 | .01 | 7.15 | 7.04 | 6.91 | 6.42 | .02 | .02 | .03 |
| C | PLV 1-F Bowl Diff. P | IN. $H_2O$ | .06 | .06 | 6.65 | 7.07 | 6.82 | 6.12 | .06 | .06 | .06 |
| C | PLV 1-A Coal Air Out. P | IN. $H_2O$ | 8.21 | 8.23 | 9.80 | 9.90 | 9.21 | 8.45 | 8.07 | 7.95 | 8.15 |
| C | PLV 1-B Coal Air Out. P | IN. $H_2O$ | 10.04 | 10.28 | 11.55 | 11.16 | 10.73 | 9.56 | 10.37 | 10.49 | 10.43 |
| C | PLV 1-C Coal Air Out. P | IN. $H_2O$ | 9.66 | 9.42 | -.13 | -.17 | -.14 | -.23 | 9.12 | 9.37 | 9.41 |
| C | PLV 1-D Coal Air Out. P | IN. $H_2O$ | 9.14 | 9.18 | 10.96 | 10.64 | 10.22 | 9.42 | 9.17 | 9.11 | 9.26 |
| C | PLV 1-E Coal Air Out. P | IN. $H_2O$ | 1.13 | .05 | 11.15 | 11.24 | 10.94 | 10.28 | .05 | .06 | .05 |
| C | PLV 1-F Coal Air Out. P | IN. $H_2O$ | 1.37 | -1.26 | 9.04 | 10.15 | 9.34 | 8.54 | -1.47 | -1.26 | -1.19 |
| C | PLV 1-A Pri. Air In. Flow | 0-125% | 126.8 | 126.8 | 125.6 | 125.4 | 126.2 | 125.8 | 127.1 | 127.3 | 126.1 |
| C | PLV 1-B Pri. Air In. Flow | 0-125% | 128.8 | 129.3 | 128.5 | 128.7 | 128.4 | 128.5 | 128.9 | 129.3 | 129.6 |
| C | PLV 1-C Pri. Air In. Flow | 0-125% | 130.8 | 131.2 | 33.1 | 59.5 | 42.4 | 0.0 | 130.0 | 131.7 | 131.0 |
| C | PLV 1-D Pri. Air In. Flow | 0-125% | 126.0 | 125.6 | 125.2 | 125.2 | 125.4 | 125.6 | 125.4 | 125.6 | 125.8 |
| C | PLV 1-E Pri. Air In. Flow | 0-125% | 0.0 | 0.0 | 127.5 | 128.0 | 127.8 | 127.8 | 0.0 | 0.0 | 0.0 |
| C | PLV 1-F Pri. Air In. Flow | 0-125% | 0.0 | 0.0 | 125.6 | 124.8 | 124.7 | 124.7 | 0.0 | 0.0 | 0.0 |
| C | PLV 1-A Coal Air Disch. Temp. | °F | 144 | 143 | 143 | 141 | 143 | 144 | 142 | 142 | 142 |

* C - Computer Data; B - Board Data; NA - Not Available.

# BASELINE OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 3/10 | 3/08 | 3/15 | 3/13 | 5/23 | 5/23 | 5/23 | 3/10 | 3/09 | 3/10 |
| | Time | | 09:45 | 14:00 | 15:35 | 10:00 | 12:35 | 14:30 | 16:20 | 14:00 | 10:00 | 16:30 |
| *C | Load | MW | 524 | 524 | 483 | 399 | 324 | 323 | 322 | 514 | 515 | 482 |
| | **PULVERIZER DATA** | | | | | | | | | | | |
| C | PLV 1-B Coal Air Disch. Temp. | °F | 146 | 142 | 145 | 146 | 121 | 114 | 110 | 145 | 143 | 146 |
| C | PLV 1-C Coal Air Disch. Temp. | °F | 55 | 79 | 89 | 43 | 144 | 144 | 144 | 57 | 69 | 55 |
| C | PLV 1-D Coal Air Disch. Temp. | °F | 147 | 144 | 146 | 146 | 141 | 144 | 142 | 147 | 146 | 146 |
| C | PLV 1-E Coal Air Disch. Temp. | °F | 141 | 138 | 141 | 143 | 138 | 138 | 138 | 141 | 139 | 142 |
| C | PLV 1-F Coal Air Disch. Temp | °F | 145 | 141 | 144 | 145 | 141 | 142 | 142 | 144 | 142 | 144 |
| C | PLV 1-A Feeder Coal Flow | $10^3$LB/HR | 116 | 116 | 105 | 87 | 0 | 0 | 0 | 114 | 114 | 106 |
| C | PLV 1-B Feeder Coal Flow | $10^3$LB/HR | 117 | 112 | 106 | 88 | 0 | 0 | 0 | 115 | 111 | 107 |
| C | PLV 1-C Feeder Coal Flow | $10^3$LB/HR | 0 | 0 | 0 | 0 | 87 | 87 | 87 | 0 | 0 | 0 |
| C | PLV 1-D Feeder Coal Flow | $10^3$LB/HR | 114 | 113 | 105 | 87 | 88 | 88 | 89 | 112 | 112 | 104 |
| C | PLV 1-E Feeder Coal Flow | $10^3$LB/HR | 116 | 115 | 106 | 88 | 88 | 88 | 88 | 114 | 114 | 106 |
| C | PLV 1-F Feeder Coal Flow | $10^3$LB/HR | 116 | 116 | 104 | 86 | 86 | 86 | 87 | 113 | 115 | 105 |
| C | PLV 1-A Mill | AMPS | 73 | 74 | 70 | 64 | 0 | 0 | 0 | 73 | 74 | 70 |
| C | PLV 1-B Mill | AMPS | 72 | 71 | 70 | 65 | 0 | 0 | 0 | 71 | 70 | 70 |
| C | PLV 1-C Mill | AMPS | 0 | 0 | 0 | 0 | 65 | 67 | 66 | 0 | 0 | 0 |
| C | PLV 1-D Mill | AMPS | 74 | 73 | 71 | 66 | 65 | 65 | 65 | 73 | 75 | 70 |
| C | PLV 1-E Mill | AMPS | 75 | 76 | 72 | 65 | 67 | 67 | 66 | 75 | 75 | 73 |
| C | PLV 1-F Mill | AMPS | 75 | 74 | 71 | 65 | 65 | 66 | 65 | 74 | 75 | 71 |
| | **FAN DAMPER POSITION - % OPEN** | | | | | | | | | | | |
| *B | 1-A FD Fan Inlet Vane | | 72 | 70 | 73 | 63 | 58 | 62 | 64 | 70 | 73 | 70 |
| B | 1-B FD Fan Inlet Vane | | 71 | 70 | 71 | 62 | 57 | 60 | 62 | 69 | 71 | 70 |
| B | 1-A PA Fan Inlet Vane | | 30 | 29 | 28 | 28 | 32 | 32 | 32 | 30 | 30 | 30 |
| B | 1-B PA Fan Inlet Vane | | 25 | 24 | 24 | 23 | 26 | 26 | 26 | 25 | 25 | 25 |
| | **SPRAY VALVE POSITION - % OPEN** | | | | | | | | | | | |
| B | 1-A SH Spray Valve | | 100 | 25 | 36 | 23 | 11 | 8 | 10 | 100 | 45 | 85 |
| B | 1-B SH Spray Valve | | 92 | 13 | 24 | 17 | 6 | 5 | 20 | 100 | 32 | 68 |
| B | 1-A RH Spray Valve | | 47 | 32 | 41 | 0 | 0 | 0 | 0 | 84 | 50 | 31 |
| B | 1-B RH Spray Valve | | 65 | 43 | 41 | 0 | 0 | 0 | 0 | 61 | 70 | 41 |
| | **MISCELLANEOUS** | | | | | | | | | | | |
| B | Burner Tilt | ± DEGREES | -3° | 0° | -3° | +15° | +6° | +6° | +6° | -3° | 0° | -3° |
| B | Aux. Air Dampers | % OPEN | 100 | 98 | 100 | 56 | 13 | 21 | 25 | 79 | 100 | 84 |
| B | 1-A Fuel/Air Dampers | % OPEN | 51 | 50 | 45 | 31 | 0 | 0 | 0 | 50 | 50 | 45 |
| B | 1-B Fuel/Air Dampers | % OPEN | 52 | 49 | 45 | 34 | 0 | 0 | 0 | 50 | 49 | 46 |
| B | 1-C Fuel/Air Dampers | % OPEN | 0 | 2 | 0 | 0 | 87 | 88 | 90 | 0 | 0 | 0 |
| B | 1-D Fuel/Air Dampers | % OPEN | 51 | 52 | 46 | 35 | 84 | 85 | 83 | 50 | 50 | 46 |
| B | 1-E Fuel/Air Dampers | % OPEN | 51 | 52 | 45 | 34 | 80 | 82 | 84 | 50 | 50 | 46 |
| B | 1-F Fuel/Air Dampers | % OPEN | 51 | 52 | 45 | 33 | 76 | 78 | 80 | 50 | 50 | 46 |
| B | 1-A Pri. Air Fan | AMPS | 170 | 175 | 171 | 173 | 165 | 168 | 168 | 171 | 173 | 170 |
| B | 1-B Pri. Air Fan | AMPS | 180 | 184 | 181 | 185 | 175 | 178 | 178 | 181 | 180 | 180 |
| B | 1-A ID Fan | AMPS | 500 | 500 | 500 | 380 | 280 | 300 | 310 | 480 | 500 | 470 |
| B | 1-B ID Fan | AMPS | 430 | 420 | 430 | 320 | 300 | 320 | 320 | 410 | 430 | 400 |
| B | 1-A FD Fan | AMPS | 201 | 208 | 210 | 187 | 167 | 175 | 179 | 198 | 210 | 200 |
| B | 1-B FD Fan | AMPS | 198 | 193 | 197 | 177 | 157 | 162 | 166 | 188 | 198 | 190 |
| B | 1-A ID Fan | RPM | 480 | 480 | 480 | 430 | 320 | 340 | 354 | 480 | 480 | 480 |
| B | 1-B ID Fan | RPM | 490 | 490 | 480 | 430 | 315 | 345 | 354 | 488 | 500 | 480 |
| B | 1-A Blr. Circ. Wtr. Pump | AMPS | 71 | 73 | 75 | 79 | 83 | 83 | 81 | 74 | 72 | 73 |
| B | 1-B Blr. Circ. Wtr. Pump | AMPS | 76 | 76 | 79 | 81 | 85 | 83 | 84 | 77 | 75 | 76 |
| B | 1-C Blr. Circ. Wtr. Pump | AMPS | 70 | 72 | 73 | 78 | 80 | 79 | 78 | 72 | 71 | 71 |
| B | 1-D Blr. Circ. Wtr. Pump | AMPS | 72 | 73 | 75 | 80 | 85 | 83 | 83 | 74 | 72 | 73 |
| C | N Drum Level ± Norm. $H_2O$ Level | IN. | -.72 | -.70 | -.57 | -.67 | -.79 | -.63 | -.35 | -.68 | -.78 | -.64 |
| C | S Drum Level ± Norm. $H_2O$ Level | IN. | -3.05 | -2.87 | -2.01 | -1.58 | -2.02 | -2.26 | -1.70 | -3.28 | -2.92 | -2.95 |
| C | Flue Gas Combustibles | % | .062 | .064 | .067 | .064 | .063 | .065 | .063 | .068 | .060 | .068 |
| C | Flue Gas Oxygen | % | 3.8 | 3.9 | 4.8 | 5.3 | 5.1 | 5.7 | 6.0 | 3.9 | 4.0 | 5.0 |
| C | Baronmetric Press. | IN. HGA | 29.76 | 30.08 | 30.07 | 30.08 | 30.05 | 30.03 | 30.02 | 29.81 | 29.66 | 29.87 |

* C - Computer Data; B - Board Data; NA - Not Available.

# BASELINE OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1976 | 5/21 | 5/25 | 3/12 | 3/9 | 3/10 | 3/13 | 5/25 | 5/25 | 5/25 |
| | TIME | | 05:00 | 13:00 | 06:00 | 14:00 | 18:50 | 13:30 | 18:20 | 16:30 | 14:35 |
| *C | LOAD | MW | 321 | 321 | 525 | 512 | 484 | 400 | 322 | 325 | 322 |
| | **PULVERIZER DATA** | | | | | | | | | | |
| C | PLV 1-B COAL AIR DISCH. TEMP. | °F | 145 | 151 | 145 | 144 | 145 | 146 | 151 | 154 | 153 |
| C | PLV 1-C COAL AIR DISCH. TEMP. | °F | 145 | 144 | 50 | 68 | 53 | 44 | 143 | 144 | 144 |
| C | PLV 1-D COAL AIR DISCH. TEMP. | °F | 143 | 142 | 147 | 146 | 147 | 145 | 142 | 142 | 142 |
| C | PLV 1-E COAL AIR DISCH. TEMP. | °F | 94 | 79 | 141 | 140 | 141 | 142 | 82 | 80 | 80 |
| C | PLV 1-F COAL AIR DISCH. TEMP. | °F | 104 | 134 | 144 | 143 | 144 | 146 | 110 | 114 | 122 |
| C | PLV 1-A FEEDER COAL FLOW | $10^3$LB/HR | 86 | 88 | 119 | 112 | 107 | 86 | 86 | 88 | 88 |
| C | PLV 1-B FEEDER COAL FLOW | $10^3$LB/HR | 88 | 90 | 120 | 109 | 109 | 88 | 88 | 90 | 90 |
| C | PLV 1-C FEEDER COAL FLOW | $10^3$LB/HR | 88 | 89 | 0 | 0 | 0 | 0 | 88 | 90 | 90 |
| C | PLV 1-D FEEDER COAL FLOW | $10^3$LB/HR | 88 | 90 | 117 | 110 | 105 | 87 | 89 | 91 | 91 |
| C | PLV 1-E FEEDER COAL FLOW | $10^3$LB/HR | 0 | 0 | 112 | 112 | 107 | 87 | 0 | 0 | 0 |
| C | PLV 1-F FEEDER COAL FLOW | $10^3$LB/HR | 0 | 0 | 112 | 112 | 106 | 86 | 0 | 0 | 0 |
| C | PLV 1-A MILL | AMPS | 64 | 64 | 77 | 75 | 69 | 65 | 65 | 65 | 65 |
| C | PLV 1-B MILL | AMPS | 65 | 65 | 74 | 71 | 70 | 65 | 65 | 65 | 66 |
| C | PLV 1-C MILL | AMPS | 66 | 67 | 0 | 0 | 0 | 0 | 67 | 67 | 68 |
| C | PLV 1-D MILL | AMPS | 66 | 66 | 76 | 75 | 70 | 66 | 66 | 66 | 67 |
| C | PLV 1-E MILL | AMPS | 0 | 0 | 76 | 75 | 73 | 66 | 0 | 0 | 0 |
| C | PLV 1-F MILL | AMPS | 0 | 0 | 71 | 76 | 71 | 65 | 0 | 0 | 0 |
| | **FAN DAMPER POSITION - % OPEN** | | | | | | | | | | |
| *B | 1-A FD FAN INLET VANE | | 52 | 69 | 71 | 72 | 70 | 64 | 59 | 65 | 69 |
| B | 1-B FD FAN INLET VANE | | 51 | 67 | 70 | 71 | 70 | 63 | 58 | 64 | 68 |
| B | 1-A PA FAN INLET VANE | | 31 | 31 | 30 | 30 | 29 | 29 | 31 | 31 | 31 |
| B | 1-B PA FAN INLET VANE | | 26 | 25 | 25 | 25 | 24 | 24 | 26 | 26 | 26 |
| | **SPRAY VALVE POSITION - % OPEN** | | | | | | | | | | |
| B | 1-A SH SPRAY VALVE | | 41 | 26 | 52 | 30 | 53 | 22 | 26 | 32 | 32 |
| B | 1-B SH SPRAY VALVE | | 45 | 25 | 30 | 23 | 41 | 12 | 28 | 41 | 27 |
| B | 1-A RH SPRAY VALVE | | 19 | 8 | 100 | 49 | 36 | 0 | 17 | 18 | 14 |
| B | 1-B RH SPRAY VALVE | | 15 | 5 | 100 | 68 | 50 | 0 | 12 | 12 | 9 |
| | **MISCELLANEOUS** | | | | | | | | | | |
| B | BURNER TILT | ± DEGREES | +6° | +3° | -3° | 0° | -3° | +17° | +4° | +3° | +4° |
| B | AUX. AIR DAMPERS | % OPEN | 0 | 29 | 95 | 100 | 90 | 57 | 0 | 18 | 31 |
| B | 1-A FUEL/AIR DAMPERS | % OPEN | 79 | 83 | 54 | 49 | 45 | 31 | 81 | 85 | 85 |
| B | 1-B FUEL/AIR DAMPERS | % OPEN | 82 | 86 | 54 | 47 | 46 | 33 | 84 | 87 | 87 |
| B | 1-C FUEL/AIR DAMPERS | % OPEN | 87 | 92 | 0 | 0 | 0 | 0 | 89 | 83 | 93 |
| B | 1-D FUEL/AIR DAMPERS | % OPEN | 82 | 88 | 54 | 50 | 46 | 35 | 85 | 87 | 89 |
| B | 1-E FUEL/AIR DAMPERS | % OPEN | 0 | 0 | 50 | 50 | 46 | 33 | 0 | 0 | 0 |
| B | 1-F FUEL/AIR DAMPERS | % OPEN | 0 | 0 | 44 | 50 | 46 | 32 | 0 | 0 | 0 |
| B | 1-A PRI. AIR FAN | AMPS | 170 | 165 | 170 | 170 | 170 | 171 | 165 | 165 | 165 |
| B | 1-B PRI. AIR FAN | AMPS | 178 | 175 | 180 | 180 | 180 | 185 | 175 | 175 | 175 |
| B | 1-A ID FAN | AMPS | 270 | 340 | 480 | 500 | 480 | 380 | 290 | 310 | 350 |
| B | 1-B ID FAN | AMPS | 300 | 350 | 410 | 430 | 410 | 320 | 310 | 320 | 340 |
| B | 1-A FD FAN | AMPS | 158 | 189 | 199 | 205 | 200 | 187 | 165 | 180 | 189 |
| B | 1-B FD FAN | AMPS | 149 | 175 | 187 | 190 | 190 | 171 | 155 | 165 | 178 |
| B | 1-A ID FAN | RPM | 300 | 393 | 480 | 480 | 480 | 430 | 316 | 360 | 400 |
| B | 1-B ID FAN | RPM | 300 | 393 | 480 | 490 | 480 | 430 | 326 | 360 | 400 |
| B | 1-A BLR. CIRC. WTR. PUMP | AMPS | 80 | 79 | 73 | 70 | 73 | 79 | 82 | 80 | 79 |
| B | 1-B BLR. CIRC. WTR. PUMP | AMPS | 83 | 83 | 76 | 75 | 76 | 81 | 83 | 83 | 80 |
| B | 1-C BLR. CIRC. WTR. PUMP | AMPS | 79 | 77 | 72 | 70 | 71 | 76 | 78 | 78 | 76 |
| B | 1-D BLR. CIRC. WTR. PUMP | AMPS | 83 | 79 | 74 | 72 | 73 | 80 | 82 | 80 | 78 |
| C | N DRUM LEVEL ± NORM. $H_2O$ LEVEL | IN. | -.64 | -.56 | -.64 | -.69 | -.65 | -.55 | -.77 | -.67 | -.54 |
| C | S DRUM LEVEL ± NORM. $H_2O$ LEVEL | IN. | -2.56 | -2.13 | -1.60 | -2.54 | -3.03 | -1.15 | -1.40 | -1.79 | -2.25 |
| C | FLUE GAS COMBUSTIBLES | % | .063 | .067 | .065 | .064 | .066 | .065 | .066 | .068 | .066 |
| C | FLUE GAS OXYGEN | % | 4.2 | 7.0 | 3.5 | 4.1 | 5.0 | 5.3 | 4.6 | 5.9 | 7.0 |
| C | BARONMETRIC PRESS. | IN. HGA | 30.08 | 29.98 | 29.01 | 29.56 | 29.94 | 30.00 | 29.91 | 29.92 | 29.95 |

* C - COMPUTER DATA; B - BOARD DATA; NA - NOT AVAILABLE.

# BIASED FIRING OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 5/19 | 5/19 | 3/12 | 5/19 | 5/12 | 5/12 | 5/16 | 5/21 | 6/27 |
| | Time | | 16:15 | 13:50 | 07:15 | 11:00 | 11:00 | 09:20 | 09:30 | 03:10 | 09:40 |
| *C | Load | MW | 505 | 506 | 524 | 506 | 422 | 422 | 421 | 320 | 314 |
| | **FLOWS $10^3$LB/HR** | | | | | | | | | | |
| C | Feedwater | | 3176 | 3200 | 3111 | 3111 | 2666 | 2634 | 2624 | 1727 | 1979 |
| C | Superheat Spray L | | 80 | 66 | 122 | 113 | 0 | 0 | 0 | 90 | 0 |
| C | Superheat Spray R | | 83 | 68 | 108 | 95 | 29 | 57 | 22 | 121 | 20 |
| C | Reheat Spray L | | 38 | 54 | 81 | 35 | 10 | 9 | 10 | 9 | 0 |
| C | Reheat Spray R | | 62 | 74 | 83 | 59 | 6 | 0 | 0 | 24 | 2 |
| C | BFP Turb. Extr. Stm. Flow 1-A | | 43 | 43 | 0 | 42 | 0 | 0 | 42 | 39 | 34 |
| C | BFP Turb. Extr. Stm. Flow 1-B | | 68 | 69 | 0 | 69 | 0 | 0 | 72 | 68 | 89 |
| C | BFP Turb. Mn. Stm. Flow Combined | | 8.47 | 8.49 | 7.69 | 8.13 | 8.80 | 8.87 | 8.70 | 7.12 | 0.00 |
| C | Hot Air to Burners L Windbox | | 1481 | 1382 | 1516 | 1384 | 1247 | 1169 | 1285 | 819 | 1006 |
| C | Hot Air to Burners R Windbox | | 1555 | 1472 | 1466 | 1473 | 1300 | 1226 | 1342 | 826 | 951 |
| | **PRESSURES** | | | | | | | | | | |
| | **Steam & Water - PSIG** | | | | | | | | | | |
| C | Feedwater to Econ. | | 2732 | 2731 | 2728 | 2720 | 2649 | 2643 | 2645 | 2546 | 2564 |
| C | Boiler Drum | | 2674 | 2678 | 2676 | 2670 | 2607 | 2604 | 2605 | 2519 | 2531 |
| C | Turbine Throttle | | 2403 | 2403 | 2396 | 2402 | 2400 | 2400 | 2399 | 2400 | 2407 |
| C | Turbine 1st Stage | | 1618 | 1620 | 1649 | 1623 | 1319 | 1322 | 1321 | 951 | 966 |
| C | HP Htr. 1-G1 & 1-G2 Steam In. | | 519 | 520 | 539 | 518 | 416 | 414 | 415 | 312 | 301 |
| | **Air & Gas - IN $H_2O$** | | | | | | | | | | |
| C | FD Fan 1-A Discharge | | 14.07 | 13.28 | 5.36 | 13.11 | 11.67 | 10.86 | 11.98 | 5.00 | 6.96 |
| C | FD Fan 1-B Discharge | | 13.15 | 11.98 | 8.67 | 11.61 | 10.05 | 9.49 | 10.04 | 4.39 | 5.75 |
| C | Air Htr. 1-A Air In. | | 11.14 | 10.45 | 7.32 | 10.40 | 9.30 | 8.71 | 9.33 | 3.82 | 5.30 |
| C | Air Htr. 1-B Air In. | | 10.26 | 9.51 | 6.75 | 9.43 | 8.45 | 7.93 | 8.56 | 3.26 | 4.55 |
| C | Air Htr. 1-A Air Out. | | 7.02 | 6.65 | 3.44 | 6.61 | 6.24 | 6.02 | 6.35 | 2.35 | 3.43 |
| C | Air Htr. 1-B Air Out. | | 7.02 | 6.64 | 3.46 | 6.74 | 6.28 | 6.17 | 6.22 | 2.27 | 3.36 |
| C | Furn. Right Windbox | | 5.33 | 5.20 | 2.39 | 5.30 | 5.21 | 5.23 | 5.17 | 1.95 | 2.94 |
| C | Furn. Left Windbox | | 5.46 | 5.31 | 2.42 | 5.41 | 5.24 | 5.29 | 5.21 | 1.93 | 2.80 |
| C | Rt. WDBX to Furn. Diff. P | | 6.50 | 6.53 | 3.20 | 6.53 | 6.54 | 6.55 | 6.54 | 2.02 | 2.12 |
| C | Left WDBX to Furn. Diff. P | | 7.01 | 6.94 | 4.00 | 6.90 | 7.00 | 7.01 | 6.99 | 3.52 | 3.58 |
| C | Furnace | | -0.26 | -0.64 | -0.43 | -0.70 | -0.49 | -0.42 | -0.52 | -0.20 | -0.54 |
| C | Pri. SH Gas Out. | | -0.43 | -0.57 | -0.73 | -0.47 | -0.50 | -0.53 | -0.56 | -0.59 | -0.73 |
| C | Reheater Gas Out. | | -0.98 | -1.13 | -0.69 | -1.05 | -0.87 | -0.86 | -0.91 | -0.81 | -0.86 |
| C | Econ. Gas In. | | -2.13 | -2.16 | -2.45 | -2.15 | -1.71 | -1.62 | -1.82 | -1.32 | -1.23 |
| C | Econ. Gas Out. | | -5.73 | -5.61 | -6.18 | -5.67 | -4.19 | -3.84 | -4.31 | -2.58 | -2.68 |
| C | Air Htr. 1-A Gas In. | | -7.96 | -7.74 | -8.49 | -7.97 | -6.14 | -5.81 | -5.91 | -3.52 | -3.83 |
| C | Air Htr. 1-B Gas In. | | -7.73 | -7.54 | -8.10 | -7.44 | -5.67 | -5.42 | -6.04 | -3.76 | -3.96 |
| C | Air Htr. 1-A Gas Out. | | -14.1 | -13.6 | -14.9 | -13.5 | -10.3 | -9.7 | -10.5 | -6.3 | -6.4 |
| C | Air Htr. 1-B Gas Out. | | -12.9 | -12.4 | -13.6 | -12.2 | -9.3 | -9.0 | -9.7 | -6.0 | -6.3 |
| C | IDF 1-A Disch. | | -0.09 | -0.16 | -0.56 | -0.21 | -0.56 | -0.79 | -0.35 | -0.86 | -0.41 |
| C | IDF 1-B Disch. | | -0.02 | -0.12 | -0.47 | -0.19 | -0.52 | -0.74 | -0.34 | -0.84 | -0.40 |
| C | PAF 1-A Disch. Hdr. | | 32.26 | 32.44 | 32.91 | 32.31 | 31.89 | 31.93 | 31.90 | 31.59 | 31.64 |
| C | PAF 1-B Disch. Hdr. | | 33.43 | 33.44 | 32.68 | 33.23 | 32.75 | 32.75 | 32.87 | 32.77 | 32.79 |
| *B | Pri. Hot Air Duct | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | **TEMPERATURES** | | | | | | | | | | |
| | **Air & Gas - °F** | | | | | | | | | | |
| C | 1-A FD Fan Disch. | | 84 | 81 | 58 | 75 | 70 | 64 | 73 | 75 | 87 |
| C | 1-B FD Fan Disch. | | 91 | 88 | 68 | 80 | 79 | 76 | 80 | 87 | 93 |
| C | 1-A AH Air In. | | 98 | 97 | 73 | 89 | 96 | 96 | 91 | 92 | 99 |
| C | 1-B AH Air In. | | 102 | 101 | 76 | 92 | 67 | 102 | 95 | 95 | 101 |
| C | 1-A AH Air Out. | | 688 | 688 | 720 | 681 | 639 | 629 | 627 | 594 | 549 |
| C | 1-B AH Air Out. | | 722 | 702 | 738 | 692 | 651 | 641 | 648 | 612 | 566 |
| C | 1-A AH Gas In. | | 744 | 744 | 784 | 737 | 695 | 680 | 679 | 642 | 591 |
| C | 1-B AH Gas In. | | 758 | 744 | 789 | 733 | 688 | 371 | 682 | 641 | 599 |
| C | 1-A AH Gas Out. | | 291 | 290 | 280 | 282 | 249 | 246 | 250 | 252 | 226 |
| C | 1-B AH Gas Out. | | 293 | 288 | 283 | 280 | 256 | 254 | 251 | 261 | 238 |

* C - Computer Data; B - Board Data; NA - Not Available.

# BIASED FIRING OPERATION STUDY

BOARD & COMPUTER DATA

| | Test No. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 5/23 | 5/19 | 5/10 | 3/16 | 5/12 | 3/13 | 5/16 | 5/21 | 5/23 |
| | Time | | 11:05 | 18:35 | 09:50 | 10:00 | 13:45 | 15:30 | 11:45 | 01:15 | 09:10 |
| *C | Load | MW | 324 | 491 | 497 | 522 | 422 | 400 | 422 | 320 | 323 |
| | **Flows - $10^3$ LB/HR** | | | | | | | | | | |
| C | Feedwater | | 1940 | 3005 | 2972 | 3139 | 2660 | 2458 | 2634 | 1720 | 1909 |
| C | Superheat Spray L | | 12 | 107 | 125 | 135 | 0 | 0 | 9 | 92 | 36 |
| C | Superheat Spray R | | 46 | 101 | 140 | 111 | 39 | 34 | 32 | 122 | 48 |
| C | Reheat Spray L | | 0 | 40 | 66 | 70 | 11 | 10 | 10 | 5 | 0 |
| C | Reheat Spray R | | 0 | 64 | 80 | 75 | 8 | 0 | 0 | 22 | 0 |
| C | BFP Turb. Extr. Stm. Flow 1-A | | 44 | 42 | 0 | 0 | 0 | 0 | 42 | 39 | 44 |
| C | BFP Turb. Extr. Stm. Flow 1-B | | 34 | 67 | 0 | 0 | 0 | 0 | 73 | 70 | 34 |
| C | BFP Turb. Mn. Stm. Flow Combined | | 14.70 | 8.08 | 7.65 | 7.51 | 8.93 | 7.61 | 8.95 | 7.53 | 14.99 |
| C | Hot Air to Burners L Windbox | | 902 | 1502 | 1514 | 1576 | 1411 | 1290 | 1472 | 967 | 993 |
| C | Hot Air to Burners R Windbox | | 913 | 1583 | 1554 | 1552 | 1869 | 1287 | 1533 | 979 | 1027 |
| | **Pressures** | | | | | | | | | | |
| | **Steam & Water - PSIG** | | | | | | | | | | |
| C | Feedwater to Econ. | | 2565 | 2711 | 2701 | 2734 | 2648 | 2623 | 2647 | 2544 | 2563 |
| C | Boiler Drum | | 2539 | 2660 | 2652 | 2687 | 2608 | 2587 | 2608 | 2520 | 2540 |
| C | Turbine Throttle | | 2402 | 2400 | 2400 | 2395 | 2408 | 2402 | 2406 | 2405 | 2405 |
| C | Turbine 1st Stage | | 984 | 1559 | 1574 | 1672 | 1323 | 1238 | 1326 | 953 | 983 |
| C | HP Htr. 1-G1 & 1-G2 Steam In. | | 310 | 505 | 513 | 537 | 261 | 391 | 416 | 311 | 308 |
| | **Air & Gas - IN $H_2O$** | | | | | | | | | | |
| C | FD Fan 1-A Discharge | | 7.35 | 14.17 | 13.78 | 5.47 | 12.75 | 4.26 | 13.09 | 7.95 | 9.52 |
| C | FD Fan 1-B Discharge | | 6.46 | 13.30 | 12.75 | 8.78 | 11.24 | 6.66 | 11.96 | 6.67 | 8.33 |
| C | Air Htr. 1-A Air In. | | 5.99 | 11.27 | 11.12 | 7.58 | 10.11 | 5.78 | 10.29 | 6.21 | 7.62 |
| C | Air Htr. 1-B Air In. | | 5.57 | 10.49 | 10.26 | 7.04 | 9.11 | 5.36 | 9.60 | 5.50 | 7.04 |
| C | Air Htr. 1-A Air Out. | | 4.41 | 7.18 | 7.13 | 3.52 | 6.47 | 2.90 | 6.63 | 4.20 | 5.58 |
| C | Air Htr. 1-B Air Out. | | 4.32 | 7.19 | 7.20 | 3.38 | 6.50 | 2.88 | 6.49 | 4.12 | 5.51 |
| C | Furn. Right Windbox | | 3.82 | 5.53 | 5.64 | 2.35 | 5.22 | 2.17 | 4.98 | 3.56 | 4.98 |
| C | Furn. Left Windbox | | 3.72 | 5.59 | 5.70 | 2.14 | 5.27 | 2.23 | 5.12 | 3.51 | 4.96 |
| C | Rt. WDBX to Furn. Diff. P | | 4.55 | 6.56 | 6.54 | 3.08 | 6.54 | 3.16 | 6.54 | 4.15 | 6.15 |
| C | Left WDBX to Furn. Diff. P | | 5.38 | 7.01 | 6.97 | 3.73 | 7.01 | 3.86 | 7.01 | 5.17 | 6.63 |
| C | Furnace | | -0.63 | -0.23 | -0.03 | -0.44 | -0.60 | -0.51 | -0.57 | -0.52 | -0.35 |
| C | Pri. SH Gas Out. | | -0.48 | -0.25 | -0.18 | -0.62 | -0.56 | -0.64 | -0.54 | -0.59 | -0.49 |
| C | Reheater Gas Out. | | -0.74 | -0.82 | -0.68 | -0.48 | -1.03 | -0.36 | -0.96 | -0.84 | -0.74 |
| C | Econ. Gas In. | | -1.22 | -2.03 | -2.10 | -2.56 | -1.88 | -1.81 | -2.05 | -1.49 | -1.29 |
| C | Econ. Gas Out. | | -2.78 | -5.68 | -5.78 | -6.22 | -4.82 | -4.47 | -5.13 | -3.00 | -2.90 |
| C | Air Htr. 1-A Gas In. | | -3.97 | -7.98 | -8.36 | -8.91 | -6.89 | -6.49 | -7.12 | -4.13 | -4.22 |
| C | Air Htr. 1-B Gas In. | | -4.12 | -7.77 | -7.99 | -8.89 | -6.50 | -6.24 | -7.20 | -4.37 | -4.37 |
| C | Air Htr. 1-A Gas Out. | | -6.9 | -14.3 | -14.5 | -15.5 | -11.6 | -11.3 | -12.6 | -7.5 | -7.6 |
| C | Air Htr. 1-B Gas Out. | | -6.4 | -13.0 | -13.1 | -14.0 | -10.6 | -10.1 | -11.6 | -6.9 | -7.1 |
| C | IDF 1-A Disch. | | -0.85 | -0.00 | -0.13 | -0.78 | -0.26 | -1.01 | -0.12 | -0.73 | -0.78 |
| C | IDF 1-B Disch. | | -0.90 | -0.06 | -0.03 | -0.92 | -0.22 | -0.97 | -0.09 | -0.69 | -0.85 |
| C | PAF 1-A Disch. Hdr. | | 31.50 | 32.32 | 33.17 | 32.87 | 31.94 | 32.47 | 31.89 | 31.76 | 31.37 |
| C | PAF 1-B Disch. Hdr. | | 32.33 | 33.37 | 34.33 | 32.78 | 32.84 | 32.29 | 32.86 | 32.73 | 32.26 |
| *B | Pri. Hot Air Duct | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | **Temperatures** | | | | | | | | | | |
| | **Air & Gas - °F** | | | | | | | | | | |
| C | 1-A FD Fan Disch. | | 74 | 84 | 76 | 40 | 76 | 47 | 73 | 77 | 68 |
| C | 1-B FD Fan Disch. | | 80 | 91 | 81 | 47 | 84 | 56 | 80 | 87 | 78 |
| C | 1-A AH Air In. | | 104 | 98 | 88 | 82 | 91 | 99 | 90 | 91 | 112 |
| C | 1-B AH Air In. | | 108 | 102 | 91 | 85 | 94 | 105 | 93 | 94 | 116 |
| C | 1-A AH Air Out. | | 564 | 690 | 702 | 698 | 651 | 631 | 637 | 606 | 552 |
| C | 1-B AH Air Out. | | 580 | 718 | 731 | 715 | 665 | 639 | 663 | 630 | 561 |
| C | 1-A AH Gas In. | | 611 | 748 | 762 | 763 | 710 | 684 | 694 | 656 | 605 |
| C | 1-B AH Gas In. | | 608 | 753 | 453 | 767 | 703 | 684 | 702 | 658 | 596 |
| C | 1-A AH Gas Out. | | 240 | 292 | 276 | 272 | 253 | 251 | 254 | 253 | 236 |
| C | 1-B AH Gas Out. | | 242 | 291 | 281 | 270 | 257 | 252 | 254 | 261 | 233 |

* C - Computer Data; B - Board Data; NA - Not Available.

# BIASED FIRING OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 5/19 | 5/19 | 3/12 | 5/19 | 5/12 | 5/12 | 5/16 | 5/21 | 6/27 |
| | Time | | 16:15 | 13:50 | 07:15 | 11:00 | 11:00 | 09:20 | 09:30 | 03:10 | 09:40 |
| *C | Load | MW | 505 | 506 | 524 | 506 | 422 | 422 | 421 | 320 | 314 |
| | **TEMPERATURES** | | | | | | | | | | |
| | **Air & Gas - °F** | | | | | | | | | | |
| C | Econ. N Gas Out. | | 797 | 777 | 836 | 770 | 716 | 706 | 722 | 661 | 610 |
| C | Econ. S Gas Out. | | 770 | 768 | 823 | 758 | 685 | 674 | 596 | 655 | *NA |
| C | 1-A PA Fan Disch. Hdr. | | 95 | 93 | 68 | 85 | 80 | 74 | 82 | 80 | 101 |
| C | 1-B PA Fan Disch. Hdr. | | NA | NA | 104 | NA | NA | NA | NA | NA | NA |
| C | 1-A AH Pri. Air Out. | | 698 | 700 | 732 | 693 | 650 | 639 | 637 | 608 | 561 |
| C | 1-B AH Pri. Air Out. | | 702 | 694 | 724 | 683 | 643 | 634 | 636 | 608 | 563 |
| | **Steam & Water - °F** | | | | | | | | | | |
| C | Boiler Econ. In. | | 474 | 474 | 478 | 474 | 451 | 452 | 451 | 425 | 417 |
| C | Downcomer 1 | | 674 | 674 | 676 | 674 | 671 | 670 | 670 | 666 | 666 |
| C | Downcomer 2 | | 676 | 676 | 678 | 676 | 672 | 672 | 672 | 667 | 667 |
| C | Downcomer 3 | | 676 | 677 | 678 | 676 | 673 | 672 | 673 | 667 | 668 |
| C | Downcomer 4 | | 680 | 680 | 682 | 680 | 677 | 677 | 677 | 672 | 418 |
| C | Downcomer 5 | | 678 | 678 | 680 | 678 | 674 | 674 | 674 | 669 | 668 |
| C | Blr. SH ATMP 1-A Stm. In. | | 836 | 832 | 856 | 835 | 821 | 834 | 829 | 917 | 833 |
| C | Blr. SH ATMP 1-B Stm. In. | | 840 | 832 | 873 | 849 | 808 | 813 | 836 | 873 | 823 |
| C | Blr. S SH Hdr. Out. | | 998 | 1012 | 1008 | 996 | 1005 | 1005 | 995 | 1006 | 999 |
| C | Blr. N SH Hdr. Out. | | 1012 | 997 | 1014 | 1016 | 1003 | 1001 | 1017 | 999 | 999 |
| C | Turbine Throttle | | 1002 | 1000 | 1008 | 1001 | 1003 | 1001 | 1002 | 1002 | NA |
| C | Blr. S RH ATMP Stm. Out. A | | 476 | 475 | 479 | 476 | 574 | 586 | 588 | 427 | 540 |
| C | Blr. N RH ATMP Stm. Out. B | | 473 | 474 | 482 | 473 | 527 | 585 | 587 | 426 | 539 |
| C | Blr. S RH Hdr. Out. A | | 982 | 1002 | 1014 | 1000 | 997 | 1003 | 974 | 998 | 924 |
| C | Blr. N RH Hdr. Out. B | | 1026 | 1011 | 1015 | 1017 | 1002 | 1004 | 1023 | 992 | 932 |
| C | HP Htr. 1-G1 & 1-G2 Extr. Stm. | | 616 | 618 | 628 | 617 | 580 | 579 | 580 | 547 | 533 |
| C | HP Htr. 1-F1 FW Out. | | 408 | 408 | 412 | 408 | 389 | 389 | 389 | 368 | NA |
| C | HP Htr. 1-F2 FW Out. | | 405 | 406 | 412 | 406 | 388 | 388 | 388 | 367 | 356 |
| C | HP Htr. 1-G1 FW Out. | | 472 | 472 | 479 | 472 | 451 | 450 | 450 | 424 | NA |
| C | HP Htr. 1-G2 FW Out. | | 473 | 473 | 479 | 473 | 451 | 451 | 451 | 424 | 416 |
| C | HP Htr. 1-G1 Drain | | 411 | 412 | 415 | 412 | 391 | 391 | 390 | 367 | NA |
| C | HP Htr. 1-G2 Drain | | 378 | 379 | 378 | 376 | 358 | 356 | 358 | 338 | 332 |
| | **PULVERIZER DATA** | | | | | | | | | | |
| C | PLV 1-A Bowl Lower P | IN. $H_2O$ | 20.6 | 20.7 | 21.7 | -0.4 | 21.0 | 21.0 | -0.4 | 18.5 | 17.0 |
| C | PLV 1-B Bowl Lower P | IN. $H_2O$ | 24.0 | 23.8 | 23.4 | 23.6 | 24.2 | 23.7 | 23.8 | 20.0 | 20.7 |
| C | PLV 1-C Bowl Lower P | IN. $H_2O$ | 21.6 | 21.9 | 0.2 | 22.3 | 23.4 | 23.7 | 23.0 | 19.7 | 0.1 |
| C | PLV 1-D Bowl Lower P | IN. $H_2O$ | 23.0 | 23.0 | 23.6 | 23.0 | -0.2 | -0.2 | 23.4 | 19.6 | 30.3 |
| C | PLV 1-E Bowl Lower P | IN. $H_2O$ | 22.2 | -1.1 | 21.9 | 22.2 | 22.3 | 22.3 | 21.8 | -1.0 | 18.1 |
| C | PLV 1-F Bowl Lower P | IN. $H_2O$ | -1.5 | 19.5 | 18.9 | 20.1 | -0.1 | -0.1 | 0.1 | -1.4 | 16.8 |
| C | PLV 1-A Bowl Diff. P | IN. $H_2O$ | 6.90 | 6.94 | 7.79 | 0.44 | 7.23 | 7.22 | 0.44 | 6.34 | 5.89 |
| C | PLV 1-B Bowl Diff. P | IN. $H_2O$ | 7.88 | 7.79 | 8.11 | 7.68 | 8.25 | 8.00 | 7.86 | 6.46 | 6.64 |
| C | PLV 1-C Bowl Diff. P | IN. $H_2O$ | 7.15 | 7.29 | 0.04 | 7.18 | 7.74 | 7.85 | 7.65 | 6.62 | 0.02 |
| C | PLV 1-D Bowl Diff. P | IN. $H_2O$ | 7.66 | 7.80 | 8.09 | 7.73 | -0.00 | -0.02 | 7.72 | 6.68 | 0.05 |
| C | PLV 1-E Bowl Diff. P | IN. $H_2O$ | 6.92 | 0.12 | 7.04 | 6.94 | 7.17 | 7.10 | 6.93 | 0.19 | 5.97 |
| C | PLV 1-F Bowl Diff. P | IN. $H_2O$ | 0.06 | 6.73 | 6.64 | 6.93 | -0.02 | -0.03 | 0.00 | 0.06 | 5.78 |
| C | PLV 1-A Coal Air Out. P | IN. $H_2O$ | 9.30 | 9.45 | 10.13 | -1.24 | 6.05 | 6.05 | -1.37 | 8.20 | 7.41 |
| C | PLV 1-B Coal Air Out. P | IN. $H_2O$ | 11.97 | 11.86 | 11.69 | 11.74 | 11.79 | 11.51 | 11.89 | 10.04 | 10.38 |
| C | PLV 1-C Coal Air Out. P | IN. $H_2O$ | 10.51 | 10.66 | -0.13 | 10.86 | 11.22 | 11.32 | 11.19 | 9.58 | 0.17 |
| C | PLV 1-D Coal Air Out. P | IN. $H_2O$ | 10.98 | 11.02 | 11.15 | 11.05 | 0.06 | 0.06 | 11.28 | 9.15 | 30.20 |
| C | PLV 1-E Coal Air Out. P | IN. $H_2O$ | 10.83 | -1.25 | 11.32 | 10.88 | 10.77 | 10.80 | 10.71 | -1.17 | 8.72 |
| C | PLV 1-F Coal Air Out. P | IN. $H_2O$ | -1.64 | 9.31 | 9.08 | 9.70 | 0.11 | 0.11 | 0.03 | -1.38 | 8.38 |
| C | PLV 1-A Pri. Air In. Flow | 0-125% | 127 | 127 | 125 | 0 | 127 | 127 | 0 | 127 | 123 |
| C | PLV 1-B Pri. Air In. Flow | 0-125% | 129 | 128 | 128 | 129 | 129 | 128 | 129 | 128 | 127 |
| C | PLV 1-C Pri. Air In. Flow | 0-125% | 129 | 130 | 38 | 129 | 131 | 130 | 129 | 131 | 51 |
| C | PLV 1-D Pri. Air In. Flow | 0-125% | 126 | 125 | 126 | 126 | 0 | 0 | 126 | 126 | 31 |
| C | PLV 1-E Pri. Air In. Flow | 0-125% | 129 | 0 | 128 | 130 | 126 | 126 | 126 | 0 | 126 |
| C | PLV 1-F Pri. Air In. Flow | 0-125% | 0 | 124 | 125 | 125 | 0 | 0 | 0 | 0 | 130 |
| C | PLV 1-A Coal Air Disch. Temp. | °F | 143 | 143 | 143 | 88 | 143 | 143 | 87 | 143 | 146 |

* C - Computer Data; B - Board Data; NA Not Available.

# BIASED FIRING OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 5/23 | 5/19 | 5/10 | 3/16 | 5/12 | 3/13 | 5/18 | 5/21 | 5/23 |
| | Time | | 11:05 | 18:35 | 09:50 | 10:00 | 13:45 | 15:30 | 11:45 | 01:15 | 09:10 |
| *C | Load | MW | 324 | 491 | 497 | 522 | 422 | 400 | 422 | 320 | 323 |
| | **TEMPERATURES** | | | | | | | | | | |
| | Air & Gas - °F | | | | | | | | | | |
| C | Econ. N Gas Out. | | 642 | 791 | 803 | 803 | 737 | 715 | 748 | 676 | 653 |
| C | Econ. S Gas Out. | | 557 | 701 | 788 | 810 | 631 | 722 | 612 | 673 | 538 |
| C | 1-A PA Fan Disch. Hdr. | | 83 | 94 | 86 | 53 | 86 | 58 | 82 | 82 | 78 |
| C | 1-B PA Fan Disch. Hdr. | | *NA | NA | NA | 61 | NA | 80 | NA | NA | NA |
| C | 1-A AH Pri. Air Out. | | 578 | 702 | 713 | 710 | 661 | 641 | 649 | 619 | 567 |
| C | 1-B AH Pri. Air Out. | | 574 | 697 | 713 | 699 | 653 | 627 | 648 | 620 | 556 |
| | Steam & Water - °F | | | | | | | | | | |
| C | Boiler Econ. In. | | 424 | 471 | 473 | 480 | 452 | 447 | 451 | 424 | 424 |
| C | Downcomer 1 | | 665 | 673 | 673 | 678 | 671 | 672 | 670 | 665 | 665 |
| C | Downcomer 2 | | 668 | 675 | 674 | 680 | 672 | 674 | 672 | 667 | 667 |
| C | Downcomer 3 | | 669 | 676 | 675 | 680 | 673 | 674 | 673 | 668 | 668 |
| C | Downcomer 4 | | 673 | 679 | 679 | 684 | 677 | 678 | 677 | 672 | 673 |
| C | Downcomer 5 | | 670 | 677 | 676 | 681 | 675 | 676 | 674 | 669 | 670 |
| C | Blr. SH ATMP 1-A Stm. In. | | 850 | 844 | 865 | 846 | 828 | 827 | 828 | 915 | 855 |
| C | Blr. SH ATMP 1-B Stm. In. | | 821 | 851 | 863 | 868 | 819 | 837 | 845 | 870 | 827 |
| C | Blr. S SH Hdr. Out. | | 1006 | 992 | 1011 | 999 | 1004 | 1003 | 990 | 1004 | 1003 |
| C | Blr. N SH Hdr. Out. | | 1005 | 1018 | 1005 | 1019 | 1005 | 1021 | 1022 | 1006 | 1008 |
| C | Turbine Throttle | | 1005 | 1001 | 1005 | 1004 | 1000 | 1009 | 999 | 1003 | 1003 |
| C | Blr. S RH ATMP Stm. Out. A | | 552 | 472 | 472 | 481 | 578 | 588 | 588 | 427 | 552 |
| C | Blr. N RH ATMP Stm. Out. B | | 551 | 470 | 471 | 482 | 500 | 587 | 587 | 427 | 551 |
| C | Blr. S RH Hdr. Out. A | | 963 | 983 | 982 | 989 | 999 | 998 | 969 | 995 | 973 |
| C | Blr. N RH Hdr. Out. B | | 978 | 1027 | 1021 | 1030 | 1004 | 1012 | 1037 | 995 | 980 |
| C | HP Htr. 1-G1 & 1-G2 Extr. Stm. | | 546 | 612 | 618 | 624 | 580 | 580 | 577 | 545 | 545 |
| C | HP Htr. 1-F1 FW Out. | | 366 | 405 | 407 | 413 | 389 | 386 | 389 | 367 | 367 |
| C | HP Htr. 1-F2 FW Out. | | 366 | 404 | 406 | 412 | 388 | 386 | 388 | 366 | 365 |
| C | HP Htr. 1-G1 FW Out. | | 424 | 469 | 472 | 480 | 451 | 448 | 450 | 424 | 423 |
| C | HP Htr. 1-G2 FW Out. | | 424 | 470 | 472 | 480 | 451 | 448 | 451 | 423 | 424 |
| C | HP Htr. 1-G1 Drain | | 366 | 409 | 410 | 416 | 391 | 387 | 391 | 366 | 366 |
| C | HP Htr. 1-G2 Drain | | 335 | 376 | 376 | 384 | 360 | 359 | 358 | 337 | 334 |
| | **PULVERIZER DATA** | | | | | | | | | | |
| C | PLV 1-A Bowl Lower P | IN. $H_2O$ | -0.3 | 20.6 | 21.5 | 21.4 | 20.7 | 18.3 | -0.5 | 18.3 | -0.3 |
| C | PLV 1-B Bowl Lower P | IN. $H_2O$ | -1.3 | 24.0 | 25.3 | -0.0 | 24.0 | 18.9 | 24.0 | 20.6 | -1.5 |
| C | PLV 1-C Bowl Lower P | IN. $H_2O$ | 19.4 | 21.5 | 23.9 | 24.4 | 23.2 | 0.2 | 23.0 | 19.5 | 19.8 |
| C | PLV 1-D Bowl Lower P | IN. $H_2O$ | 19.3 | 22.7 | -0.3 | 23.6 | -0.2 | 19.8 | 23.6 | 19.7 | 19.3 |
| C | PLV 1-E Bowl Lower P | IN. $H_2O$ | 19.7 | 22.0 | 23.5 | 22.7 | 22.0 | 19.8 | 21.9 | -1.1 | 19.9 |
| C | PLV 1-F Bowl Lower P | IN. $H_2O$ | 18.1 | -1.4 | 22.4 | 21.2 | -0.1 | 17.6 | 0.1 | -1.3 | 18.2 |
| C | PLV 1-A Bowl Diff. P | IN. $H_2O$ | 0.44 | 6.83 | 7.28 | 7.54 | 7.11 | 6.58 | 0.44 | 6.31 | 0.44 |
| C | PLV 1-B Bowl Diff. P | IN. $H_2O$ | 0.20 | 7.74 | 8.30 | 0.01 | 8.18 | 6.67 | 7.97 | 6.61 | 0.21 |
| C | PLV 1-C Bowl Diff. P | IN. $H_2O$ | 6.34 | 7.12 | 7.82 | 8.43 | 7.72 | 0.02 | 7.73 | 6.53 | 6.47 |
| C | PLV 1-D Bowl Diff. P | IN. $H_2O$ | 6.47 | 7.60 | 0.29 | 8.06 | 0.02 | 6.84 | 7.82 | 6.72 | 6.48 |
| C | PLV 1-E Bowl Diff. P | IN. $H_2O$ | 6.16 | 6.84 | 7.34 | 7.25 | 7.16 | 6.44 | 6.94 | 0.17 | 6.21 |
| C | PLV 1-F Bowl Diff. P | IN. $H_2O$ | 6.14 | 0.06 | 7.38 | 7.30 | -0.01 | 6.18 | 0.00 | 0.06 | 6.12 |
| C | PLV 1-A Coal Air Out. P | IN. $H_2O$ | -1.15 | 9.36 | 8.99 | 9.86 | 6.12 | 8.37 | -1.41 | 8.17 | -1.16 |
| C | PLV 1-B Coal Air Out. P | IN. $H_2O$ | -1.28 | 12.00 | 12.55 | 0.43 | 11.68 | 9.55 | 11.85 | 10.13 | -1.35 |
| C | PLV 1-C Coal Air Out. P | IN. $H_2O$ | 9.46 | 10.50 | 11.70 | 11.27 | 11.09 | -0.23 | 11.14 | 9.48 | 9.78 |
| C | PLV 1-D Coal Air Out. P | IN. $H_2O$ | 9.34 | 10.91 | -0.70 | 11.43 | 0.06 | 9.45 | 11.34 | 9.23 | 9.36 |
| C | PLV 1-E Coal Air Out. P | IN. $H_2O$ | 9.75 | 10.93 | 11.51 | 11.80 | 10.57 | 10.29 | 10.66 | -1.35 | 9.85 |
| C | PLV 1-F Coal Air Out. P | IN. $H_2O$ | 9.07 | -1.40 | 10.90 | 10.60 | 0.11 | 8.52 | 0.09 | -1.54 | 8.98 |
| C | PLV 1-A Pri. Air In. Flow | 0-125% | 0 | 127 | 127 | 126 | 127 | 125 | 0 | 127 | 0 |
| C | PLV 1-B Pri. Air In. Flow | 0-125% | 31 | 129 | 129 | 42 | 128 | 128 | 129 | 129 | 32 |
| C | PLV 1-C Pri. Air In. Flow | 0-125% | 131 | 130 | 130 | 131 | 130 | 0 | 131 | 132 | 131 |
| C | PLV 1-D Pri. Air In. Flow | 0-125% | 126 | 125 | 49 | 125 | 0 | 125 | 125 | 126 | 126 |
| C | PLV 1-E Pri. Air In. Flow | 0-125% | 129 | 129 | 126 | 128 | 126 | 128 | 126 | 0 | 130 |
| C | PLV 1-F Pri. Air In. Flow | 0-125% | 124 | 0 | 126 | 126 | 0 | 125 | 0 | 0 | 124 |
| C | PLV 1-A Coal Air Disch. Temp. | °F | 84 | 143 | 146 | 145 | 144 | 144 | 88 | 143 | 79 |

* C - Computer Data; B - Board Data; NA - Not Available.

# BIASED FIRING OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 5/19 | 5/19 | 3/12 | 5/19 | 5/12 | 5/12 | 5/16 | 5/21 | 6/27 |
| | Time | | 16:15 | 13:50 | 07:15 | 11:00 | 11:00 | 09:20 | 09:30 | 03:10 | 09:40 |
| *C | Load | MW | 505 | 506 | 524 | 506 | 422 | 422 | 421 | 320 | 314 |
| | **PULVERIZER DATA** | | | | | | | | | | |
| C | PLV 1-B Coal Air Disch. Temp. | °F | 144 | 144 | 145 | 143 | 144 | 143 | 144 | 141 | 153 |
| C | PLV 1-C Coal Air Disch. Temp. | °F | 145 | 145 | 49 | 144 | 146 | 146 | 146 | 145 | *NA |
| C | PLV 1-D Coal Air Disch. Temp. | °F | 142 | 143 | 146 | 142 | 107 | 106 | 142 | 143 | 117 |
| C | PLV 1-E Coal Air Disch. Temp. | °F | 138 | 128 | 142 | 138 | 139 | 140 | 139 | 100 | 142 |
| C | PLV 1-F Coal Air Disch. Temp. | °F | 159 | 142 | 145 | 142 | 118 | 117 | 78 | 110 | 145 |
| C | PLV 1-A Feeder Coal Flow | $10^3$ LB/HR | 115 | 115 | 120 | 0 | 116 | 113 | 0 | 85 | 83 |
| C | PLV 1-B Feeder Coal Flow | $10^3$ LB/HR | 116 | 116 | 120 | 116 | 119 | 115 | 117 | 87 | 85 |
| C | PLV 1-C Feeder Coal Flow | $10^3$ LB/HR | 116 | 166 | 0 | 116 | 117 | 115 | 117 | 87 | NA |
| C | PLV 1-D Feeder Coal Flow | $10^3$ LB/HR | 116 | 116 | 118 | 116 | 0 | 0 | 117 | 88 | NA |
| C | PLV 1-E Feeder Coal Flow | $10^3$ LB/HR | 116 | 0 | 112 | 116 | 117 | 114 | 117 | 0 | 84 |
| C | PLV 1-F Feeder Coal Flow | $10^3$ LB/HR | 0 | 116 | 113 | 116 | 0 | 0 | 0 | 0 | 82 |
| C | PLV 1-A Mill | AMPS | 70 | 71 | 76 | 0 | 72 | 70 | 0 | 63 | 64 |
| C | PLV 1-B Mill | AMPS | 74 | 74 | 75 | 72 | 75 | 74 | 74 | 65 | 66 |
| C | PLV 1-C Mill | AMPS | 73 | 73 | 0 | 72 | 71 | 72 | 73 | 66 | NA |
| C | PLV 1-D Mill | AMPS | 75 | 75 | 78 | 75 | 0 | 0 | 75 | 65 | NA |
| C | PLV 1-E Mill | AMPS | 75 | 0 | 76 | 75 | 78 | 76 | 78 | 0 | 66 |
| C | PLV 1-F Mill | AMPS | 0 | 76 | 73 | 75 | 0 | 0 | 0 | 0 | 66 |
| | **FAN DAMPER POSITION - % OPEN** | | | | | | | | | | |
| *B | 1-A FD Fan Inlet Vane | | 78 | 75 | 71 | 74 | 70 | 67 | 71 | 53 | 59 |
| B | 1-B FD Fan Inlet Vane | | 77 | 74 | 70 | 72 | 68 | 65 | 70 | 51 | 62 |
| B | 1-A PA Fan Inlet Vane | | 36 | 36 | 30 | 35 | 30 | 29 | 31 | 32 | 28 |
| B | 1-B PA Fan Inlet Vane | | 31 | 31 | 25 | 30 | 24 | 23 | 25 | 26 | 28 |
| | **SPRAY VALVE POSITION - % OPEN** | | | | | | | | | | |
| B | 1-A SH Spray Valve | | 29 | 24 | 55 | 40 | 11 | 17 | 22 | 40 | 8 |
| B | 1-B SH Spray Valve | | 21 | 13 | 27 | 24 | 8 | 12 | 0 | 46 | 12 |
| B | 1-A RH Spray Valve | | 46 | 55 | 100 | 43 | 2 | 1 | 0 | 13 | 0 |
| B | 1-B RH Spray Valve | | 34 | 50 | 100 | 32 | 1 | 0 | 0 | 10 | 0 |
| | **MISCELLANEOUS** | | | | | | | | | | |
| B | Burner Tilt | ± DEGREES | 0° | -4° | -3° | -9° | -4° | +1° | +11° | +6° | +6° |
| B | Aux. Air Dampers | % OPEN | 39 | 29 | 66 | 31 | 21 | 17 | 25 | 0 | 0 |
| B | 1-A Fuel/Air Dampers | % OPEN | 100 | 100 | 54 | 100 | 100 | 100 | 100 | 78 | 77 |
| B | 1-B Fuel/Air Dampers | % OPEN | 100 | 100 | 55 | 100 | 100 | 100 | 100 | 81 | 77 |
| B | 1-C Fuel/Air Dampers | % OPEN | 100 | 100 | 100 | 100 | 100 | 37 | 100 | 86 | 100 |
| B | 1-D Fuel/Air Dampers | % OPEN | 100 | 100 | 55 | 100 | 0 | 100 | 100 | 81 | 100 |
| B | 1-E Fuel/Air Dampers | % OPEN | 100 | 100 | 50 | 100 | 100 | 100 | 100 | 100 | 75 |
| B | 1-F Fuel/Air Dampers | % OPEN | 100 | 100 | 44 | 100 | 100 | 0 | 0 | 100 | 75 |
| B | 1-A Pri. Air Fan | AMPS | 173 | 173 | 170 | 175 | 166 | 165 | 165 | 168 | 160 |
| B | 1-B Pri. Air Fan | AMPS | 183 | 184 | 180 | 185 | 173 | 173 | 175 | 175 | 195 |
| B | 1-A ID Fan | AMPS | 460 | 460 | 480 | 460 | 370 | 350 | 390 | 260 | 300 |
| B | 1-B ID Fan | AMPS | 410 | 390 | 400 | 390 | 330 | 300 | 320 | 300 | 280 |
| B | 1-A FD Fan | AMPS | 218 | 205 | 197 | 205 | 193 | 180 | 195 | 158 | 169 |
| B | 1-B FD Fan | AMPS | 198 | 180 | 183 | 183 | 180 | 161 | 181 | 145 | 150 |
| B | 1-A ID Fan | RPM | 485 | 480 | 480 | 477 | 418 | 390 | 435 | 298 | 330 |
| B | 1-B ID Fan | RPM | 495 | 488 | 480 | 488 | 423 | 397 | 438 | 305 | NA |
| B | 1-A Blr. Circ. Wtr. Pump | AMPS | 74 | 75 | 73 | 75 | 80 | 80 | 80 | 80 | 83 |
| B | 1-B Blr. Circ. Wtr. Pump | AMPS | 78 | 79 | 76 | 79 | 81 | 82 | 83 | 83 | 87 |
| B | 1-C Blr. Circ. Wtr. Pump | AMPS | 73 | 73 | 71 | 75 | 76 | 78 | 78 | 78 | NA |
| B | 1-D Blr. Circ. Wtr. Pump | AMPS | 74 | 76 | 74 | 78 | 80 | 81 | 80 | 81 | 84 |
| C | N Drum Level ± Norm. $H_2O$ Level | IN. | -0.73 | -0.42 | -0.64 | -0.80 | -0.48 | -0.82 | -0.76 | -0.79 | -0.69 |
| C | S Drum Level ± Norm. $H_2O$ Level | IN. | -3.26 | -0.27 | -2.38 | -1.40 | -1.45 | -2.23 | -2.43 | -2.56 | -2.57 |
| C | Flue Gas Combustibles | % | 0.063 | 0.067 | 0.062 | 0.066 | 0.062 | 0.065 | 0.062 | 0.060 | 0.055 |
| C | Flue Gas Oxygen | % | 3.3 | 2.6 | 3.5 | 3.4 | 3.9 | 3.6 | 4.1 | 4.0 | 5.1 |
| C | Baronmetric Press. | IN. HGA | 29.76 | 29.83 | 28.95 | 29.97 | 30.04 | 30.09 | 29.54 | 30.01 | 30.10 |

* C - Computer Data; B - Board Data; NA - Not Available.

# BIASED FIRING OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 5/23 | 5/19 | 5/10 | 3/16 | 5/12 | 3/13 | 5/16 | 5/21 | 5/23 |
| | Time | | 11:05 | 18:35 | 09:50 | 10:00 | 13:45 | 15:30 | 11:45 | 01:15 | 09:10 |
| *C | Load | MW | 324 | 491 | 497 | 522 | 422 | 400 | 422 | 320 | 323 |
| | **PULVERIZER DATA** | | | | | | | | | | |
| C | PLV 1-B Coal Air Disch. Temp. | °F | 130 | 143 | 152 | 83 | 144 | 146 | 144 | 144 | 152 |
| C | PLV 1-C Coal Air Disch. Temp. | °F | 144 | 145 | 150 | 149 | 147 | 45 | 146 | 145 | 143 |
| C | PLV 1-D Coal Air Disch. Temp. | °F | 141 | 143 | 91 | 147 | 110 | 147 | 143 | 143 | 138 |
| C | PLV 1-E Coal Air Disch. Temp. | °F | 138 | 138 | 152 | 143 | 139 | 142 | 139 | 111 | 138 |
| C | PLV 1-F Coal Air Disch. Temp. | °F | 142 | 141 | 162 | 146 | 121 | 145 | 78 | 118 | 141 |
| C | PLV 1-A Feeder Coal Flow | $10^3$ LB/HR | *NA | 106 | 114 | 116 | 117 | 86 | 0 | 85 | 0 |
| C | PLV 1-B Feeder Coal Flow | $10^3$ LB/HR | NA | 108 | 116 | 0 | 118 | 87 | 117 | 87 | 0 |
| C | PLV 1-C Feeder Coal Flow | $10^3$ LB/HR | 87 | 107 | 114 | 114 | 118 | 0 | 117 | 86 | 88 |
| C | PLV 1-D Feeder Coal Flow | $10^3$ LB/HR | 88 | 108 | 0 | 116 | 0 | 86 | 118 | 87 | 89 |
| C | PLV 1-E Feeder Coal Flow | $10^3$ LB/HR | 88 | 107 | 114 | 116 | 117 | 87 | 118 | 0 | 89 |
| C | PLV 1-F Feeder Coal Flow | $10^3$ LB/HR | 86 | 0 | 112 | 115 | 0 | 85 | 0 | 0 | 70 |
| C | PLV 1-A Mill | AMPS | 0 | 68 | 73 | 72 | 71 | 65 | 0 | 63 | 0 |
| C | PLV 1-B Mill | AMPS | 0 | 72 | 73 | 0 | 75 | 65 | 75 | 67 | 0 |
| C | PLV 1-C Mill | AMPS | 67 | 72 | 73 | 74 | 73 | 0 | 74 | 66 | 66 |
| C | PLV 1-D Mill | AMPS | 65 | 74 | 0 | 75 | 0 | 67 | 75 | 66 | 66 |
| C | PLV 1-E Mill | AMPS | 67 | 75 | 75 | 75 | 78 | 67 | 77 | 0 | 66 |
| C | PLV 1-F Mill | AMPS | 66 | 0 | 70 | 75 | 0 | 67 | 0 | 0 | 65 |
| | **FAN DAMPER POSITION - % OPEN** | | | | | | | | | | |
| *B | 1-A FD Fan Inlet Vane | | 57 | 79 | 77 | 70 | 74 | 64 | 75 | 60 | 61 |
| B | 1-B FD Fan Inlet Vane | | 56 | 77 | 76 | 70 | 73 | 63 | 74 | 59 | 60 |
| B | 1-A PA Fan Inlet Vane | | 31 | 36 | 37 | 28 | 30 | 29 | 31 | 32 | 31 |
| B | 1-B PA Fan Inlet Vane | | 25 | 31 | 32 | 24 | 25 | 24 | 26 | 26 | 25 |
| | **SPRAY VALVE POSITION - % OPEN** | | | | | | | | | | |
| B | 1-A SH Spray Valve | | 14 | 50 | 68 | 65 | 15 | 23 | 23 | 39 | 15 |
| B | 1-B SH Spray Valve | | 8 | 33 | 57 | 28 | 3 | 6 | 4 | 47 | 12 |
| B | 1-A RH Spray Valve | | 0 | 48 | 81 | 61 | 4 | 0 | 0 | 15 | 0 |
| B | 1-B RH Spray Valve | | 0 | 34 | 58 | 62 | 3 | 0 | 0 | 10 | 0 |
| | **MISCELLANEOUS** | | | | | | | | | | |
| B | Burner Tilt | ± DEGREES | +5° | +2° | -4° | -3° | -3° | +1° | +6° | +9° | +6° |
| B | Aux. Air Dampers | % OPEN | 0 | 40 | 34 | 81 | 30 | 50 | 39 | 0 | 0 |
| B | 1-A Fuel/Air Dampers | % OPEN | 0 | 100 | 100 | 51 | 100 | 32 | 100 | 76 | 0 |
| B | 1-B Fuel/Air Dampers | % OPEN | 0 | 100 | 100 | 100 | 100 | 33 | 100 | 81 | 0 |
| B | 1-C Fuel/Air Dampers | % OPEN | 87 | 100 | 100 | 51 | 100 | 100 | 100 | 84 | 89 |
| B | 1-D Fuel/Air Dampers | % OPEN | 83 | 100 | 100 | 54 | 0 | 34 | 100 | 80 | 84 |
| B | 1-E Fuel/Air Dampers | % OPEN | 81 | 100 | 100 | 52 | 100 | 33 | 100 | 0 | 82 |
| B | 1-F Fuel/Air Dampers | % OPEN | 78 | 100 | 100 | 51 | 100 | 33 | 0 | 0 | 79 |
| B | 1-A Pri. Air Fan | AMPS | 169 | 173 | 175 | 171 | 165 | 175 | 166 | 165 | 168 |
| B | 1-B Pri. Air Fan | AMPS | 179 | 183 | 185 | 185 | 170 | 182 | 175 | 175 | 178 |
| B | 1-A ID Fan | AMPS | 280 | 500 | 490 | 500 | 410 | 390 | 443 | 300 | 300 |
| B | 1-B ID Fan | AMPS | 310 | 420 | 420 | 430 | 340 | 320 | 367 | 310 | 310 |
| B | 1-A FD Fan | AMPS | 166 | 225 | 213 | 204 | 203 | 187 | 210 | 171 | 175 |
| B | 1-B FD Fan | AMPS | 155 | 198 | 196 | 197 | 187 | 175 | 195 | 158 | 165 |
| B | 1-A ID Fan | RPM | 320 | 488 | 482 | 480 | 445 | 430 | 463 | 345 | 338 |
| B | 1-B ID Fan | RPM | 323 | 496 | 500 | 490 | 457 | 430 | 478 | 340 | 345 |
| B | 1-A Blr. Circ. Wtr. Pump | AMPS | 83 | 73 | 73 | 75 | 79 | 80 | 79 | 79 | 81 |
| B | 1-B Blr. Circ. Wtr. Pump | AMPS | 84 | 77 | 77 | 76 | 80 | 82 | 81 | 82 | 84 |
| B | 1-C Blr. Circ. Wtr. Pump | AMPS | 79 | 73 | 72 | 71 | 75 | 78 | 75 | 77 | 78 |
| B | 1-D Blr. Circ. Wtr. Pump | AMPS | 84 | 74 | 73 | 75 | 79 | 79 | 77 | 80 | 83 |
| C | N Drum Level ± Norm. $H_2O$ Level | IN. | -0.51 | -0.76 | -0.75 | -0.68 | -0.54 | -0.61 | -0.47 | -0.53 | -0.62 |
| C | S Drum Level ± Norm. $H_2O$ Level | IN. | -2.36 | -3.22 | -3.12 | -2.88 | -1.33 | -1.48 | -3.26 | -2.51 | -2.22 |
| C | Flue Gas Combustibles | % | 0.064 | 0.064 | 0.061 | 0.062 | 0.062 | 0.065 | 0.062 | 0.059 | 0.065 |
| C | Flue Gas Oxygen | % | 4.4 | 3.5 | 3.8 | 4.3 | 4.9 | 5.5 | 5.1 | 5.8 | 6.0 |
| C | Baronmetric Press. | IN. HGA | 30.10 | 29.73 | 29.66 | 29.82 | 29.91 | 29.99 | 29.55 | 29.92 | 30.14 |

* C - Computer Data; B - Board Data; NA - Not Available.

# OVERFIRE AIR OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 3/17 | 3/17 | 3/20 | 3/20 | 3/22 | 3/20 | 3/20 | 3/20 |
| | Time | | 09:30 | 10:45 | 16:50 | 19:45 | 17:00 | 10:05 | 12:00 | 14:30 |
| *C | Load | MW | 517 | 512 | 524 | 525 | 526 | 521 | 522 | 522 |
| | **FLOWS - $10^3$LB/HR** | | | | | | | | | |
| C | Feedwater | | 3083 | 3084 | 3367 | 3331 | 3233 | 3480 | 3372 | 3388 |
| C | Superheat Spray L | | 101 | 102 | 14 | 56 | 95 | 0 | 0 | 0 |
| C | Superheat Spray R | | 109 | 105 | 43 | 42 | 94 | 12 | 25 | 31 |
| C | Reheat Spray L | | 78 | 78 | 42 | 48 | 50 | 10 | 35 | 39 |
| C | Reheat Spray R | | 82 | 82 | 66 | 70 | 72 | 15 | 59 | 63 |
| C | BFP Turb. Extr. Stm. Flow 1-A | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | BFP Turb. Extr. Stm. Flow 1-B | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | BFP Turb. Mn. Stm. Flow Combined | | 7.6 | 7.5 | 8.2 | 8.2 | 8.0 | 8.5 | 8.4 | 8.2 |
| C | Hot Air to Burners L Windbox | | 1608 | 1604 | 1609 | 1564 | 1582 | 1486 | 1480 | 1486 |
| C | Hot Air to Burners R Windbox | | 1557 | 1556 | 1576 | 1535 | 1539 | 1474 | 1472 | 1470 |
| | **PRESSURES** | | | | | | | | | |
| | Steam & Water - PSIG | | | | | | | | | |
| C | Feedwater to Econ. | | 2723 | 2722 | 2750 | 2750 | 2741 | 2766 | 2754 | 2756 |
| C | Boiler Drum | | 2673 | 2672 | 2689 | 2689 | 2687 | 2699 | 2692 | 2692 |
| C | Turbine Throttle | | 2400 | 2402 | 2397 | 2399 | 2398 | 2401 | 2403 | 2399 |
| C | Turbine 1st Stage | | 1624 | 1616 | 1677 | 1682 | 1680 | 1689 | 1680 | 1682 |
| C | HP Htr. 1-G1 & 1-G2 Steam In. | | 529 | 527 | 537 | 540 | 541 | 528 | 536 | 536 |
| | Air & Gas - IN $H_2O$ | | | | | | | | | |
| C | FD Fan 1-A Discharge | | 5.56 | 5.54 | 6.04 | 5.77 | 5.38 | 5.20 | 5.42 | 5.32 |
| C | FD Fan 1-B Discharge | | 9.16 | 9.13 | 10.20 | 9.63 | 8.91 | 8.54 | 8.84 | 8.69 |
| C | Air Htr. 1-A Air In. | | 7.75 | 7.77 | 8.41 | 8.10 | 7.50 | 7.07 | 7.23 | 7.21 |
| C | Air Htr. 1-B Air In. | | 7.19 | 7.18 | 7.82 | 7.62 | 6.93 | 6.56 | 6.63 | 6.57 |
| C | Air Htr. 1-A Air Out. | | 3.60 | 3.64 | 4.00 | 3.80 | 3.39 | 3.36 | 3.43 | 3.38 |
| C | Air Htr. 1-B Air Out. | | 3.38 | 3.46 | 3.92 | 3.73 | 3.40 | 3.37 | 3.34 | 3.36 |
| C | Furn. Right Windbox | | 2.22 | 2.25 | 2.42 | 2.47 | 2.27 | 2.10 | 2.12 | 2.16 |
| C | Furn. Left Windbox | | 2.20 | 2.25 | 2.52 | 2.50 | 2.25 | 2.14 | 2.12 | 2.21 |
| C | Rt. WDBX to Furn. Diff. P | | 3.39 | 3.43 | 3.16 | 3.18 | 3.23 | 3.18 | 3.13 | 3.18 |
| C | Left WDBX to Furn. Diff. P | | 3.96 | 4.02 | 3.92 | 3.99 | 3.87 | 4.01 | 3.90 | 3.96 |
| C | Furnace | | -0.53 | -0.49 | -0.18 | -0.27 | -0.48 | -0.39 | -0.56 | -0.60 |
| C | Pri. SH Gas Out. | | -0.63 | -0.70 | -0.50 | -0.57 | -0.72 | -0.70 | -0.65 | -0.81 |
| C | Reheater Gas Out. | | -0.56 | -0.63 | -0.31 | -0.47 | -0.64 | -0.42 | -0.58 | -0.61 |
| C | Econ. Gas In. | | -2.48 | -2.49 | -2.04 | -2.32 | -2.45 | -2.02 | -2.20 | -2.24 |
| C | Econ. Gas Out. | | -6.45 | -6.46 | -5.84 | -5.94 | -6.11 | -5.38 | -5.64 | -5.58 |
| C | Air Htr. 1-A Gas In. | | -8.93 | -8.92 | -7.96 | -8.13 | -8.72 | -7.67 | -7.68 | -7.64 |
| C | Air Htr. 1-B Gas In. | | -8.60 | -8.60 | -7.74 | -7.94 | -8.19 | -7.08 | -7.38 | -7.42 |
| C | Air Htr. 1-A Gas Out. | | -15.5 | -15.6 | -14.6 | -14.6 | -15.4 | -13.0 | -13.6 | -13.6 |
| C | Air Htr. 1-B Gas Out. | | -14.1 | -14.0 | -13.1 | -13.3 | -13.9 | -11.9 | -12.2 | -12.4 |
| C | IDF 1-A Discharge | | -0.58 | -0.58 | -0.04 | -0.23 | -0.44 | -0.09 | -0.10 | -0.11 |
| C | IDF 1-B Discharge | | -0.62 | -0.63 | -0.04 | -0.20 | -0.39 | 0.11 | -0.08 | -0.07 |
| C | PAF 1-A Discharge Hdr. | | 32.95 | 32.93 | 33.42 | 33.24 | 33.00 | 33.48 | 33.53 | 33.44 |
| C | PAF 1-B Discharge Hdr. | | 32.74 | 32.80 | 33.40 | 33.18 | 32.87 | 33.32 | 33.42 | 33.44 |
| *B | Pri. Hot Air Duct | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | **TEMPERATURES** | | | | | | | | | |
| | Air & Gas - °F | | | | | | | | | |
| C | 1-A FD Fan Discharge | | 44 | 45 | 72 | 67 | 59 | 77 | 75 | 77 |
| C | 1-B FD Fan Discharge | | 52 | 53 | 81 | 76 | 67 | 83 | 82 | 85 |
| C | 1-A AH Air In. | | 75 | 75 | 86 | 82 | 79 | 93 | 90 | 93 |
| C | 1-B AH Air In. | | 78 | 78 | 88 | 84 | 82 | 96 | 93 | 94 |
| C | 1-A AH Air Out. | | 712 | 714 | 696 | 707 | 691 | 653 | 673 | 681 |
| C | 1-B AH Air Out. | | 734 | 736 | 721 | 739 | 720 | 673 | 696 | 705 |
| C | 1-A AH Gas In. | | 778 | 780 | 758 | 769 | 757 | 709 | 730 | 738 |
| C | 1-B AH Gas In. | | 783 | 785 | 768 | 785 | 762 | 714 | 738 | 746 |
| C | 1-A AH Gas Out. | | 274 | 274 | 281 | 282 | 272 | 266 | 274 | 279 |
| C | 1-B AH Gas Out. | | 275 | 275 | 280 | 286 | 275 | 269 | 272 | 278 |

* C - Computer Data; B - Board Data; NA - Not Available.

# OVERFIRE AIR OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 3/24 | 3/24 | 3/24 | 6/24 | 6/24 | 6/24 | 3/25 | 6/30 |
| | Time | | 00:45 | 02:20 | 04:00 | 12:00 | 13:20 | 09:45 | 10:15 | 09:50 |
| *C | Load | MW | 473 | 473 | 472 | 524 | 525 | 523 | 510 | 526 |
| | **FLOWS - $10^3$LB/HR** | | | | | | | | | |
| C | Feedwater | | 2912 | 2834 | 2800 | 3297 | 3289 | 3327 | 3079 | 3255 |
| C | Superheat Spray L | | 56 | 59 | 84 | 70 | 82 | 70 | 97 | 85 |
| C | Superheat Spray R | | 79 | 78 | 91 | 79 | 94 | 78 | 98 | 95 |
| C | Reheat Spray L | | 45 | 46 | 57 | 28 | 50 | 10 | 67 | 33 |
| C | Reheat Spray R | | 61 | 62 | 70 | 63 | 77 | 50 | 76 | 60 |
| C | BFP Turb. Extr. Stm. Flow 1-A | | 0 | 0 | 0 | 43 | 43 | 43 | 0 | 43 |
| C | BFP Turb. Extr. Stm. Flow 1-B | | 0 | 0 | 0 | 77 | 76 | 76 | 0 | 89 |
| C | BFP Turb. Mn. Stm. Flow Combined | | 6.8 | 6.4 | 6.1 | 8.1 | 8.0 | 8.1 | 7.6 | 8.0 |
| C | Hot Air to Burners L Windbox | | 1668 | 1658 | 1543 | 1767 | 1774 | 1785 | 1477 | 1739 |
| C | Hot Air to Burners R Windbox | | 1614 | 1613 | 1510 | 1663 | 1668 | 1683 | 1454 | 1637 |
| | **PRESSURES** | | | | | | | | | |
| | Steam & Water - PSIG | | | | | | | | | |
| C | Feedwater to Econ. | | 2691 | 2684 | 2675 | 2746 | 2745 | 2744 | 2720 | 2751 |
| C | Boiler Drum | | 2644 | 2637 | 2631 | 2691 | 2691 | 2686 | 2670 | 2698 |
| C | Turbine Throttle | | 2405 | 2401 | 2400 | 2401 | 2402 | 2402 | 2394 | 2405 |
| C | Turbine 1st Stage | | 1496 | 1465 | 1456 | 1680 | 1679 | 1679 | 1614 | 1687 |
| C | HP Htr. 1-G1 & 1-G2 Steam In. | | 485 | 478 | 480 | 538 | 538 | 531 | 522 | 535 |
| | Air & Gas - IN $H_2O$ | | | | | | | | | |
| C | FD Fan 1-A Discharge | | 6.24 | 6.08 | 5.58 | 14.98 | 15.15 | 15.12 | 5.37 | 14.75 |
| C | FD Fan 1-B Discharge | | 11.72 | 10.30 | 9.30 | 13.58 | 13.55 | 13.71 | 8.52 | 13.35 |
| C | Air Htr. 1-A Air In. | | 8.94 | 8.54 | 7.70 | 11.51 | 11.59 | 11.63 | 7.53 | 11.45 |
| C | Air Htr. 1-B Air In. | | 8.41 | 7.93 | 7.11 | 10.42 | 10.54 | 10.56 | 6.72 | 10.34 |
| C | Air Htr. 1-A Air Out. | | 4.44 | 4.11 | 3.57 | 7.05 | 7.01 | 7.03 | 3.59 | 7.13 |
| C | Air Htr. 1-B Air Out. | | 4.53 | 4.13 | 3.61 | 7.05 | 7.00 | 6.98 | 3.58 | 7.01 |
| C | Furn. Right Windbox | | 3.14 | 2.68 | 2.39 | 5.41 | 5.33 | 5.37 | 2.39 | 5.38 |
| C | Furn. Left Windbox | | 3.06 | 2.57 | 2.39 | 5.40 | 5.29 | 5.31 | 2.43 | 5.38 |
| C | Rt. WDBX to Furn. Diff. P | | 3.67 | 3.16 | 3.20 | 5.47 | 5.43 | 5.45 | 3.14 | 5.46 |
| C | Left WDBX to Furn. Diff. P | | 4.24 | 3.92 | 4.00 | 6.13 | 6.13 | 6.09 | 3.94 | 6.13 |
| C | Furnace | | -0.14 | -0.23 | -0.44 | -0.53 | -0.61 | -0.43 | -0.45 | -0.43 |
| C | Pri. SH Gas Out. | | -0.38 | -0.27 | -0.76 | -0.68 | -0.71 | -0.65 | -0.67 | -0.64 |
| C | Reheater Gas Out. | | -0.25 | -0.16 | -0.59 | -1.18 | -1.25 | -1.11 | -0.54 | -1.08 |
| C | Econ. Gas In. | | -1.99 | -2.00 | -2.36 | -2.23 | -2.36 | -2.31 | -2.27 | -2.23 |
| C | Econ. Gas Out. | | -6.00 | -5.90 | -5.76 | -6.52 | -6.64 | -6.51 | -5.76 | -6.21 |
| C | Air Htr. 1-A Gas In. | | -8.30 | -8.39 | -7.88 | -8.55 | -8.82 | -8.86 | -7.72 | -8.48 |
| C | Air Htr. 1-B Gas In. | | -7.70 | -7.82 | -7.26 | -8.39 | -8.68 | -8.71 | -7.39 | -8.47 |
| C | Air Htr. 1-A Gas Out. | | -14.8 | -14.8 | -14.0 | -15.2 | -15.5 | -15.5 | -14.0 | -14.6 |
| C | Air Htr. 1-B Gas Out. | | -13.2 | -13.4 | -12.6 | -14.2 | -14.7 | -14.6 | -12.7 | -13.9 |
| C | IDF 1-A Discharge | | -0.16 | -0.28 | -0.36 | 0.29 | 0.21 | 0.26 | -0.35 | 0.07 |
| C | IDF 1-B Discharge | | 0.05 | -0.12 | -0.21 | 0.36 | 0.28 | 0.32 | -0.29 | 0.04 |
| C | PAF 1-A Disch. Hdr. | | 32.92 | 33.00 | 32.86 | 32.61 | 32.60 | 32.50 | 33.22 | 32.82 |
| C | PAF 1-B Disch. Hdr. | | 32.92 | 32.86 | 32.77 | 33.95 | 33.88 | 33.75 | 33.09 | 33.49 |
| *B | Pri. Hot Air Duct | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | **TEMPERATURES** | | | | | | | | | |
| | Air & Gas - °F | | | | | | | | | |
| C | 1-A FD Fan Disch. | | 66 | 62 | 60 | 78 | 80 | 75 | 59 | 75 |
| C | 1-B FD Fan Disch. | | 75 | 71 | 70 | 87 | 90 | 83 | 70 | 79 |
| C | 1-A AH Air In. | | 80 | 77 | 76 | 91 | 92 | 87 | 79 | 86 |
| C | 1-B AH Air In. | | 83 | 80 | 79 | 92 | 94 | 88 | 82 | 87 |
| C | 1-A AH Air Out. | | 693 | 698 | 701 | 665 | 670 | 658 | 695 | 663 |
| C | 1-B AH Air Out. | | 716 | 720 | 725 | 692 | 702 | 681 | 722 | 677 |
| C | 1-A AH Gas In. | | 758 | 764 | 764 | 720 | 725 | 714 | 758 | 722 |
| C | 1-B AH Gas In. | | 760 | 767 | 768 | 736 | 744 | 723 | 764 | 725 |
| C | 1-A AH Gas Out. | | 272 | 273 | 273 | 265 | 270 | 260 | 272 | 260 |
| C | 1-B AH Gas Out. | | 272 | 270 | 274 | 271 | 275 | 265 | 283 | 264 |

* C - Computer Data; B - Board Data; NA - Not Available.

# OVERFIRE AIR OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1976 | 6/25 | 6/30 | 6/29 | 6/25 | 6/26 | 6/25 | 6/27 | 6/29 |
| | TIME | | 11:15 | 08:35 | 08:50 | 14:45 | 10:30 | 16:25 | 11:35 | 01:30 |
| *C | LOAD | MW | 524 | 526 | 523 | 517 | 419 | 422 | 316 | 322 |
| | FLOWS - $10^3$LB/HR | | | | | | | | | |
| C | FEEDWATER | | 3262 | 3284 | 3262 | 3203 | 2651 | 2517 | 2062 | 1891 |
| C | SUPERHEAT SPRAY L | | 138 | 80 | 88 | 101 | 35 | 77 | 0 | 56 |
| C | SUPERHEAT SPRAY R | | 103 | 100 | 89 | 100 | 34 | 80 | 2 | 61 |
| C | REHEAT SPRAY L | | 40 | 23 | 40 | 53 | 0 | 0 | 0 | 0 |
| C | REHEAT SPRAY R | | 68 | 53 | 58 | 78 | 2 | 37 | 3 | 3 |
| C | BFP TURB. EXTR. STM. FLOW 1-A | | 43 | 43 | 43 | 42 | 43 | 39 | 34 | 39 |
| C | BFP TURB. EXTR. STM. FLOW 1-B | | 76 | 89 | 89 | 74 | 81 | 72 | 89 | 89 |
| C | BFP TURB. MN. STM. FLOW COMBINED | | 8.3 | 8.1 | 8.3 | 7.8 | 8.6 | 6.3 | 0.0 | 7.1 |
| C | HOT AIR TO BURNERS L WINDBOX | | 1793 | 1777 | 1611 | 1704 | 1453 | 1346 | 1006 | 1022 |
| C | HOT AIR TO BURNERS R WINDBOX | | 1674 | 1649 | 1529 | 1607 | 1365 | 1241 | 944 | 952 |
| | PRESSURES | | | | | | | | | |
| | STEAM & WATER - PSIG | | | | | | | | | |
| C | FEEDWATER TO ECON. | | 2739 | 2751 | 2751 | 2745 | 2652 | 2638 | 2571 | 2559 |
| C | BOILER DRUM | | 2688 | 2699 | 2696 | 2694 | 2607 | 2598 | 2533 | 2527 |
| C | TURBINE THROTTLE | | 2411 | 2406 | 2403 | 2416 | 2405 | 2404 | 2408 | 2405 |
| C | TURBINE 1ST STAGE | | 1671 | 1697 | 1685 | 1644 | 1305 | 1291 | 984 | 975 |
| C | HP HTR. 1-G1 & 1-G2 STEAM IN. | | 534 | 535 | 535 | 499 | 411 | 416 | 306 | 309 |
| | AIR & GAS - IN $H_2O$ | | | | | | | | | |
| C | FD FAN 1-A DISCHARGE | | 15.24 | 14.86 | 14.19 | 14.69 | 12.78 | 10.97 | 6.36 | 6.51 |
| C | FD FAN 1-B DISCHARGE | | 13.82 | 13.27 | 12.57 | 13.36 | 11.02 | 9.26 | 4.99 | 5.26 |
| C | AIR HTR. 1-A AIR IN. | | 11.76 | 11.26 | 11.02 | 11.30 | 9.78 | 8.35 | 4.66 | 4.80 |
| C | AIR HTR. 1-B AIR IN. | | 10.71 | 10.39 | 9.89 | 10.09 | 8.71 | 7.23 | 3.95 | 4.09 |
| C | AIR HTR. 1-A AIR OUT. | | 7.09 | 7.12 | 6.91 | 6.90 | 6.34 | 5.28 | 2.86 | 2.27 |
| C | AIR HTR. 1-B AIR OUT. | | 6.95 | 6.91 | 6.76 | 6.82 | 6.42 | 5.32 | 2.76 | 2.87 |
| C | FURN. RIGHT WINDBOX | | 5.41 | 5.33 | 5.30 | 5.36 | 5.41 | 4.28 | 2.33 | 2.42 |
| C | FURN. LEFT WINDBOX | | 5.40 | 5.35 | 5.36 | 5.29 | 5.39 | 4.00 | 2.26 | 2.42 |
| C | RT. WDBX TO FURN. DIFF. P | | 5.46 | 5.41 | 5.43 | 5.45 | 5.44 | 4.03 | 1.35 | 1.56 |
| C | LEFT WDBX TO FURN. DIFF. P | | 6.44 | 6.02 | 6.07 | 6.17 | 6.15 | 5.12 | 3.00 | 3.10 |
| C | FURNACE | | -0.52 | -0.47 | -0.54 | -0.54 | -0.52 | -0.53 | -0.51 | -0.54 |
| C | PRI. SH GAS OUT. | | -0.74 | -0.60 | -0.67 | -0.92 | -0.70 | -0.77 | -0.71 | -0.64 |
| C | REHEATER GAS OUT. | | -1.24 | -1.03 | -1.12 | -1.38 | -1.03 | -1.13 | -0.90 | -0.85 |
| C | ECON. GAS IN. | | -2.43 | -2.21 | -2.24 | -2.33 | -1.70 | -1.80 | -1.26 | -1.32 |
| C | ECON. GAS OUT. | | -6.68 | -6.18 | -5.83 | -6.32 | -4.43 | -4.44 | -2.71 | -2.77 |
| C | AIR HTR. 1-A GAS IN. | | -8.79 | -8.50 | -7.78 | -8.52 | -6.28 | -6.09 | -3.81 | -3.87 |
| C | AIR HTR. 1-B GAS IN. | | -8.83 | -8.51 | -7.83 | -8.50 | -6.14 | -6.26 | -3.99 | -4.02 |
| C | AIR HTR. 1-A GAS OUT. | | -15.6 | -14.7 | -13.8 | -14.8 | -10.6 | -10.7 | -6.29 | -6.53 |
| C | AIR HTR. 1-B GAS OUT. | | -14.6 | -14.2 | -13.2 | -14.2 | -9.9 | -10.2 | -6.19 | -6.46 |
| C | IDF 1-A DISCHARGE | | 0.18 | 0.11 | -0.01 | 0.09 | -0.26 | -0.23 | -0.32 | -0.50 |
| C | IDF 1-B DISCHARGE | | 0.11 | 0.06 | 0.06 | 0.13 | 0.04 | -0.16 | -0.32 | -0.49 |
| C | PAF 1-A DISCH. HDR. | | 32.63 | 32.79 | 32.77 | 32.74 | 31.73 | 32.50 | 31.75 | 31.84 |
| C | PAF 1-B DISCH. HDR. | | 33.78 | 33.77 | 34.16 | 33.89 | 32.61 | 33.76 | 32.64 | 32.98 |
| *B | PRI. HOT AIR DUCT | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | TEMPERATURES | | | | | | | | | |
| | AIR & GAS - °F | | | | | | | | | |
| C | 1-A FD FAN DISCH. | | 81 | 74 | 73 | 87 | 88 | 89 | 89 | 83 |
| C | 1-B FD FAN DISCH. | | 86 | 78 | 81 | 91 | 93 | 95 | 94 | 90 |
| C | 1-A AH AIR IN. | | 93 | 84 | 85 | 99 | 100 | 102 | 102 | 96 |
| C | 1-B AH AIR IN. | | 93 | 85 | 87 | 101 | 103 | 104 | 104 | 97 |
| C | 1-A AH AIR OUT. | | 667 | 651 | 665 | 680 | 606 | 634 | 535 | 568 |
| C | 1-B AH AIR OUT. | | 695 | 657 | 690 | 708 | 627 | 661 | 555 | 592 |
| C | 1-A AH GAS IN. | | 724 | 711 | 725 | 734 | 654 | 687 | 580 | 614 |
| C | 1-B AH GAS IN. | | 737 | 712 | 732 | 750 | 663 | 702 | 584 | 629 |
| C | 1-A AH GAS OUT. | | 270 | 255 | 259 | 277 | 244 | 259 | 222 | 226 |
| C | 1-B AH GAS OUT. | | 273 | 255 | 270 | 282 | 262 | 275 | 233 | 241 |

* C - COMPUTER DATA; B - BOARD DATA; NA - NOT AVAILABLE.

# OVERFIRE AIR OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 3/17 | 3/17 | 3/20 | 3/20 | 3/22 | 3/20 | 3/20 | 3/20 |
| | Time | | 09:30 | 10:45 | 16:50 | 19:45 | 17:00 | 10:05 | 12:00 | 14:30 |
| *C | Load | MW | 517 | 512 | 524 | 525 | 526 | 521 | 522 | 522 |
| | TEMPERATURES | | | | | | | | | |
| | Air & Gas - °F | | | | | | | | | |
| C | Econ. N Gas Out. | | 810 | 812 | 800 | 817 | 796 | 748 | 774 | 777 |
| C | Econ. S Gas Out. | | 813 | 815 | 790 | 790 | 796 | 749 | 766 | 770 |
| C | 1-A PA Fan Disch. Hdr. | | 56 | 57 | 84 | 79 | 70 | 88 | 88 | 90 |
| C | 1-B PA Fan Disch. Hdr. | | 72 | 72 | 95 | 90 | 85 | 108 | 98 | 102 |
| C | 1-A AH Pri. Air Out. | | 725 | 727 | 707 | 717 | 704 | 661 | 682 | 690 |
| C | 1-B AH Pri. Air Out. | | 717 | 718 | 702 | 720 | 696 | 656 | 677 | 686 |
| | Steam & Water - °F | | | | | | | | | |
| C | Boiler Econ. In. | | 477 | 477 | 478 | 480 | 480 | 476 | 478 | 478 |
| C | Downcomer 1 | | 676 | 676 | 678 | 678 | 678 | 679 | 679 | 679 |
| C | Downcomer 2 | | 679 | 678 | 680 | 680 | 679 | 681 | 680 | 680 |
| C | Downcomer 3 | | 679 | 679 | 680 | 680 | 680 | 681 | 681 | 680 |
| C | Downcomer 4 | | 682 | 682 | 684 | 684 | 684 | 685 | 684 | 683 |
| C | Downcomer 5 | | 680 | 680 | 681 | 681 | 681 | 683 | 682 | 682 |
| C | Blr. SH ATMP 1-A Stm. In. | | 845 | 845 | 811 | 819 | 838 | 796 | 810 | 809 |
| C | Blr. SH ATMP 1-B Stm. In. | | 847 | 849 | 830 | 843 | 846 | 808 | 823 | 820 |
| C | Blr. S SH Hdr. Out. | | *NA | NA | NA | NA | NA | NA | NA | 1009 |
| C | Blr. N SH Hdr. Out. | | NA | NA | NA | NA | NA | NA | NA | 1018 |
| C | Turbine Throttle | | 1003 | 1004 | 1005 | 1006 | 1005 | 996 | 1006 | 1008 |
| C | Blr. S RH ATMP Stm. Out. A | | 478 | 478 | 482 | 482 | 482 | 602 | 483 | 482 |
| C | Blr. N RH ATMP Stm. Out. B | | 480 | 480 | 482 | 481 | 482 | 521 | 482 | 482 |
| C | Blr. S RH Hdr. Out. A | | 991 | 992 | 991 | 991 | 997 | 989 | 988 | 993 |
| C | Blr. N RH Hdr. Out. B | | 1019 | 1022 | 1017 | 1020 | 1025 | 1026 | 1022 | 1023 |
| C | HP Htr. 1-G1 & 1-G2 Extr. Stm. | | 623 | 622 | 624 | 625 | 626 | 613 | 623 | 626 |
| C | HP Htr. 1-F1 FW Out. | | 411 | 411 | 412 | 412 | 413 | 410 | 412 | 411 |
| C | HP Htr. 1-F2 FW Out. | | 411 | 410 | 412 | 412 | 413 | 410 | 411 | 411 |
| C | HP Htr. 1-G1 FW Out. | | 478 | 477 | 480 | 480 | 481 | 477 | 479 | 479 |
| C | HP Htr. 1-G2 FW Out. | | 478 | 477 | 479 | 480 | 481 | 477 | 479 | 479 |
| C | HP Htr. 1-G1 Drain | | 414 | 413 | 416 | 416 | 417 | 414 | 416 | 416 |
| C | HP Htr. 1-G2 Drain | | 382 | 380 | 384 | 382 | 382 | 380 | 384 | 384 |
| | PULVERIZER DATA | | | | | | | | | |
| C | PLV 1-A Bowl Lower P | In. $H_2O$ | 21.4 | 21.2 | 21.6 | 21.6 | 21.0 | 21.1 | 21.2 | 21.2 |
| C | PLV 1-B Bowl Lower P | In. $H_2O$ | -0.03 | -0.03 | 0.03 | 0.02 | 0.02 | 0.04 | 0.04 | 0.04 |
| C | PLV 1-C Bowl Lower P | In. $H_2O$ | 24.4 | 24.1 | 23.0 | 23.1 | 24.6 | 22.1 | 22.2 | 22.1 |
| C | PLV 1-D Bowl Lower P | In. $H_2O$ | 23.3 | 23.5 | 23.9 | 23.0 | 23.2 | 23.1 | 23.1 | 23.1 |
| C | PLV 1-E Bowl Lower P | In. $H_2O$ | 22.5 | 22.5 | 22.4 | 22.7 | 22.0 | 21.8 | 22.0 | 21.9 |
| C | PLV 1-F Bowl Lower P | In. $H_2O$ | 21.0 | 20.8 | 21.2 | 21.2 | 22.2 | 20.9 | 20.7 | 20.4 |
| C | PLV 1-A Bowl Diff. P | In. $H_2O$ | 7.50 | 7.37 | 7.29 | 7.44 | 7.35 | 7.24 | 7.24 | 7.31 |
| C | PLV 1-B Bowl Diff. P | In. $H_2O$ | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| C | PLV 1-C Bowl Diff. P | In. $H_2O$ | 8.40 | 8.35 | 7.89 | 8.06 | 8.59 | 7.74 | 7.86 | 7.75 |
| C | PLV 1-D Bowl Diff. P | In. $H_2O$ | 7.98 | 8.03 | 8.05 | 8.19 | 8.06 | 7.79 | 7.90 | 7.93 |
| C | PLV 1-E Bowl Diff. P | In. $H_2O$ | 7.24 | 7.22 | 6.97 | 7.11 | 7.07 | 6.84 | 6.96 | 6.98 |
| C | PLV 1-F Bowl Diff. P | In. $H_2O$ | 7.19 | 7.14 | 6.98 | 7.07 | 6.94 | 6.91 | 6.92 | 6.88 |
| C | PLV 1-A Coal Air Out. P | In. $H_2O$ | 9.71 | 9.83 | 10.40 | 10.19 | 10.43 | 9.97 | 10.32 | 10.34 |
| C | PLV 1-B Coal Air Out. P | In. $H_2O$ | 0.40 | 0.40 | 0.43 | 0.45 | 0.40 | 0.43 | 0.43 | 0.42 |
| C | PLV 1-C Coal Air Out. P | In. $H_2O$ | 11.24 | 10.97 | 10.94 | 11.00 | 11.34 | 10.22 | 10.37 | 10.34 |
| C | PLV 1-D Coal Air Out. P | In. $H_2O$ | 11.34 | 11.26 | 11.55 | 11.49 | 11.00 | 11.15 | 11.14 | 11.06 |
| C | PLV 1-E Coal Air Out. P | In. $H_2O$ | 11.66 | 11.59 | 11.90 | 12.08 | 11.45 | 11.42 | 11.60 | 11.54 |
| C | PLV 1-F Coal Air Out. P | In. $H_2O$ | 10.33 | 10.28 | 10.44 | 10.59 | 9.86 | 10.08 | 10.24 | 10.23 |
| C | PLV 1-A Pri. Air In. Flow | 0-125% | 126 | 126 | 126 | 126 | 126 | 125 | 126 | 125 |
| C | PLV 1-B Pri. Air In. Flow | 0-125% | 42 | 42 | 41 | 42 | 43 | 43 | 42 | 42 |
| C | PLV 1-C Pri. Air In. Flow | 0-125% | 131 | 130 | 131 | 130 | 131 | 131 | 131 | 131 |
| C | PLV 1-D Pri. Air In. Flow | 0-125% | 125 | 125 | 126 | 126 | 125 | 126 | 125 | 126 |
| C | PLV 1-E Pri. Air In. Flow | 0-125% | 128 | 127 | 128 | 128 | 128 | 129 | 128 | 128 |
| C | PLV 1-F Pri. Air In. Flow | 0-125% | 124 | 124 | 125 | 125 | 125 | 125 | 125 | 126 |
| C | PLV 1-A Coal Air Disch. Temp. | °F | 144 | 144 | 145 | 145 | 145 | 145 | 145 | 145 |

* C - Computer Data; B - Board Data; NA - Not Available.

# OVERFIRE AIR OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 3/24 | 3/24 | 3/24 | 6/24 | 6/24 | 6/24 | 3/25 | 6/30 |
| | Time | | 00:45 | 02:20 | 04:00 | 12:00 | 13:20 | 09:45 | 10:15 | 09:50 |
| *C | Load | MW | 473 | 473 | 472 | 524 | 525 | 523 | 510 | 526 |
| | **TEMPERATURES** | | | | | | | | | |
| | **Air & Gas - °F** | | | | | | | | | |
| C | Econ. N Gas Out. | | 788 | 787 | 785 | 750 | 756 | 740 | 795 | 738 |
| C | Econ. S Gas Out. | | 800 | 807 | 800 | 744 | 748 | 744 | 743 | 745 |
| C | 1-A PA Fan Disch. Hdr. | | 77 | 72 | 72 | 90 | 91 | 85 | 70 | 86 |
| C | 1-B PA Fan Disch. Hdr. | | 102 | 92 | 92 | *NA | NA | NA | 95 | NA |
| C | 1-A AH Pri. Air Out. | | 705 | 712 | 713 | 678 | 684 | 671 | 707 | 676 |
| C | 1-B AH Pri. Air Out. | | 693 | 698 | 705 | 680 | 688 | 668 | 705 | 665 |
| | **Steam & Water - °F** | | | | | | | | | |
| C | Boiler Econ. In. | | 470 | 467 | 468 | 467 | 467 | 465 | 478 | 467 |
| C | Downcomer 1 | | 675 | 673 | 672 | 675 | 675 | 676 | 674 | 676 |
| C | Downcomer 2 | | 677 | 675 | 674 | 677 | 677 | 677 | 676 | 677 |
| C | Downcomer 3 | | 677 | 676 | 676 | 677 | 677 | 677 | 678 | 677 |
| C | Downcomer 4 | | 681 | 680 | 680 | 682 | 681 | 681 | 681 | 681 |
| C | Downcomer 5 | | 678 | 678 | 677 | 679 | 678 | 678 | 683 | 679 |
| C | Blr. SH ATMP 1-A Stm. In. | | 838 | 841 | 849 | 830 | 849 | 824 | 840 | 845 |
| C | Blr. SH ATMP 1-B Stm. In. | | 834 | 839 | 851 | 847 | 850 | 843 | 846 | 836 |
| C | Blr. S SH Hdr. Out. | | 1006 | 1004 | 1003 | 996 | 1013 | 1004 | 1002 | 1010 |
| C | Blr. N SH Hdr. Out. | | 1010 | 1007 | 1009 | 993 | 1010 | 1003 | 1013 | 998 |
| C | Turbine Throttle | | 1003 | 1004 | 1004 | 991 | 1006 | 1000 | 1004 | NA |
| C | Blr. S RH ATMP Stm. Out. A | | 471 | 467 | 466 | 481 | 479 | 486 | 476 | 481 |
| C | Blr. N RH ATMP Stm. Out. B | | 470 | 466 | 467 | 478 | 478 | 481 | 477 | 479 |
| C | Blr. S RH Hdr. Out. A | | 1006 | 1004 | 993 | 973 | 969 | 992 | 989 | 1003 |
| C | Blr. N RH Hdr. Out. B | | 1008 | 1010 | 1017 | 1022 | 1021 | 1014 | 1032 | 1000 |
| C | HP Htr. 1-G1 & 1-G2 Extr. Stm. | | 606 | 605 | 604 | 615 | 629 | 616 | 621 | 623 |
| C | HP Htr. 1-F1 FW Out. | | 404 | 402 | 402 | 129 | 132 | 125 | 409 | 428 |
| C | HP Htr. 1-F2 FW Out. | | 403 | 401 | 402 | 400 | 400 | 399 | 408 | 400 |
| C | HP Htr. 1-G1 FW Out. | | 468 | 467 | 467 | 208 | 208 | 208 | 476 | 191 |
| C | HP Htr. 1-G2 FW Out. | | 469 | 467 | 467 | 466 | 467 | 466 | 476 | 467 |
| C | HP Htr. 1-G1 Drain | | 406 | 404 | 404 | 120 | 120 | 119 | 412 | 100 |
| C | HP Htr. *1-G2 Drain | | 374 | 372 | 372 | 374 | 376 | 373 | 376 | 407 |
| | **PULVERIZER DATA** | | | | | | | | | |
| C | PLV 1-A Bowl Lower P | IN. $H_2O$ | 20.1 | 20.0 | 19.7 | 20.7 | 20.7 | 20.6 | 20.6 | 20.4 |
| C | PLV 1-B Bowl Lower P | IN. $H_2O$ | 24.0 | 23.3 | 22.7 | 23.9 | 23.8 | 23.6 | 23.1 | 24.6 |
| C | PLV 1-C Bowl Lower P | IN. $H_2O$ | 22.0 | 22.3 | 22.2 | 0.09 | 0.09 | 0.09 | 22.9 | 0.09 |
| C | PLV 1-D Bowl Lower P | IN. $H_2O$ | 0.30 | 0.30 | 0.30 | 22.3 | 22.2 | 22.1 | 0.20 | 21.7 |
| C | PLV 1-E Bowl Lower P | IN. $H_2O$ | 21.0 | 21.0 | 20.8 | 21.8 | 21.9 | 21.9 | 21.5 | 22.8 |
| C | PLV 1-F Bowl Lower P | IN. $H_2O$ | 18.7 | 18.8 | 18.5 | 21.4 | 21.4 | 21.3 | 20.1 | 21.2 |
| C | PLV 1-A Bowl Diff. P | IN. $H_2O$ | 6.85 | 6.85 | 6.87 | 6.93 | 6.91 | 6.84 | 7.17 | 6.79 |
| C | PLV 1-B Bowl Diff. P | IN. $H_2O$ | 7.73 | 7.59 | 7.45 | 7.84 | 7.77 | 7.72 | 7.90 | 7.91 |
| C | PLV 1-C Bowl Diff. P | IN. $H_2O$ | 7.59 | 7.67 | 7.74 | 0.0 | 0.02 | 0.01 | 7.97 | 0.0 |
| C | PLV 1-D Bowl Diff. P | IN. $H_2O$ | 0.05 | 0.05 | 0.05 | 7.33 | 7.34 | 7.23 | 0.05 | 7.16 |
| C | PLV 1-E Bowl Diff. P | IN. $H_2O$ | 6.75 | 6.73 | 6.76 | 7.16 | 7.10 | 7.10 | 6.96 | 7.43 |
| C | PLV 1-F Bowl Diff. P | IN. $H_2O$ | 6.39 | 6.36 | 6.40 | 7.13 | 7.14 | 7.09 | 6.87 | 6.93 |
| C | PLV 1-A Coal Air Out. P | IN. $H_2O$ | 9.92 | 9.78 | 9.43 | 9.40 | 9.46 | 9.50 | 10.12 | 9.36 |
| C | PLV 1-B Coal Air Out. P | IN. $H_2O$ | 12.64 | 12.18 | 11.70 | 11.93 | 11.86 | 11.82 | 11.67 | 12.49 |
| C | PLV 1-C Coal Air Out. P | IN. $H_2O$ | 10.48 | 10.50 | 10.16 | 0.05 | 0.04 | 0.06 | 4.90 | 0.0 |
| C | PLV 1-D Coal Air Out. P | IN. $H_2O$ | 0.22 | 0.21 | 0.21 | 10.97 | 10.81 | 10.74 | 0.21 | 10.51 |
| C | PLV 1-E Coal Air Out. P | IN. $H_2O$ | 11.10 | 11.06 | 10.72 | 10.71 | 10.62 | 10.58 | 11.20 | 11.10 |
| C | PLV 1-F Coal Air Out. P | IN. $H_2O$ | 9.20 | 9.24 | 8.92 | 10.52 | 10.36 | 10.41 | 9.80 | 10.47 |
| C | PLV 1-A Pri. Air In. Flow | 0-125% | 126 | 126 | 126 | 124 | 123 | 124 | 126 | 123 |
| C | PLV 1-B Pri. Air In. Flow | 0-125% | 130 | 130 | 130 | 125 | 124 | 124 | 130 | 128 |
| C | PLV 1-C Pri. Air In. Flow | 0-125% | 132 | 131 | 131 | 131 | 38 | 0 | 130 | 0 |
| C | PLV 1-D Pri. Air In. Flow | 0-125% | 0 | 0 | 0 | 123 | 123 | 123 | 0 | 123 |
| C | PLV 1-E Pri. Air In. Flow | 0-125% | 127 | 128 | 128 | 127 | 127 | 127 | 128 | 126 |
| C | PLV 1-F Pri. Air In. Flow | 0-125% | 125 | 125 | 125 | 128 | 128 | 127 | 125 | 128 |
| C | PLV 1-A Coal Air Disch. Temp. | °F | 144 | 144 | 143 | 148 | 149 | 147 | 143 | 147 |

* C - Computer Data; B - Board Data; NA - Not Available.

# OVERFIRE AIR OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1976 | 6/25 | 6/30 | 6/29 | 6/25 | 6/26 | 6/25 | 6/27 | 6/29 |
| | TIME | | 11:15 | 08:35 | 08:50 | 14:45 | 10:30 | 16:25 | 11:35 | 01:30 |
| *C | LOAD | MW | 524 | 526 | 523 | 517 | 419 | 422 | 316 | 322 |
| | **TEMPERATURES** | | | | | | | | | |
| | **AIR & GAS - °F** | | | | | | | | | |
| C | ECON. N GAS OUT. | | 750 | 733 | 747 | 756 | 684 | 704 | 601 | 625 |
| C | ECON. S GAS OUT. | | *NA | 743 | 748 | NA | NA | NA | NA | 631 |
| C | 1-A PA FAN DISCH. HDR. | | 96 | 84 | 83 | 101 | 102 | 102 | 102 | 93 |
| C | 1-B PA FAN DISCH. HDR. | | NA | NA | NA | NA | NA | NA | NA | NA |
| C | 1-A AH PRI. AIR OUT. | | 682 | 664 | 678 | 694 | 617 | 651 | 549 | 581 |
| C | 1-B AH PRI. AIR OUT. | | 678 | 651 | 672 | 694 | 620 | 660 | 548 | 582 |
| | **STEAM & WATER - °F** | | | | | | | | | |
| C | BOILER ECON. IN. | | 467 | 467 | 468 | 466 | 444 | 446 | 417 | 421 |
| C | DOWNCOMER 1 | | 675 | 675 | 676 | 675 | 670 | 671 | 665 | 668 |
| C | DOWNCOMER 2 | | 676 | 677 | 678 | 677 | 672 | 672 | 666 | 669 |
| C | DOWNCOMER 3 | | 676 | 677 | 678 | 676 | 672 | 672 | 667 | 669 |
| C | DOWNCOMER 4 | | 680 | 681 | 683 | 680 | 676 | 676 | 667 | 673 |
| C | DOWNCOMER 5 | | 678 | 678 | 680 | 678 | 674 | 673 | 675 | 670 |
| C | BLR. SH ATMP 1-A STM. IN. | | 840 | 842 | 840 | 849 | 825 | 858 | 667 | 855 |
| C | BLR. SH ATMP 1-B STM. IN. | | 866 | 833 | 842 | 854 | 831 | 859 | 824 | 855 |
| C | BLR. S SH HDR. OUT. | | 992 | 1011 | 1007 | 1005 | 999 | 1005 | 790 | 1005 |
| C | BLR. N SH HDR. OUT. | | 1012 | 1001 | 1006 | 1007 | 1010 | 1006 | 982 | 1009 |
| C | TURBINE THROTTLE | | 1000 | NA | NA | 969 | 681 | 913 | NA | NA |
| C | BLR. S RH ATMP STM. OUT. A | | 479 | 482 | 481 | 477 | 585 | 457 | 484 | 549 |
| C | BLR. N RH ATMP STM. OUT. B | | 478 | 481 | 480 | 477 | 585 | 455 | 527 | 548 |
| C | BLR. S RH HDR. OUT. A | | 976 | 1004 | 993 | 977 | 974 | 986 | 924 | 969 |
| C | BLR. N RH HDR. OUT. B | | 1021 | 996 | 1013 | 1008 | 1011 | 1012 | 894 | 988 |
| C | HP HTR. 1-G1 & 1-G2 EXTR. STM. | | 620 | 621 | 623 | 609 | 579 | 583 | 527 | 543 |
| C | HP HTR. 1-F1 FW OUT. | | 177 | 138 | NA | 199 | 271 | 206 | 189 | 83 |
| C | HP HTR. 1-F2 FW OUT. | | 400 | 400 | 400 | 395 | 379 | 381 | 356 | 359 |
| C | HP HTR. 1-G1 FW OUT. | | 208 | 191 | 191 | 208 | 207 | 208 | 195 | 192 |
| C | HP HTR. 1-G2 FW OUT. | | 466 | 467 | 467 | 460 | 443 | 444 | 417 | 420 |
| C | HP HTR. 1-G1 DRAIN | | 122 | 102 | 198 | 142 | 104 | 137 | 113 | 189 |
| C | HP HTR. 1-G2 DRAIN | | 374 | 433 | 347 | 370 | 355 | 357 | 332 | 299 |
| | **PULVERIZER DATA** | | | | | | | | | |
| C | PLV 1-A BOWL LOWER P | IN. $H_2O$ | 20.3 | 20.4 | 20.2 | 19.8 | 19.7 | 18.0 | 16.8 | 17.5 |
| C | PLV 1-B BOWL LOWER P | IN. $H_2O$ | 24.1 | 24.4 | 24.9 | 24.9 | 23.9 | 22.1 | 20.8 | 21.6 |
| C | PLV 1-C BOWL LOWER P | IN. $H_2O$ | 0.09 | 0.09 | 0.09 | 0.10 | 0.11 | 0.10 | 0.11 | 0.09 |
| C | PLV 1-D BOWL LOWER P | IN. $H_2O$ | 22.0 | 21.7 | 21.6 | 21.5 | 21.6 | 19.4 | 30.3 | 17.9 |
| C | PLV 1-E BOWL LOWER P | IN. $H_2O$ | 21.4 | 22.8 | 22.5 | 20.7 | 21.3 | 18.9 | 18.5 | 18.8 |
| C | PLV 1-F BOWL LOWER P | IN. $H_2O$ | 20.7 | 21.1 | 20.5 | 19.4 | -1.3 | 17.5 | 16.6 | -1.3 |
| C | PLV 1-A BOWL DIFF. P | IN. $H_2O$ | 6.83 | 6.76 | 6.80 | 6.75 | 6.35 | 6.26 | 5.80 | 6.06 |
| C | PLV 1-B BOWL DIFF. P | IN. $H_2O$ | 7.84 | 7.84 | 8.05 | 8.13 | 7.71 | 7.09 | 6.68 | 6.87 |
| C | PLV 1-C BOWL DIFF. P | IN. $H_2O$ | 0.02 | 0.01 | 0.03 | 0.02 | 0.01 | 0.02 | 0.03 | 0.04 |
| C | PLV 1-D BOWL DIFF. P | IN. $H_2O$ | 7.30 | 7.09 | 7.12 | 7.28 | 7.14 | 6.63 | 0.05 | 6.02 |
| C | PLV 1-E BOWL DIFF. P | IN. $H_2O$ | 7.04 | 7.40 | 7.41 | 6.90 | 7.00 | 6.35 | 6.27 | 6.29 |
| C | PLV 1-F BOWL DIFF. P | IN. $H_2O$ | 7.03 | 6.91 | 6.87 | 6.63 | 0.06 | 6.08 | 5.65 | 0.06 |
| C | PLV 1-A COAL AIR OUT. P | IN. $H_2O$ | 9.23 | 9.37 | 9.12 | 8.85 | 8.96 | 7.84 | 7.49 | 7.82 |
| C | PLV 1-B COAL AIR OUT. P | IN. $H_2O$ | 12.06 | 12.28 | 12.51 | 12.33 | 11.88 | 10.98 | 10.39 | 10.90 |
| C | PLV 1-C COAL AIR OUT. P | IN. $H_2O$ | 0.03 | 0.05 | 0.09 | 0.07 | 0.11 | 0.09 | 0.16 | 0.18 |
| C | PLV 1-D COAL AIR OUT. P | IN. $H_2O$ | 10.72 | 10.53 | 10.54 | 10.15 | 10.41 | 9.12 | 30.17 | 8.51 |
| C | PLV 1-E COAL AIR OUT. P | IN. $H_2O$ | 10.34 | 10.98 | 10.93 | 9.82 | 10.36 | 8.96 | 8.99 | 9.10 |
| C | PLV 1-F COAL AIR OUT. P | IN. $H_2O$ | 9.89 | 10.38 | 9.99 | 9.11 | -1.33 | 8.12 | 7.99 | -1.22 |
| C | PLV 1-A PRI. AIR IN. FLOW | 0-125% | 124 | 124 | 124 | 124 | 124 | 127 | 123 | 124 |
| C | PLV 1-B PRI. AIR IN. FLOW | 0-125% | 126 | 128 | 128 | 128 | 127 | 127 | 127 | 128 |
| C | PLV 1-C PRI. AIR IN. FLOW | 0-125% | 45 | 0 | 0 | 73 | 74 | 81 | 64 | 36 |
| C | PLV 1-D PRI. AIR IN. FLOW | 0-125% | 123 | 123 | 124 | 123 | 123 | 123 | 31 | 123 |
| C | PLV 1-E PRI. AIR IN. FLOW | 0-125% | 126 | 126 | 126 | 126 | 126 | 126 | 126 | 126 |
| C | PLV 1-F PRI. AIR IN. FLOW | 0-125% | 127 | 128 | 128 | 128 | 0 | 127 | 127 | 0 |
| C | PLV 1-A COAL AIR DISCH. TEMP. | °F | 146 | 146 | 152 | 150 | 140 | 150 | 143 | 152 |

* C - COMPUTER DATA; B - BOARD DATA; NA - NOT AVAILABLE.

# OVERFIRE AIR OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1976 | 3/17 | 3/17 | 3/20 | 3/20 | 3/22 | 3/20 | 3/20 | 3/20 |
| | TIME | | 09:30 | 10:45 | 16:50 | 19:45 | 17:00 | 10:05 | 12:00 | 14:30 |
| *C | LOAD | MW | 517 | 512 | 524 | 525 | 526 | 521 | 522 | 522 |
| | **PULVERIZER DATA** | | | | | | | | | |
| C | PLV 1-B COAL AIR DISCH. TEMP. | °F | 82 | 87 | 93 | 93 | 88 | 91 | 92. | 93 |
| C | PLV 1-C COAL AIR DISCH. TEMP. | °F | 150 | 148 | 149 | 149 | 142 | 150 | 149 | 149 |
| C | PLV 1-D COAL AIR DISCH. TEMP. | °F | 148 | 148 | 148 | 149 | 147 | 145 | 145 | 146 |
| C | PLV 1-E COAL AIR DISCH. TEMP. | °F | 143 | 142 | 142 | 142 | 142 | 142 | 142 | 142 |
| C | PLV 1-F COAL AIR DISCH. TEMP. | °F | 146 | 146 | 146 | 146 | 146 | 146 | 146 | 147 |
| C | PLV 1-A FEEDER COAL FLOW | $10^3$LB/HR | 114 | 114 | 116 | 117 | 114 | 115 | 115 | 114 |
| C | PLV 1-B FEEDER COAL FLOW | $10^3$LB/HR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | PLV 1-C FEEDER COAL FLOW | $10^3$LB/HR | 107 | 106 | 108 | 109 | 113 | 107 | 107 | 107 |
| C | PLV 1-D FEEDER COAL FLOW | $10^3$LB/HR | 115 | 116 | 117 | 118 | 115 | 116 | 115 | 116 |
| C | PLV 1-E FEEDER COAL FLOW | $10^3$LB/HR | 116 | 116 | 116 | 118 | 114 | 116 | 116 | 116 |
| C | PLV 1-F FEEDER COAL FLOW | $10^3$LB/HR | 116 | 116 | 116 | 117 | 115 | 115 | 115 | 115 |
| C | PLV 1-A MILL | AMPS | 71 | 71 | 73 | 73 | 72 | 72 | 72 | 72 |
| C | PLV 1-B MILL | AMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | PLV 1-C MILL | AMPS | 74 | 74 | 74 | 73 | 78 | 74 | 75 | 74 |
| C | PLV 1-D MILL | AMPS | 73 | 73 | 76 | 75 | 75 | 76 | 76 | 75 |
| C | PLV 1-E MILL | AMPS | 75 | 75 | 78 | 77 | 75 | 77 | 76 | 75 |
| C | PLV 1-F MILL | AMPS | 74 | 75 | 76 | 77 | 76 | 77 | 77 | 75 |
| | **FAN DAMPER POSITION - % OPEN** | | | | | | | | | |
| *B | 1-A FD FAN INLET VANE | | 71 | 71 | 75 | 74 | 72 | 73 | 72 | 73 |
| B | 1-B FD FAN INLET VANE | | 70 | 70 | 74 | 73 | 71 | 72 | 72 | 72 |
| B | 1-A PA FAN INLET VANE | | 28 | 28 | 33 | 32 | 30 | 34 | 34 | 34 |
| B | 1-B PA FAN INLET VANE | | 24 | 24 | 29 | 28 | 26 | 30 | 30 | 30 |
| | **SPRAY VALVE POSITION - % OPEN** | | | | | | | | | |
| B | 1-A SH SPRAY VALVE | | 45 | 37 | 22 | 21 | 62 | 0 | 17 | 12 |
| B | 1-B SH SPRAY VALVE | | 27 | 25 | 0 | 5 | 30 | 0 | 0 | 0 |
| B | 1-A RH SPRAY VALVE | | 80 | 84 | 49 | 56 | 60 | 6 | 28 | 33 |
| B | 1-B RH SPRAY VALVE | | 90 | 96 | 35 | 40 | 43 | 9 | 41 | 46 |
| | **MISCELLANEOUS** | | | | | | | | | |
| B | BURNER TILT | ± DEGREES | -3° | -3° | +1° | +3° | 0° | +5° | +5° | -1° |
| B | AUX. AIR DAMPERS | % OPEN | 100 | 100 | 81 | 69 | 68 | 77 | 66 | 58 |
| B | 1-A FUEL/AIR DAMPERS | % OPEN | 50 | 50 | 51 | 53 | 50 | 50 | 50 | 50 |
| B | 1 B FUEL/AIR DAMPERS | % OPEN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B | 1-C FUEL/AIR DAMPERS | % OPEN | 47 | 46 | 47 | 48 | 51 | 45 | 46 | 46 |
| B | 1-D FUEL/AIR DAMPERS | % OPEN | 53 | 53 | 54 | 55 | 53 | 52 | 53 | 53 |
| B | 1-E FUEL/AIR DAMPERS | % OPEN | 51 | 51 | 52 | 53 | 51 | 50 | 51 | 51 |
| B | 1-F FUEL/AIR DAMPERS | % OPEN | 51 | 51 | 51 | 52 | 51 | 50 | 50 | 50 |
| B | 1-A PRI. AIR FAN | AMPS | 172 | 172 | 170 | 170 | 171 | 170 | 170 | 169 |
| B | 1-B PRI. AIR FAN | AMPS | 183 | 183 | 182 | 181 | 182 | 180 | 182 | 181 |
| B | 1-A ID FAN | AMPS | 500 | 500 | 500 | 500 | 490 | 470 | 460 | 470 |
| B | 1-B ID FAN | AMPS | 430 | 430 | 430 | 420 | 420 | 400 | 400 | 400 |
| B | 1-A FD FAN | AMPS | 208 | 207 | 203 | 200 | 202 | 195 | 194 | 192 |
| B | 1-B FD FAN | AMPS | 195 | 195 | 193 | 190 | 190 | 183 | 184 | 182 |
| B | 1-A ID FAN | RPM | 485 | 485 | 490 | 490 | 480 | 480 | 483 | 480 |
| B | 1-B ID FAN | RPM | 495 | 495 | 500 | 500 | 495 | 490 | 490 | 490 |
| B | 1-A BLR. CIRC. WTR. PUMP | AMPS | 74 | 74 | 76 | 76 | 75 | 80 | 77 | 77 |
| B | 1-B BLR. CIRC. WTR. PUMP | AMPS | 77 | 77 | 78 | 78 | 78 | 80 | 79 | 79 |
| B | 1-C BLR. CIRC. WTR. PUMP | AMPS | 72 | 72 | 74 | 72 | 73 | 76 | 75 | 74 |
| B | 1-D BLR. CIRC. WTR. PUMP | AMPS | 74 | 74 | 74 | 74 | 74 | 78 | 76 | 76 |
| C | N DRUM LEVEL ± NORM. $H_2O$ LEVEL | IN. | -0.69 | -0.62 | -0.69 | -0.53 | -0.68 | -0.48 | -0.58 | -0.44 |
| C | S DRUM LEVEL ± NORM. $H_2O$ LEVEL | IN. | -2.25 | -2.27 | -2.22 | -2.75 | -2.97 | -2.28 | -2.61 | -2.64 |
| C | FLUE GAS COMBUSTIBLES | % | 0.065 | 0.066 | 0.061 | 0.061 | 0.063 | 0.063 | 0.064 | 0.064 |
| C | FLUE GAS OXYGEN | % | 4.0 | 3.9 | 4.0 | 3.9 | 4.0 | 3.6 | 3.4 | 3.6 |
| C | BAROMETRIC PRESS. | IN. HGA | 30.04 | 29.99 | 28.80 | 28.89 | 30.29 | 28.64 | 28.72 | 28.72 |

* C - COMPUTER DATA; B - BOARD DATA; NA - NOT AVAILABLE.

# OVERFIRE AIR OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1976 | 3/24 | 3/24 | 3/24 | 6/24 | 6/24 | 6/24 | 3/25 | 6/30 |
| | TIME | | 00:45 | 02:20 | 04:00 | 12:00 | 13:20 | 09:45 | 10:15 | 09:50 |
| *C | LOAD | MW | 473 | 473 | 472 | 524 | 525 | 523 | 510 | 526 |
| | **PULVERIZER DATA** | | | | | | | | | |
| C | PLV 1-B COAL AIR DISCH. TEMP. | °F | 146 | 144 | 143 | 154 | 155 | 153 | 142 | 156 |
| C | PLV 1-C COAL AIR DISCH. TEMP. | °F | 149 | 148 | 148 | 0 | 0 | 0 | 148 | 0 |
| C | PLV 1-D COAL AIR DISCH. TEMP. | °F | 155 | 152 | 149 | 147 | 148 | 146 | 86 | 145 |
| C | PLV 1-E COAL AIR DISCH. TEMP. | °F | 142 | 141 | 140 | 142 | 143 | 143 | 140 | 156 |
| C | PLV 1-F COAL AIR DISCH. TEMP. | °F | 146 | 146 | 144 | 149 | 149 | 148 | 144 | 148 |
| C | PLV 1-A FEEDER COAL FLOW | $10^3$ LB/HR | 102 | 101 | 102 | 118 | 118 | 118 | 110 | 117 |
| C | PLV 1-B FEEDER COAL FLOW | $10^3$ LB/HR | 105 | 105 | 105 | 119 | 120 | 119 | 114 | 118 |
| C | PLV 1-C FEEDER COAL FLOW | $10^3$ LB/HR | 102 | 102 | 103 | 0 | 0 | 0 | 111 | 0 |
| C | PLV 1-D FEEDER COAL FLOW | $10^3$ LB/HR | 0 | 0 | 0 | 118 | 118 | 118 | 0 | 117 |
| C | PLV 1-E FEEDER COAL FLOW | $10^3$ LB/HR | 104 | 104 | 104 | 118 | 118 | 117 | 112 | 115 |
| C | PLV 1-F FEEDER COAL FLOW | $10^3$ LB/HR | 103 | 102 | 102 | 117 | 118 | 116 | 112 | 117 |
| C | PLV 1-A MILL | AMPS | 66 | 67 | 66 | 72 | 73 | 71 | 73 | 71 |
| C | PLV 1-B MILL | AMPS | 72 | 72 | 72 | 74 | 74 | 74 | 73 | 73 |
| C | PLV 1-C MILL | AMPS | 72 | 71 | 71 | 0 | 0 | 0 | 73 | 0 |
| C | PLV 1-D MILL | AMPS | 0 | 0 | 0 | 72 | 72 | 72 | 0 | 72 |
| C | PLV 1-E MILL | AMPS | 71 | 70 | 69 | 75 | 75 | 74 | 75 | 73 |
| C | PLV 1-F MILL | AMPS | 73 | 71 | 71 | 74 | 75 | 74 | 76 | 74 |
| | **FAN DAMPER POSITION - % OPEN** | | | | | | | | | |
| *B | 1-A FD FAN INLET VANE | | 76 | 75 | 73 | 80 | 81 | 80 | 72 | 77 |
| B | 1-B FD FAN INLET VANE | | 76 | 75 | 73 | 83 | 83 | 83 | 70 | 80 |
| B | 1-A PA FAN INLET VANE | | 30 | 30 | 30 | 31 | 31 | 30 | 29 | 30 |
| B | 1-B PA FAN INLET VANE | | 26 | 25 | 25 | 30 | 30 | 30 | 25 | 30 |
| | **SPRAY VALVE POSITION - % OPEN** | | | | | | | | | |
| B | 1-A SH SPRAY VALVE | | 44 | 46 | 70 | 25 | 29 | 25 | 34 | 28 |
| B | 1-B SH SPRAY VALVE | | 32 | 31 | 39 | 61 | 62 | 62 | 26 | 35 |
| B | 1-A RH SPRAY VALVE | | 39 | 37 | 46 | 47 | 65 | 36 | 63 | 41 |
| B | 1-B RH SPRAY VALVE | | 41 | 44 | 54 | 34 | 47 | 25 | 74 | 39 |
| | **MISCELLANEOUS** | | | | | | | | | |
| B | BURNER TILT | ± DEGREES | 0° | 0° | 0° | +1° | +7° | +3° | 0° | +3° |
| B | AUX. AIR DAMPERS | % OPEN | 41 | 90 | 66 | 100 | 26 | 25 | 60 | 25 |
| B | 1-A FUEL/AIR DAMPERS | % OPEN | 42 | 42 | 42 | 100 | 100 | 100 | 47 | 100 |
| B | 1-B FUEL/AIR DAMPERS | % OPEN | 44 | 43 | 44 | 0 | 100 | 100 | 49 | 100 |
| B | 1-C FUEL/AIR DAMPERS | % OPEN | 43 | 42 | 43 | 100 | 0 | 0 | 49 | 0 |
| B | 1-D FUEL/AIR DAMPERS | % OPEN | 0 | 0 | 0 | 100 | 100 | 100 | 0 | 100 |
| B | 1-E FUEL/AIR DAMPERS | % OPEN | 44 | 43 | 45 | 100 | 100 | 100 | 49 | 100 |
| B | 1-F FUEL/AIR DAMPERS | % OPEN | 43 | 43 | 44 | 100 | 100 | 100 | 49 | 100 |
| B | 1-A PRI. AIR FAN | AMPS | 167 | 170 | 170 | 165 | 165 | 165 | 162 | 165 |
| B | 1-B PRI. AIR FAN | AMPS | 180 | 180 | 180 | 200 | 200 | 202 | 182 | 205 |
| B | 1-A ID FAN | AMPS | 500 | 500 | 480 | 510 | 520 | 520 | 460 | 490 |
| B | 1-B ID FAN | AMPS | 430 | 430 | 410 | 470 | 480 | 480 | 400 | 450 |
| B | 1-A FD FAN | AMPS | 211 | 210 | 203 | 226 | 228 | 229 | 200 | 224 |
| B | 1-B FD FAN | AMPS | 198 | 195 | 188 | 202 | 205 | 205 | 185 | 204 |
| B | 1-A ID FAN | RPM | 493 | 494 | 490 | *NA | NA | NA | 487 | 490 |
| B | 1-B ID FAN | RPM | 499 | 498 | 495 | NA | NA | NA | 492 | NA |
| B | 1-A BLR. CIRC. WTR. PUMP | AMPS | 76 | 76 | 75 | 74 | 73 | 75 | 76 | 77 |
| B | 1-B BLR. CIRC. WTR. PUMP | AMPS | 78 | 78 | 78 | 80 | 80 | 81 | 78 | 82 |
| B | 1-C BLR. CIRC. WTR. PUMP | AMPS | 73 | 72 | 73 | 73 | 73 | 75 | 72 | 75 |
| B | 1-D BLR. CIRC. WTR. PUMP | AMPS | 75 | 74 | 74 | 75 | 74 | 76 | 74 | 78 |
| C | N DRUM LEVEL ± NORM. $H_2O$ LEVEL | IN. | -0.72 | -0.49 | -0.66 | -0.35 | -0.54 | -0.74 | -0.48 | -0.35 |
| C | S DRUM LEVEL ± NORM. $H_2O$ LEVEL | IN. | -2.24 | -1.96 | -2.50 | -2.60 | -2.45 | -1.83 | -2.64 | -0.70 |
| C | FLUE GAS COMBUSTIBLES | % | 0.060 | 0.060 | 0.057 | 0.056 | 0.055 | 0.054 | 0.063 | 0.056 |
| C | FLUE GAS OXYGEN | % | 4.7 | 5.1 | 4.6 | 3.2 | 3.9 | 3.7 | 3.6 | 4.3 |
| C | BARONMETRIC PRESS. | IN. HGA | 29.53 | 29.49 | 29.43 | 29.52 | 29.45 | 29.59 | 29.81 | 29.85 |

* C - COMPUTER DATA; B - BOARD DATA; NA - NOT AVAILABLE.

# OVERFIRE AIR OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1976 | 6/25 | 6/30 | 6/29 | 6/25 | 6/26 | 6/25 | 6/27 | 6/29 |
| | Time | | 11:15 | 08:35 | 08:50 | 14:45 | 10:30 | 16:25 | 11:35 | 01:30 |
| *C | Load | MW | 524 | 526 | 523 | 517 | 419 | 422 | 316 | 322 |
| | **PULVERIZER DATA** | | | | | | | | | |
| C | PLV 1-B Coal Air Disch. Temp. | °F | 153 | 154 | 158 | 156 | 147 | 161 | 150 | 156 |
| C | PLV 1-C Coal Air Disch. Temp. | °F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | PLV 1-D Coal Air Disch. Temp. | °F | 146 | 144 | 150 | 150 | 141 | 151 | 111 | 148 |
| C | PLV 1-E Coal Air Disch. Temp. | °F | 142 | 154 | 159 | 142 | 143 | 142 | 147 | 158 |
| C | PLV 1-F Coal Air Disch. Temp. | °F | 147 | 143 | 150 | 150 | 114 | 152 | 142 | 111 |
| C | PLV 1-A Feeder Coal Flow | $10^3$ LB/HR | 117 | 118 | 113 | 115 | 116 | 90 | 84 | 83 |
| C | PLV 1-B Feeder Coal Flow | $10^3$ LB/HR | 118 | 119 | 116 | 116 | 117 | 92 | 86 | 86 |
| C | PLV 1-C Feeder Coal Flow | $10^3$ LB/HR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | PLV 1-D Feeder Coal Flow | $10^3$ LB/HR | 117 | 118 | 114 | 115 | 115 | 91 | 0 | 84 |
| C | PLV 1-E Feeder Coal Flow | $10^3$ LB/HR | 117 | 115 | 114 | 114 | 115 | 92 | 86 | 84 |
| C | PLV 1-F Feeder Coal Flow | $10^3$ LB/HR | 116 | 117 | 113 | 114 | 0 | 90 | 84 | 0 |
| C | PLV 1-A Mill | AMPS | 73 | 71 | 70 | 72 | 74 | 63 | 64 | 63 |
| C | PLV 1-B Mill | AMPS | 75 | 73 | 74 | 76 | 75 | 69 | 67 | 67 |
| C | PLV 1-C Mill | AMPS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | PLV 1-D Mill | AMPS | 73 | 74 | 73 | 72 | 74 | 68 | 0 | 64 |
| C | PLV 1-E Mill | AMPS | 75 | 71 | 70 | 76 | 75 | 68 | 66 | 65 |
| C | PLV 1-F Mill | AMPS | 76 | 75 | 73 | 75 | 0 | 69 | 67 | 0 |
| | **FAN DAMPER POSITION - % OPEN** | | | | | | | | | |
| *B | 1-A FD Fan Inlet Vane | | 80 | 78 | 76 | 81 | 73 | 70 | 59 | 58 |
| B | 1-B FD Fan Inlet Vane | | 83 | 81 | 79 | 83 | 76 | 73 | 62 | 61 |
| B | 1-A PA Fan Inlet Vane | | 31 | 30 | 30 | 31 | 28 | 33 | 28 | 28 |
| B | 1-B PA Fan Inlet Vane | | 30 | 29 | 29 | 31 | 28 | 33 | 28 | 27 |
| | **SPRAY VALVE POSITION - % OPEN** | | | | | | | | | |
| B | 1-A SH Spray Valve | | 89 | 28 | 28 | 49 | 19 | 29 | 0 | 26 |
| B | 1-B SH Spray Valve | | 59 | 35 | 33 | 50 | 15 | 33 | 0 | 26 |
| B | 1-A RH Spray Valve | | 53 | 36 | 48 | 69 | 0 | 25 | 0 | 0 |
| B | 1-B RH Spray Valve | | 41 | 30 | 40 | 50 | 0 | 17 | 0 | 0 |
| | **MISCELLANEOUS** | | | | | | | | | |
| B | Burner Tilt | ± DEGREES | +8° | +3° | +6° | +6° | +6° | +3° | +11° | +8° |
| B | Aux. Air Dampers | % OPEN | 26 | 25 | 19 | 23 | 14 | 3 | 0 | 0 |
| B | 1-A Fuel/Air Dampers | % OPEN | 100 | 100 | 100 | 100 | 100 | 94 | 80 | 77 |
| B | 1-B Fuel/Air Dampers | % OPEN | 100 | 100 | 100 | 100 | 100 | 92 | 80 | 77 |
| B | 1-C Fuel/Air Dampers | % OPEN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B | 1-D Fuel/Air Dampers | % OPEN | 100 | 100 | 100 | 100 | 100 | 89 | 0 | 74 |
| B | 1-E Fuel/Air Dampers | % OPEN | 100 | 100 | 100 | 100 | 100 | 89 | 77 | 75 |
| B | 1-F Fuel/Air Dampers | % OPEN | 100 | 100 | 100 | 100 | 0 | 90 | 77 | 0 |
| B | 1-A Pri. Air Fan | AMPS | 165 | 165 | 165 | 165 | 155 | 165 | 160 | 155 |
| B | 1-B Pri. Air Fan | AMPS | 200 | 203 | 200 | 200 | 190 | 200 | 195 | 195 |
| B | 1-A ID Fan | AMPS | 520 | 500 | 470 | 510 | 390 | 380 | 300 | 290 |
| B | 1-B ID Fan | AMPS | 470 | 450 | 420 | 470 | 340 | 340 | 280 | 260 |
| B | 1-A FD Fan | AMPS | 165 | 225 | 214 | 222 | 200 | 185 | 165 | 165 |
| B | 1-B FD Fan | AMPS | 200 | 205 | 193 | 200 | 180 | 170 | 150 | 147 |
| B | 1-A ID Fan | RPM | *NA | 490 | 480 | 500 | 450 | 450 | 330 | 325 |
| B | 1-B ID Fan | RPM | NA | NA | NA | NA | NA | NA | NA | NA |
| B | 1-A Blr. Circ. Wtr. Pump | AMPS | 74 | 77 | 75 | 75 | 78 | 75 | 83 | 80 |
| B | 1-B Blr. Circ. Wtr. Pump | AMPS | 79 | 82 | 80 | 80 | 84 | 82 | 87 | 85 |
| B | 1-C Blr. Circ. Wtr. Pump | AMPS | 73 | 74 | 73 | 73 | 78 | 75 | 0 | 77 |
| B | 1-D Blr. Circ. Wtr. Pump | AMPS | 74 | 80 | 75 | 76 | 81 | 78 | 85 | 84 |
| C | N Drum Level ± Norm. $H_2O$ Level | IN. | -0.77 | -0.87 | -0.44 | -0.72 | -0.52 | -0.53 | -0.59 | -0.56 |
| C | S Drum Level ± Norm. $H_2O$ Level | IN. | -2.99 | -0.89 | -2.19 | -1.40 | -1.39 | -1.30 | -2.03 | -1.42 |
| C | Flue Gas Combustibles | % | 0.056 | 0.056 | 0.055 | 0.056 | 0.055 | 0.055 | 0.053 | 0.048 |
| C | Flue Gas Oxygen | % | 3.4 | 4.4 | 3.5 | 4.3 | 4.6 | 4.3 | 5.8 | 4.7 |
| C | Baronmetric Press. | IN. HGA | 29.65 | 29.86 | 29.75 | 29.65 | 29.89 | 29.63 | 30.12 | 29.76 |

* C - Computer Data; B - Board Data; NA - Not Available.

# WATERWALL CORROSION COUPON
# DATA SUMMARY

## WEIGHT LOSS EVALUATION

## BASELINE TEST

| Probe Loc. | Probe No. | Coupon No. | Initial Wt. g | Final Wt. g | Wt. Loss g | Wt. Loss/ Coupon $mg/cm^2$ | Avg. Wt. Loss/ Probe $mg/cm^2$ |
|---|---|---|---|---|---|---|---|
| 1 | A | 11 | 192.4714 | 191.6956 | .7758 | 15.3814 | |
| | | 12 | 189.2624 | 188.5251 | .7373 | 14.6180 | 11.2471 |
| | | 13 | 187.7834 | 187.3753 | .4081 | 8.0912 | |
| | | 14 | 189.5986 | 189.1607 | .3479 | 6.8976 | |
| 2 | B | 11 | 191.8667 | 191.3217 | .5450 | 10.8054 | |
| | | 12 | 193.0534 | 192.5138 | .5396 | 10.6983 | 7.9955 |
| | | 13 | 192.4719 | 192.1794 | .2925 | 5.7992 | |
| | | 14 | 187.2771 | 187.0411 | .2360 | 4.6790 | |
| 3 | C | 11 | 189.6148 | 189.1926 | .4222 | 8.3707 | |
| | | 12 | 192.3205 | 191.8693 | .4512 | 8.9457 | 7.7150 |
| | | 13 | 194.2087 | 193.8685 | .3402 | 6.7450 | |
| | | 14 | 195.2487 | 194.9058 | .3429 | 6.7985 | |
| 4 | D | 11 | 181.0037 | 180.7035 | .3002 | 5.9519 | |
| | | 12 | 196.4728 | 196.1221 | .3407 | 6.7549 | 5.5544 |
| | | 13 | 192.6319 | 192.3687 | .2632 | 5.2183 | |
| | | 14 | 189.7795 | 189.5630 | .2165 | 4.2924 | |
| 5 | E | 11 | 191.8554 | 191.4543 | .4011 | 7.9524 | |
| | | 12 | 194.4597 | 193.9813 | .4784 | 9.4850 | 7.8731 |
| | | 13 | 191.4211 | 191.0273 | .3938 | 7.8077 | |
| | | 14 | 196.5282 | 196.2131 | .3151 | 6.2473 | |

Avg. Wt. Loss/Test 8.0770 $mg/cm^2$

# WATERWALL CORROSION COUPON DATA SUMMARY

## WEIGHT LOSS EVALUATION

## OVERFIRE AIR TEST

| Probe Loc. | Probe No. | Coupon No. | Initial Wt. g | Final Wt. g | Wt. Loss g | Wt. Loss/ Coupon mg/cm$^2$ | Avg. Wt. Loss/ Probe mg/cm$^2$ |
|---|---|---|---|---|---|---|---|
| 1 | G | 11 | 194.9117 | 194.5574 | .3543 | 7.0245 | |
| | | 12 | 190.1947 | 189.8822 | .3125 | 6.1957 | 8.4445 |
| | | 13 | 196.6078 | 196.2830 | .3248 | 6.4396 | |
| | | 14 | 196.0734 | 195.3612 | .7121 | 14.1182 | |
| 2 | H | 11 | 186.5016 | 186.0373 | .4643 | 9.2053 | |
| | | 12 | 190.5570 | 190.0113 | .5457 | 10.8191 | 9.9423 |
| | | 13 | 195.0431 | 194.5049 | .5382 | 10.6704 | |
| | | 14 | 191.5820 | 191.1243 | .4577 | 9.0744 | |
| 3 | I | 11 | 192.8761 | 192.2601 | .6160 | 12.2129 | |
| | | 12 | 197.6064 | 197.1149 | .4915 | 9.7445 | 9.2479 |
| | | 13 | 194.6839 | 194.3220 | .3619 | 7.1751 | |
| | | 14 | 194.3763 | 193.9799 | .3964 | 7.8591 | |
| 4 | J | 11 | 189.5101 | 189.1223 | .3878 | 7.6886 | |
| | | 12 | 191.3316 | 190.9150 | .4166 | 8.2596 | 7.2544 |
| | | 13 | 189.2178 | 188.8155 | .4023 | 7.9760 | |
| | | 14 | 188.7732 | 188.5163 | .2569 | 5.0933 | |
| 5 | K | 11 | 193.0880 | 192.7809 | .3071 | 6.0886 | |
| | | 12 | 187.8881 | 187.5455 | .3426 | 6.7924 | 5.5776 |
| | | 13 | 186.7728 | 186.5222 | .2506 | 4.9684 | |
| | | 14 | 189.5299 | 189.3049 | .2250 | 4.4609 | |

Avg. Wt. Loss/Test 8.0933 mg/cm$^2$

APPENDIX B

TEST DATA & RESULTS
FOR
UTAH POWER & LIGHT COMPANY
HUNTINGTON CANYON STATION
UNIT #2

# BASELINE OPERATION STUDY

EMISSIONS TEST DATA

| TEST NO. | | 1 | 2 | 2A | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | ← EXCESS AIR VARIATION → | | | | | | | | | |
| UNIT LOAD CONDITION | | MAX | MAX | MAX | MAX | 3/4 MAX | 1/2 MAX | 1/2 MAX | 1/2 MAX | MAX | MAX |
| FURNACE CONDITION | | CLEAN | CLEAN | CLEAN | CLEAN | CLEAN | CLEAN | CLEAN | CLEAN | CLEAN | CLEAN |
| DATE | 1975 | 5/7 | 5/5 | 5/7 | 5/7 | 10/10 | 7/16 | 7/15 | 7/16 | 5/5 | 4/30 |
| UNIT LOAD | MW | 429 | 427 | 428 | 428 | 360 | 259 | 260 | 258 | 430 | 428 |
| MAIN STEAM FLOW | KG/S | 376 | 380 | 377 | 380 | 298 | 204 | 203 | 202 | 378 | 377 |
| SHO TEMPERATURE | C | 531 | 541 | 534 | 536 | 547 | 546 | 543 | 544 | 541 | 534 |
| RHO TEMPERATURE | C | 538 | 547 | 537 | 537 | 548 | 529 | 538 | 537 | 543 | 537 |
| FUEL ELEVATIONS IN SERVICE | | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ABCD | ABCD | ABCD | ALL 5 | ALL 5 |
| OFA NOZZLE TILT | DEG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FUEL NOZZLE TILT | DEG | +14 | +11 | +13 | +15 | 0 | +18 | +11 | +6 | +8 | -3 |
| NOZZLE COMPARTMENT DAMPER POSITION - % OPEN: OFA | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OFA | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AUX | | 45 | 45 | 45 | 45 | 15 | 0 | 0 | 0 | 30 | 40 |
| A FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 50 | 50 | 45 | 45 | 10 | 0 | 0 | 0 | 40 | 45 |
| B FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 45 | 45 | 45 | 45 | 5 | 0 | 0 | 0 | 20 | 35 |
| C FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 50 | 50 | 50 | 45 | 0 | 0 | 0 | 0 | 35 | 35 |
| D FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 50 | 50 | 50 | 50 | 0 | 0 | 0 | 0 | 40 | 40 |
| E FUEL | | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 | 100 | 100 |
| AUX | | 100 | 100 | 100 | 100 | 100 | 35 | 0 | 0 | 100 | 100 |
| EXCESS AIR AT ECONOMIZER OUTLET | % | 18.9 | 27.4 | 32.9 | 40.9 | 28.9 | 23.7 | 32.1 | 50.0 | 19.5 | 29.0 |
| THEO. AIR TO THE FUEL FIRING ZONE | % | 116.4 | 124.8 | 130.1 | 137.8 | 126.9 | 122.9 | 131.1 | 150.0 | 117.5 | 126.3 |
| $NO_x$ (ADJ. TO 0% $O_2$) | PPM | 476 | 533 | 670 | 718 | 662 | 509 | 573 | 734 | 535 | 522 |
| $NO_x$ AS $NO_2$ | NG/J | 248.0 | 262.8 | 332.4 | 357.0 | 328.0 | 249.2 | 284.3 | 360.3 | 267.1 | 256.6 |
| $SO_2$ (ADJ. TO 0% $O_2$) | PPM | NA | 388 | 396 | 374 | 436 | 376 | 363 | 326 | 364 | 237 |
| $SO_2$ | NG/J | 0 | 266.3 | 273.2 | 259.1 | 300.1 | 256.2 | 250.5 | 222.8 | 252.5 | 163.4 |
| CO (ADJ. TO 0% $O_2$) | PPM | NA | 23 | 25 | 27 | NA | 16 | 16 | 17 | 23 | 124 |
| CO | NG/J | 0 | 6.9 | 7.7 | 8.2 | 0 | 4.8 | 4.8 | 5.0 | 6.9 | 37.5 |
| HC (ADJ. TO 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ AT ECONOMIZER OUTLET | % | 3.4 | 4.6 | 5.3 | 6.2 | 4.8 | 4.1 | 5.2 | 7.1 | 3.5 | 4.8 |
| $O_2$ AT A.H. OUTLET | % | 4.5 | 5.8 | 6.4 | 7.3 | 7.3 | 6.1 | 6.2 | 8.6 | 5.4 | 6.1 |
| $CO_2$ AT ECONOMIZER OUTLET | % | 15.4 | 14.1 | 13.5 | 12.8 | 14.0 | 14.7 | 13.6 | 12.1 | 15.1 | 14.2 |
| $CO_2$ AT A.H. OUTLET | % | 14.4 | 13.1 | 12.6 | 11.9 | 11.8 | 13.0 | 12.8 | 10.8 | 13.4 | 13.0 |
| CARBON LOSS IN FLYASH | % | 0.52 | 0.37 | 0.22 | 0.31 | 0.12 | 0.23 | 0.30 | 0.12 | 0.68 | 0.29 |

# BASELINE OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | EXCESS AIR VARIATION | | | | | | | | | |
| UNIT LOAD CONDITION | | MAX | 1/2 MAX | 1/2 MAX | MAX | MAX | MAX | 3/4 MAX | 1/2 MAX | 1/2 MAX | 1/2 MAX |
| FURNACE CONDITION | | CLEAN | | | MODERATELY DIRTY | | | | | | |
| DATE | 1975 | 5/1 | 7/17 | 7/18 | 5/9 | 5/9 | 5/9 | 10/9 | 7/22 | 7/21 | 7/21 |
| UNIT LOAD | MW | 428 | 256 | 259 | 433 | 433 | 433 | 361 | 258 | 260 | 258 |
| MAIN STEAM FLOW | KG/S | 375 | 203 | 208 | 377 | 375 | 375 | 298 | 204 | 206 | 205 |
| SHO TEMPERATURE | C | 545 | 543 | 543 | 532 | 536 | 539 | 548 | 541 | 541 | 542 |
| RHO TEMPERATURE | C | 546 | 536 | 534 | 538 | 538 | 540 | 545 | 528 | 536 | 536 |
| FUEL ELEVATIONS IN SERVICE | | ALL 5 | ABCD | ABCD | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ACDE | ACDE | ACDE |
| OFA NOZZLE TILT | DEG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FUEL NOZZLE TILT | DEG | +7 | +6 | +3 | +3 | +8 | +1 | 0 | +12 | +13 | +13 |
| NOZZLE COMPARTMENT DAMPER POSITION - % OPEN | | | | | | | | | | | |
| OFA | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OFA | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AUX | | 45 | 0 | 0 | 30 | 35 | 45 | 15 | 0 | 0 | 0 |
| A FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 45 | 0 | 0 | 45 | 45 | 50 | 15 | 0 | 0 | 0 |
| B FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 0 |
| AUX | | 40 | 0 | 0 | 25 | 30 | 35 | 5 | 0 | 0 | 0 |
| C FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 40 | 0 | 0 | 35 | 45 | 50 | 10 | 0 | 0 | 0 |
| D FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 20 | 100 | 100 | 100 |
| AUX | | 50 | 0 | 0 | 40 | 45 | 50 | 20 | 0 | 0 | 0 |
| E FUEL | | 100 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 100 | 0 | 0 | 100 | 100 | 100 | 100 | 0 | 0 | 0 |
| EXCESS AIR AT ECONOMIZER OUTLET | % | 40.9 | 27.4 | 48.8 | 15.0 | 20.2 | 35.5 | 23.0 | 25.2 | 28.9 | 47.8 |
| THEO. AIR TO THE FUEL FIRING ZONE | % | 137.8 | 126.4 | 147.6 | 113.1 | 118.1 | 132.6 | 121.3 | 124.3 | 127.9 | 146.6 |
| $NO_x$ (ADJ. TO 0% $O_2$) | PPM | 594 | 474 | 645 | 433 | 514 | 644 | 592 | 438 | 470 | 669 |
| $NO_x$ AS $NO_2$ | NG/J | 295.3 | 232.6 | 318.8 | 213.8 | 253.7 | 319.1 | 285.2 | 215.7 | 233.0 | 333.1 |
| $SO_2$ (ADJ. TO 0% $O_2$) | PPM | 271 | 236 | 332 | 258 | 372 | 355 | 405 | 446 | 448 | 474 |
| $SO_2$ | NG/J | 187.3 | 160.9 | 228.0 | 177.7 | 255.2 | 245.2 | 281.1 | 306.1 | 309.0 | 328.2 |
| CO (ADJ. TO 0% $O_2$) | PPM | NA | 15 | 16 | 35 | 24 | 27 | 14 | 15 | NA | 16 |
| CO | NG/J | 0 | 4.6 | 5.0 | 10.4 | 7.2 | 8.3 | 4.1 | 4.5 | 0 | 5.0 |
| HC (ADJ. TO 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ AT ECONOMIZER OUTLET | % | 6.2 | 4.6 | 7.0 | 2.8 | 3.6 | 5.6 | 4.0 | 4.3 | 4.8 | 6.9 |
| $O_2$ AT A.H. OUTLET | % | 7.6 | 5.7 | 8.1 | 4.4 | 5.0 | 6.6 | 5.9 | 6.0 | 6.9 | 8.1 |
| $CO_2$ AT ECONOMIZER OUTLET | % | 12.8 | 14.3 | 12.1 | 15.8 | 15.1 | 13.4 | 14.7 | 14.5 | 14.0 | 12.2 |
| $CO_2$ AT A.H. OUTLET | % | 11.6 | 13.3 | 11.1 | 14.4 | 13.9 | 12.5 | 13.1 | 13.1 | 12.1 | 11.1 |
| CARBON LOSS IN FLYASH | % | 0.23 | 0.24 | 0.13 | 0.53 | 0.50 | 0.15 | 0.09 | 0.21 | 0.26 | 0.17 |

# BIASED FIRING OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Purpose of Test | | ← VARIATION OF FUEL ELEVATIONS IN SERVICE → | | | | | | | |
| Unit Load Condition | | ← MAXIMUM → | | | ← 3/4 MAXIMUM → | | | 1/2 MAXIMUM | |
| Excess Air Condition | | ← MINIMUM → | | | | | | | |
| Furnace Condition | | Clean | Moderate | Clean | Clean | Moderate | Clean | Clean | Moderate |
| Date | 1975 | 9/17 | 9/18 | 9/20 | 12/13 | 10/11 | 10/12 | 10/12 | 10/5 |
| Unit Load | MW | 430 | 426 | 434 | 356 | 351 | 360 | 257 | 270 |
| Main Steam Flow | kg/s | 375 | 371 | 368 | 297 | 295 | 299 | 218 | 214 |
| SHO Temperature | C | 518 | 525 | 534 | 544 | 536 | 543 | 542 | 543 |
| RHO Temperature | C | 536 | 541 | 541 | 539 | 537 | 546 | 534 | 544 |
| Fuel Elevations in Service | | BCDE | ABDE | ABCD | BCDE | ACDE | ABCE | BCDE | ABDE |
| OFA Nozzle Tilt | Deg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fuel Nozzle Tilt | Deg | +6 | -6 | -13 | +18 | -10 | -9 | +6 | -9 |
| Nozzle Compartment Damper Position - % Open: OFA | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OFA | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AUX | | 20 | 30 | 50 | 10 | 0 | 5 | 5 | 10 |
| A FUEL | | 10 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 30 | 40 | 50 | 0 | 25 | 0 | 0 | 5 |
| B FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 10 | 10 | 45 | 0 | 5 | 0 | 5 | 5 |
| C FUEL | | 100 | 0 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 25 | 25 | 50 | 0 | 0 | 0 | 0 | 0 |
| D FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 20 | 25 | 50 | 0 | 0 | 0 | 0 | 0 |
| E FUEL | | 100 | 100 | 20 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 100 | 100 | 20 | 100 | 100 | 100 | 100 | 100 |
| Excess Air at Economizer Outlet | % | 19.8 | 21.5 | 20.9 | 16.8 | 19.9 | 20.8 | 22.6 | 24.4 |
| Theo. Air to the Fuel Firing Zone | % | 107.1 | 118.9 | 117.8 | 98.5 | 119.3 | 119.8 | 106.5 | 122.8 |
| $NO_x$ (Adj. to 0% $O_2$) | PPM | 340 | 449 | 490 | 367 | 404 | 530 | 363 | 534 |
| $NO_x$ as $NO_2$ | ng/J | 168.4 | 222.7 | 243.1 | 191.5 | 203.6 | 263.4 | 178.4 | 263.3 |
| $SO_2$ (Adj. to 0% $O_2$) | PPM | 418 | 358 | 387 | 257 | 375 | 359 | 359 | 360 |
| $SO_2$ | ng/J | 287.5 | 247.8 | 267.1 | 186.4 | 262.9 | 248.2 | 245.7 | 247.1 |
| CO (Adj. to 0% $O_2$) | PPM | 56 | 16 | 30 | 20 | 14 | 16 | 16 | 14 |
| CO | ng/J | 16.7 | 4.8 | 9.2 | 6.3 | 4.4 | 4.8 | 4.8 | 4.1 |
| HC (Adj. to 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ at Economizer Outlet | % | 3.6 | 3.8 | 3.7 | 3.1 | 3.6 | 3.7 | 4.0 | 4.2 |
| $O_2$ at A.H. Outlet | % | 5.7 | 4.4 | 5.7 | 5.6 | 5.8 | 5.5 | 5.8 | 5.9 |
| $CO_2$ at Economizer Outlet | % | 15.1 | 14.9 | 15.0 | 15.3 | 15.2 | 14.9 | 14.8 | 14.5 |
| $CO_2$ at A.H. Outlet | % | 13.2 | 14.3 | 13.2 | 13.1 | 13.2 | 13.4 | 13.2 | 13.1 |
| Carbon Loss in Flyash | % | 0.26 | 0.25 | 0.55 | 0.61 | 0.20 | 0.22 | 0.46 | 0.22 |

# BIASED FIRING OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | VARIATION OF FUEL ELEVATIONS IN SERVICE | | | | | | | |
| UNIT LOAD CONDITION | | MAXIMUM | | | 3/4 MAXIMUM | | | 1/2 MAXIMUM | |
| EXCESS AIR CONDITION | | NORMAL | | | | | | | |
| FURNACE CONDITION | | CLEAN | CLEAN | MODERATE | MODERATE | CLEAN | CLEAN | CLEAN | CLEAN |
| DATE | 1975 | 9/17 | 9/18 | 9/18 | 10/11 | 12/13 | 12/13 | 7/23 | 7/24 |
| UNIT LOAD | MW | 429 | 428 | 429 | 351 | 356 | 357 | 256 | 259 |
| MAIN STEAM FLOW | KG/S | 375 | 370 | 369 | 295 | 299 | 299 | 203 | 210 |
| SHO TEMPERATURE | C | 516 | 536 | 533 | 537 | 543 | 544 | 543 | 542 |
| RHO TEMPERATURE | C | 525 | 537 | 541 | 538 | 541 | 541 | 533 | 535 |
| FUEL ELEVATIONS IN SERVICE | | BCDE | ACDE | ABCE | BCDE | ABDE | ABCD | ACDE | ABCE |
| OFA NOZZLE TILT | DEG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FUEL NOZZLE TILT | DEG | +20 | +8 | +2 | +7 | +9 | -8 | +12 | +11 |
| NOZZLE COMPARTMENT DAMPER POSITION - % OPEN: OFA | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OFA | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AUX | | 35 | 25 | 30 | 10 | 5 | 0 | 0 | 0 |
| A FUEL | | 20 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 50 | 35 | 40 | 5 | 10 | 5 | 0 | 0 |
| B FUEL | | 100 | 25 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 15 | 15 | 20 | 5 | 0 | 0 | 0 | 0 |
| C FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 20 | 40 | 40 | 5 | 0 | 5 | 0 | 0 |
| D FUEL | | 100 | 100 | 5 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 35 | 40 | 40 | 5 | 10 | 10 | 0 | 0 |
| E FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| EXCESS AIR AT ECONOMIZER OUTLET | % | 26.3 | 27.4 | 29.3 | 29.3 | 28.0 | 31.7 | 25.1 | 24.7 |
| THEO. AIR TO THE FUEL FIRING ZONE | % | 107.6 | 125.3 | 126.8 | 109.1 | 127.0 | 131.0 | 124.4 | 124.0 |
| $NO_x$ (ADJ. TO 0% $O_2$) | PPM | 421 | 462 | 513 | 421 | 549 | 502 | 382 | 453 |
| $NO_x$ AS $NO_2$ | NG/J | 208.1 | 227.3 | 255.9 | 214.2 | 283.8 | 248.4 | 187.2 | 224.3 |
| $SO_2$ (ADJ. TO 0% $O_2$) | PPM | 408 | 382 | 389 | 406 | 291 | 252 | 429 | 443 |
| $SO_2$ | NG/J | 280.8 | 261.1 | 269.9 | 286.9 | 209.5 | 173.7 | 292.2 | 305.1 |
| CO (ADJ. TO 0% $O_2$) | PPM | 17 | 17 | 17 | 17 | 18 | 21 | 15 | 15 |
| CO | NG/J | 5.0 | 5.0 | 5.2 | 5.2 | 5.7 | 6.4 | 4.5 | 4.6 |
| HC (ADJ. TO 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ AT ECONOMIZER OUTLET | % | 4.5 | 4.6 | 4.9 | 4.9 | 4.7 | 5.2 | 4.3 | 4.3 |
| $O_2$ AT A.H. OUTLET | % | 6.1 | 6.9 | 5.2 | 6.3 | 7.0 | 7.1 | 6.1 | 5.9 |
| $CO_2$ AT ECONOMIZER OUTLET | % | 14.4 | 14.4 | 14.0 | 14.0 | 13.9 | 13.7 | 14.4 | 14.4 |
| $CO_2$ AT A.H. OUTLET | % | 13.0 | 12.4 | 13.7 | 12.7 | 11.9 | 12.0 | 12.9 | 13.0 |
| CARBON LOSS IN FLYASH | % | 0.28 | 0.24 | 0.18 | 0.22 | 0.38 | 0.41 | 0.12 | 0.20 |

# OVERFIRE AIR OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | ← OVERFIRE AIR VARIATION → | | | | | | | | | | | TILT VAR WITH OFA |
| UNIT LOAD CONDITION | | ← MAXIMUM → | | | | | | | | | | | |
| EXCESS AIR CONDITION | | ← NORMAL → | | | | | ← MINIMUM → | | | ← MAXIMUM → | | | MIN |
| FURNACE CONDITION | | HEAVY | HEAVY | HEAVY | ← MODERATE → | | | | | CLEAN | CLEAN | MODERATE | MODERATE |
| DATE | 1975 | 9/17 | 9/26 | 9/26 | 9/26 | 9/26 | 10/1 | 10/1 | 10/1 | 9/27 | 10/1 | 10/1 | 10/5 |
| UNIT LOAD | MW | 428 | 430 | 430 | 430 | 431 | 430 | 429 | 428 | 428 | 429 | 430 | 427 |
| MAIN STEAM FLOW | KG/S | 369 | 372 | 372 | 370 | 370 | 372 | 372 | 370 | 369 | 368 | 370 | 370 |
| SHO TEMPERATURE | C | 532 | 529 | 530 | 533 | 532 | 534 | 528 | 531 | 528 | 535 | 535 | 526 |
| RHO TEMPERATURE | C | 539 | 539 | 538 | 537 | 536 | 547 | 541 | 543 | 540 | 540 | 540 | 540 |
| FUEL ELEVATIONS IN SERVICE | | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 |
| OFA NOZZLE TILT | DEG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -30 |
| FUEL NOZZLE TILT | DEG | +6 | -10 | -10 | -14 | -12 | +10 | +10 | +10 | +8 | +17 | +13 | -20 |
| NOZZLE COMPARTMENT DAMPER POSITION - % OPEN: OFA | | 0 | 25 | 50 | 75 | 100 | 0 | 50 | 100 | 25 | 75 | 100 | 100 |
| OFA | | 0 | 25 | 50 | 75 | 100 | 0 | 50 | 100 | 25 | 75 | 100 | 100 |
| AUX | | 20 | 25 | 20 | 15 | 15 | 20 | 15 | 15 | 45 | 15 | 15 | 15 |
| A FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 35 | 40 | 30 | 20 | 20 | 20 | 10 | 0 | 45 | 25 | 20 | 0 |
| B FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 15 | 20 | 10 | 15 | 5 | 10 | 5 | 5 | 35 | 10 | 5 | 5 |
| C FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 35 | 30 | 20 | 20 | 20 | 20 | 10 | 0 | 35 | 15 | 20 | 0 |
| D FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 20 | 40 | 30 | 20 | 20 | 20 | 0 | 0 | 30 | 25 | 25 | 0 |
| E FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| EXCESS AIR AT ECONOMIZER OUTLET | % | 27.0 | 28.2 | 26.2 | 25.5 | 25.2 | 18.5 | 19.2 | 19.2 | 30.1 | 33.8 | 33.8 | 23.1 |
| THEO. AIR TO THE FUEL FIRING ZONE | % | 125.2 | 120.2 | 111.6 | 107.1 | 105.4 | 116.7 | 102.9 | 96.6 | 123.2 | 113.8 | 112.5 | 99.6 |
| $NO_x$ (ADJ. TO 0% $O_2$) | PPM | 543 | 513 | 462 | 430 | 417 | 604 | 492 | 446 | 711 | 677 | 673 | 452 |
| $NO_x$ AS $NO_2$ | NG/J | 273.7 | 251.1 | 229.4 | 213.0 | 205.3 | 300.1 | 247.3 | 221.6 | 353.2 | 334.0 | 332.3 | 223.3 |
| $SO_2$ (ADJ. TO 0% $O_2$) | PPM | 370 | 452 | 370 | 402 | 416 | 373 | 385 | 538 | 476 | 361 | 421 | 427 |
| $SO_2$ | NG/J | 259.6 | 308.2 | 255.8 | 277.2 | 284.8 | 258.2 | 269.4 | 371.4 | 328.9 | 247.6 | 289.4 | 293.7 |
| CO (ADJ. TO 0% $O_2$) | PPM | 15 | 15 | 15 | 15 | 15 | 16 | 119 | 162 | 16 | 15 | 16 | 34 |
| CO | NG/J | 4.7 | 4.6 | 4.6 | 4.6 | 4.5 | 4.7 | 36.3 | 49.0 | 4.8 | 4.4 | 4.8 | 10.4 |
| HC (ADJ. TO 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ AT ECONOMIZER OUTLET | % | 4.6 | 4.7 | 4.5 | 4.4 | 4.3 | 3.4 | 3.5 | 3.5 | 5.2 | 5.4 | 5.4 | 4.0 |
| $O_2$ AT A.H. OUTLET | % | 6.8 | 5.1 | 5.3 | 5.6 | 5.3 | 4.8 | 4.9 | 4.7 | 7.0 | 7.8 | 7.1 | 4.8 |
| $CO_2$ AT ECONOMIZER OUTLET | % | 14.2 | 14.2 | 14.3 | 14.5 | 14.5 | 15.2 | 15.1 | 15.2 | 13.7 | 13.5 | 13.5 | 14.8 |
| $CO_2$ AT A.H. OUTLET | % | 12.3 | 13.8 | 13.5 | 13.4 | 13.7 | 13.9 | 13.8 | 14.1 | 12.1 | 11.4 | 12.0 | 14.1 |
| CARBON LOSS IN FLYASH | % | 0.20 | 0.14 | 0.24 | 0.30 | 0.28 | 0.24 | 0.59 | 0.24 | 0.22 | 0.27 | 0.16 | 0.25 |

# OVERFIRE AIR OPERATION STUDY

## EMISSIONS TEST DATA

| TEST NO. | | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | ← TILT VARIATION WITH OFA → | | | | | | ← OPTIMUM OFA OPERATION → | | | | | |
| UNIT LOAD CONDITION | | ← MAXIMUM → | | | | | | | | 3/4 MAX | 3/4 MAX | 1/2 MAX | 1/2 MAX |
| EXCESS AIR CONDITION | | ← MINIMUM → | | | | | | | | | | | |
| FURNACE CONDITION | | MODERATE | MODERATE | HEAVY | MODERATE | MODERATE | MODERATE | CLEAN | MODERATE | CLEAN | MODERATE | CLEAN | MODERATE |
| DATE | 1975 | 10/4 | 10/5 | 10/4 | 10/3 | 10/3 | 10/3 | 10/6 | 10/8 | 10/9 | 10/9 | 10/12 | 10/5 |
| UNIT LOAD | MW | 434 | 422 | 429 | 427 | 424 | 429 | 417 | 426 | 356 | 358 | 253 | 265 |
| MAIN STEAM FLOW | KG/S | 364 | 370 | 370 | 372 | 377 | 367 | 374 | 377 | 299 | 299 | 218 | 217 |
| SHO TEMPERATURE | C | 543 | 520 | 531 | 529 | 519 | 535 | 522 | 521 | 531 | 538 | 525 | 542 |
| RHO TEMPERATURE | C | 547 | 525 | 543 | 533 | 515 | 539 | 538 | 527 | 527 | 537 | 510 | 526 |
| FUEL ELEVATIONS IN SERVICE | | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ALL 5 | ABCE | BCDE | ACDE |
| OFA NOTTLE TILT | DEG | -30 | 0 | 0 | 0 | +30 | +30 | +30 | +30 | +30 | +30 | +30 | +30 |
| FUEL NOZZLE TILT | DEG | 0 | -20 | 0 | +25 | 0 | +25 | 0 | 0 | 0 | 0 | 0 | 0 |
| NOZZLE COMPARTMENT DAMPER POSITION - % OPEN: OFA | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 80 | 75 |
| OFA | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 80 | 75 |
| AUX | | 15 | 0 | 20 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 10 | 10 |
| A FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 100 |
| AUX | | 0 | 0 | 0 | 5 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| B FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 |
| AUX | | 0 | 0 | 5 | 5 | 5 | 5 | 0 | 5 | 5 | 5 | 5 | 0 |
| C FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 5 | 0 | 5 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 |
| D FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 100 | 100 |
| AUX | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E FUEL | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| EXCESS AIR AT ECONOMIZER OUTLET | % | 25.1 | 22.0 | 25.1 | 21.3 | 23.5 | 21.7 | 18.5 | 19.6 | 19.3 | 21.5 | 22.8 | 23.9 |
| THEO. AIR TO THE FUEL FIRING ZONE | % | 101.1 | 99.2 | 101.1 | 98.4 | 99.8 | 98.6 | 95.8 | 97.1 | 98.1 | 95.0 | 97.3 | 99.7 |
| $NO_x$ (ADJ. TO 0% $O_2$) | PPM | 533 | 366 | 422 | 569 | 375 | 498 | 392 | 382 | 329 | 337 | 266 | 310 |
| $NO_x$ AS $NO_2$ | NG/J | 263.4 | 179.8 | 212.1 | 283.5 | 186.1 | 252.1 | 196.5 | 190.2 | 161.3 | 167.8 | 132.0 | 155.3 |
| $SO_2$ (ADJ. TO 0% $O_2$) | PPM | 450 | 397 | 404 | 386 | 432 | 349 | 347 | 364 | 403 | 358 | 403 | 447 |
| $SO_2$ | NG/J | 309.4 | 271.1 | 281.9 | 267.5 | 298.3 | 245.9 | 241.8 | 252.1 | 275.2 | 247.8 | 278.4 | 311.1 |
| CO (ADJ. TO 0% $O_2$) | PPM | 15 | 16 | 15 | 15 | 16 | 51 | 19 | 19 | 19 | 21 | 63 | 15 |
| CO | NG/J | 4.5 | 4.8 | 4.6 | 4.4 | 4.9 | 15.8 | 5.8 | 5.8 | 5.7 | 6.3 | 19.0 | 4.5 |
| HC (ADJ. TO 0% $O_2$) | PPM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $O_2$ AT ECONOMIZER OUTLET | % | 4.3 | 3.9 | 4.3 | 3.8 | 4.1 | 3.8 | 3.4 | 3.5 | 3.5 | 3.8 | 4.0 | 4.1 |
| $O_2$ AT A.H. OUTLET | % | 5.7 | 4.9 | 5.2 | 5.1 | 5.4 | 5.1 | 5.3 | 5.6 | 6.1 | 5.8 | 5.5 | 5.7 |
| $CO_2$ AT ECONOMIZER OUTLET | % | 14.4 | 14.9 | 14.5 | 14.9 | 14.6 | 14.9 | 15.2 | 15.1 | 15.3 | 14.8 | 14.7 | 14.6 |
| $CO_2$ AT A.H. OUTLET | % | 13.1 | 14.0 | 13.8 | 13.7 | 13.5 | 13.8 | 13.5 | 13.3 | 13.0 | 13.1 | 13.3 | 13.2 |
| CARBON LOSS IN FLYASH | % | 0.21 | 0.30 | 0.28 | 0.26 | 0.22 | 0.63 | 0.40 | 0.43 | 0.20 | 0.22 | 0.47 | 0.22 |

# BASELINE OPERATION STUDY

## TEST DATA

| TEST NO. | | 1 | 2 | 2A | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 5/7 | 5/5 | 5/7 | 5/7 | 10/10 | 7/16 | 7/15 | 7/16 | 5/5 | 4/30 |
| Unit Load | MW | 429 | 427 | 428 | 428 | 360 | 259 | 260 | 258 | 430 | 428 |
| **FLOWS** | kg/sec | | | | | | | | | | |
| Feedwater | | 375 | 375 | 377 | 377 | 295 | 201 | 198 | 195 | 375 | 377 |
| 1st Stage Steam | | 372 | 372 | 374 | 373 | 282 | 186 | 186 | 185 | 373 | 369 |
| **PRESSURES** | MPa | | | | | | | | | | |
| Economizer Inlet | | 19.305 | 19.160 | 19.319 | 19.305 | 18.285 | 17.216 | 17.099 | 17.161 | 19.222 | 19.167 |
| Drum | | 18.857 | 18.802 | 18.871 | 18.857 | 18.037 | 17.023 | 16.913 | 17.016 | 18.809 | 18.788 |
| SH Outlet | | 17.168 | 17.058 | 17.154 | 17.175 | 16.961 | 16.458 | 16.361 | 16.465 | 17.106 | 17,078 |
| Turbine 1st Stage | | 12.838 | 12.810 | 12.866 | 12.845 | 9.735 | 6.426 | 6.419 | 6.384 | 12.831 | 12.742 |
| RH Inlet | | 3.820 | 3.799 | 3.806 | 3.799 | 3.034 | 2.041 | 2.048 | 2.034 | 3.820 | 3.785 |
| RH Outlet | | 3.585 | 3.564 | 3.564 | 3.564 | 2.889 | 1.972 | 1.972 | 1.972 | 3.599 | 3.571 |
| SH Spray Water | | 18.657 | 18.512 | 18.692 | 18.506 | 17.940 | 17.547 | 17.444 | 17.540 | 18.512 | 18.499 |
| HP Htr FW Inlet | | 19.519 | 19.471 | 19.588 | 19.546 | 18.623 | 17.478 | 17.395 | 17.430 | 19.478 | 19.505 |
| HP Htr Stm Inlet | | 3.792 | 3.788 | 3.785 | 3.758 | 3.061 | 2.041 | 2.048 | 2.034 | 3.799 | 3.771 |
| **TEMPERATURES** | °C | | | | | | | | | | |
| **Water and Steam** | | | | | | | | | | | |
| Economizer Inlet | | 247 | 248 | 246 | 246 | 238 | 218 | 218 | 217 | 248 | 250 |
| Economizer Outlet | L | 325 | 333 | 333 | 339 | 329 | 301 | 308 | 321 | 329 | 330 |
| Economizer Outlet | LC | 328 | 336 | 337 | 342 | 331 | 303 | 309 | 322 | 332 | 332 |
| Economizer Outlet | RC | 325 | 332 | 333 | 337 | 328 | 301 | 305 | 319 | 331 | 327 |
| Economizer Outlet | R | 326 | 334 | 335 | 339 | 331 | 299 | 307 | 318 | 331 | 334 |
| SH DESH Inlet Link | R | 396 | 402 | 400 | 403 | 408 | 394 | 399 | 408 | 401 | 400 |
| SH DESH Inlet Link | L | 396 | 397 | 402 | 408 | 407 | 397 | 404 | 413 | 399 | 399 |
| SH DESH Outlet Link | L | 395 | 390 | 401 | 403 | 403 | 391 | 391 | 393 | 393 | 399 |
| SH DESH Outlet Link | R | 394 | 396 | 398 | 400 | 400 | 388 | 388 | 391 | 399 | 398 |
| SH Div Panel Outlet Link | L | 426 | 439 | 436 | 437 | 440 | 438 | 436 | 443 | 438 | 436 |
| SH Div Panel Outlet Link | R | 435 | 438 | 441 | 441 | 435 | 434 | 433 | 434 | 434 | 435 |
| SH Pend Spcd Front Inlet Link | L | 482 | 493 | 493 | 493 | 502 | 514 | 509 | 513 | 492 | 490 |
| SH Pend Spcd Front Inlet Link | C | 489 | 493 | 494 | 493 | 501 | 518 | 506 | 508 | 492 | 489 |
| SH Pend Spcd Front Inlet Link | R | 494 | 486 | 490 | 491 | 499 | 502 | 498 | 493 | 488 | 491 |
| SH Outlet | L | 526 | 540 | 533 | 536 | 547 | 549 | 548 | 552 | 541 | 532 |
| SH Outlet | R | 536 | 541 | 535 | 535 | 546 | 541 | 537 | 537 | 540 | 536 |
| RH DESH Inlet | L | 322 | 324 | 324 | 326 | 317 | 288 | 287 | 288 | 327 | 323 |
| RH DESH Inlet | R | 323 | 324 | 325 | 326 | 318 | 293 | 292 | 292 | 327 | 324 |
| RH Radiant Wall Inlet | L | 321 | 321 | 324 | 324 | 309 | 287 | 286 | 287 | 317 | 323 |
| RH Radiant Wall Inlet | R | 322 | 321 | 324 | 326 | 312 | 293 | 292 | 292 | 313 | 323 |
| RH Radiant Wall Outlet Link | L | 360 | 365 | 359 | 359 | 347 | 340 | 339 | 341 | 358 | 357 |
| RH Radiant Wall Outlet Link | LC | 368 | 374 | 366 | 366 | 360 | 350 | 347 | 358 | 366 | 367 |
| RH Radiant Wall Outlet Link | RC | 353 | 355 | 349 | 351 | 349 | 336 | 337 | 336 | 349 | 357 |
| RH Radiant Wall Outlet Link | R | 355 | 363 | 357 | 357 | 345 | 339 | 345 | 339 | 353 | 364 |
| RH Outlet | L | 542 | 550 | 547 | 546 | 547 | 534 | 544 | 546 | 545 | 536 |
| RH Outlet | R | NA | NA | NA | NA | 550 | 525 | 532 | 528 | NA | NA |
| RH Outlet | Comb. | 539 | 548 | 538 | 538 | 550 | 533 | 538 | 539 | 545 | 538 |
| HP Heater Stm Inlet | | 321 | 324 | 324 | 326 | 317 | 291 | 290 | 291 | 326 | 324 |
| HP Heater Drain | | 216 | 216 | 216 | 216 | 206 | 188 | 189 | 188 | 216 | 216 |
| HP Heater FW In | | 209 | 209 | 209 | 209 | 202 | 186 | 186 | 186 | 209 | 209 |
| HP Heater FW Out | | 248 | 248 | 247 | 248 | 238 | 218 | 219 | 218 | 251 | 251 |
| SH DESH Spray Water | L | 125 | 126 | 127 | 128 | 144 | 144 | 146 | 145 | 128 | 136 |
| SH DESH Spray Water | R | 127 | 125 | 128 | 131 | 145 | 144 | 146 | 145 | 130 | 135 |
| RH DESH Spray Water | | 127 | 121 | 113 | 112 | 147 | 103 | 104 | 101 | 162 | 112 |
| **Air and Gas** | | | | | | | | | | | |
| AH Air Inlet | L | 37 | 39 | 36 | 36 | 42 | 42 | 39 | 39 | 38 | 34 |
| AH Air Inlet | R | 42 | 42 | 39 | 39 | 41 | 41 | 39 | 41 | 43 | 38 |
| AH Air Outlet | L | 273 | 274 | 273 | 275 | 267 | 243 | 248 | 248 | 275 | 271 |
| AH Air Outlet | R | 268 | 268 | 265 | 268 | 271 | 245 | 248 | 246 | 271 | 266 |
| AH Gas Inlet | L | 328 | 336 | 341 | 347 | 326 | 282 | 291 | 298 | 334 | 336 |
| AH Gas Inlet | R | 332 | 337 | 341 | 347 | 332 | 289 | 294 | 302 | 337 | 340 |
| AH Gas Outlet | L | 122 | 126 | 122 | 122 | 122 | 109 | 111 | 109 | 127 | 123 |
| AH Gas Outlet | R | 118 | 119 | 122 | 123 | 125 | 107 | 104 | 106 | 120 | 119 |

# BASELINE OPERATION STUDY

TEST DATA

| TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 5/1 | 7/17 | 7/18 | 5/9 | 5/9 | 5/9 | 10/9 | 7/22 | 7/21 | 7/21 |
| Unit Load | MW | 428 | 256 | 259 | 433 | 433 | 433 | 361 | 258 | 260 | 258 |
| **FLOWS** | kg/sec | | | | | | | | | | |
| Feedwater | | 344 | 198 | 198 | 377 | 375 | 373 | 297 | 204 | 204 | 198 |
| 1st Stage Steam | | 370 | 186 | 190 | 373 | 374 | 374 | 280 | 189 | 190 | 188 |
| **PRESSURES** | MPa | | | | | | | | | | |
| Economizer Inlet | | 19.181 | 17.106 | 14.582 | 19.271 | 19.285 | 19.298 | 18.368 | 17.299 | 17.050 | 17.030 |
| Drum | | 18.768 | 16.940 | 14.417 | 18.850 | 18.871 | 18.878 | 18.078 | 17.078 | 16.844 | 16.844 |
| SH Outlet | | 17.044 | 16.382 | 13.720 | 17.175 | 17.237 | 17.175 | 16.961 | 16.527 | 16.265 | 16.272 |
| Turbine 1st Stage | | 12.776 | 6.371 | 6.550 | 12.852 | 12.866 | 12.866 | 9.694 | 6.488 | 6.536 | 6.467 |
| RH Inlet | | 3.778 | 2.034 | 2.041 | 3.840 | 3.847 | 3.826 | 3.047 | 2.027 | 2.027 | 2.027 |
| RH Outlet | | 3.551 | 1.965 | 1.979 | 3.627 | 3.627 | 3.606 | 2.923 | 1.965 | 1.965 | 1.958 |
| SH Spray Water | | 18.478 | 17.437 | 14.934 | 18.692 | 18.657 | 18.712 | 17.830 | 17.526 | 17.375 | 17.375 |
| HP Htr FW Inlet | | 19.498 | 17.382 | 14.844 | 19.560 | 19.588 | 19.616 | 18.692 | 17.575 | 17.313 | 17.285 |
| HP Htr Stm Inlet | | 3.771 | 2.034 | 2.055 | 3.847 | 3.820 | 3.854 | 3.075 | 2.034 | 2.034 | 2.034 |
| **TEMPERATURES** | °C | | | | | | | | | | |
| *Water and Steam* | | | | | | | | | | | |
| Economizer Inlet | | 252 | 217 | 218 | 248 | 247 | 247 | 238 | 217 | 217 | 217 |
| Economizer Outlet | L | 342 | 304 | 317 | 331 | 340 | 348 | 327 | 302 | 304 | 317 |
| Economizer Outlet | LC | 343 | 304 | 319 | 339 | 345 | 356 | 329 | 304 | 306 | 319 |
| Economizer Outlet | RC | 342 | 303 | 317 | 339 | 342 | 351 | 325 | 303 | 304 | 317 |
| Economizer Outlet | R | 347 | 303 | 316 | 329 | 341 | 357 | 328 | 299 | 304 | 316 |
| SH DESH Inlet Link | R | 403 | 398 | 409 | 398 | 399 | 408 | 408 | 396 | 399 | 409 |
| SH DESH Inlet Link | L | 402 | 401 | 412 | 399 | 401 | 409 | 407 | 399 | 399 | 412 |
| SH DESH Outlet Link | L | 399 | 391 | 386 | 396 | 399 | 408 | 407 | 397 | 396 | 396 |
| SH DESH Outlet Link | R | 401 | 388 | 382 | 400 | 401 | 403 | 404 | 398 | 393 | 393 |
| SH Div Panel Outlet Link | L | 449 | 438 | 435 | 433 | 434 | 439 | 446 | 440 | 440 | 439 |
| SH Div Panel Outlet Link | R | 441 | 436 | 433 | 433 | 436 | 441 | 440 | 438 | 435 | 434 |
| SH Pend Spcd Front Inlet Link | L | 501 | 508 | 504 | 488 | 493 | 494 | 508 | 506 | 509 | 505 |
| SH Pend Spcd Front Inlet Link | C | 498 | 509 | 505 | 489 | 494 | 493 | 501 | 508 | 507 | 503 |
| SH Pend Spcd Front Inlet Link | R | 490 | 503 | 498 | 486 | 487 | 491 | 496 | NA | NA | NA |
| SH Outlet | L | 546 | 545 | 544 | 532 | 537 | 541 | 551 | 545 | 545 | 547 |
| SH Outlet | R | 544 | 541 | 541 | 532 | 536 | 538 | 544 | 537 | 536 | 537 |
| RH DESH Inlet | L | 326 | 287 | 303 | 326 | 327 | 330 | 317 | 284 | 286 | 286 |
| RH DESH Inlet | R | 327 | 292 | 312 | 326 | 328 | 331 | 322 | 289 | 291 | 292 |
| RH Radiant Wall Inlet | L | 325 | 286 | 302 | 311 | 311 | 309 | 299 | 283 | 284 | 285 |
| RH Radiant Wall Inlet | R | 326 | 292 | 312 | 313 | 313 | 314 | 304 | 289 | 291 | 292 |
| RH Radiant Wall Outlet Link | L | 363 | 340 | 346 | 344 | 344 | 351 | 340 | 337 | 336 | 336 |
| RH Radiant Wall Outlet Link | LC | 376 | 352 | 361 | 351 | 349 | 354 | 347 | 344 | 343 | 343 |
| RH Radiant Wall Outlet Link | RC | 362 | 341 | 353 | 342 | 341 | 343 | 342 | 332 | 333 | 333 |
| RH Radiant Wall Outlet Link | R | 370 | 346 | 353 | 350 | 347 | 348 | 339 | 333 | 339 | 338 |
| RH Outlet | L | 542 | 537 | 534 | 544 | 542 | 545 | 546 | 542 | 542 | 540 |
| RH Outlet | R | NA | 535 | 534 | NA | NA | NA | 543 | 525 | 528 | 531 |
| RH Outlet | Comb. | 548 | 538 | 536 | 539 | 539 | 542 | 546 | 538 | 538 | 537 |
| HP Heater Stm Inlet | | 325 | 291 | 308 | 325 | 327 | 329 | 318 | 288 | 289 | 290 |
| HP Heater Drain | | 216 | 188 | 188 | 217 | 217 | 217 | 206 | 188 | 188 | 188 |
| HP Heater FW In | | 209 | 186 | 186 | 210 | 210 | 210 | 202 | 185 | 185 | 186 |
| HP Heater FW Out | | 253 | 219 | 219 | 249 | 248 | 248 | 238 | 218 | 218 | 218 |
| SH DESH Spray Water | L | 138 | 145 | 144 | 128 | 125 | 129 | 144 | 141 | 143 | 144 |
| SH DESH Spray Water | R | 138 | 145 | 144 | 125 | 123 | 127 | 139 | 137 | 143 | 144 |
| RH DESH Spray Water | | 118 | 108 | 108 | 165 | 163 | 170 | 157 | 107 | 102 | 104 |
| *Air and Gas* | | | | | | | | | | | |
| AH Air Inlet | L | 39 | 42 | 46 | 37 | 38 | 38 | 47 | 39 | 39 | 39 |
| AH Air Inlet | R | 43 | 41 | 44 | 43 | 44 | 41 | 42 | 40 | 38 | 42 |
| AH Air Outlet | L | 277 | 246 | 248 | 263 | 274 | 271 | 263 | 247 | 247 | 250 |
| AH Air Outlet | R | 273 | 248 | 246 | 258 | 271 | 263 | 270 | 247 | 249 | 248 |
| AH Gas Inlet | L | 349 | 288 | 298 | 331 | 339 | 346 | 327 | 288 | 290 | 298 |
| AH Gas Inlet | R | 351 | 292 | 302 | 337 | 341 | 351 | 331 | 292 | 296 | 302 |
| AH Gas Outlet | L | 127 | 111 | 117 | 128 | 129 | 129 | 122 | 117 | 115 | 116 |
| AH Gas Outlet | R | 126 | 108 | 106 | 122 | 122 | 125 | 121 | 110 | 111 | 109 |

# BIASED FIRING OPERATION STUDY

## TEST DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 9/17 | 9/18 | 9/20 | 12/13 | 10/11 | 10/12 | 10/12 | 10/5 |
| Unit Load | MW | 430 | 426 | 434 | 356 | 351 | 360 | 257 | 270 |
| **FLOWS** | kg/sec | | | | | | | | |
| Feedwater | | 375 | 370 | 369 | 297 | 295 | 299 | 218 | 207 |
| 1st Stage Steam | | 359 | 359 | 359 | 288 | 280 | 288 | 180 | 200 |
| **PRESSURES** | MPa | | | | | | | | |
| Economizer Inlet | | 19.154 | 19.133 | 19.098 | 18.381 | 18.381 | 18.278 | 17.588 | 17.588 |
| Drum | | 18.712 | 18.636 | 18.616 | 18.071 | 18.085 | 17.975 | 17.451 | 17.430 |
| SH Outlet | | 17.044 | 16.940 | 16.913 | 16.961 | 16.940 | 16.961 | 16.892 | 16.844 |
| Turbine 1st Stage | | 12.438 | 12.397 | 12.417 | 9.935 | 9.611 | 9.956 | 6.743 | 6.922 |
| RH Inlet | | 3.771 | 3.764 | 3.778 | 3.047 | 2.985 | 3.068 | 2.137 | 2.227 |
| RH Outlet | | 3.613 | 3.592 | 3.613 | 2.882 | 2.903 | 2.937 | 2.068 | 2.151 |
| SH Spray Water | | 18,512 | 18.450 | NA | 17.975 | 17.975 | 17.893 | 17.561 | NA |
| HP Htr FW Inlet | | 19.554 | 19.512 | 19.305 | 18.630 | 18.643 | 18.636 | 17.926 | 17.933 |
| HP Htr Stm Inlet | | 3.806 | 3.792 | 3.820 | 3.040 | 3.034 | 3.116 | 2.144 | 2.248 |
| **TEMPERATURES** | °C | | | | | | | | |
| **Water and Steam** | | | | | | | | | |
| Economizer Inlet | | 249 | 248 | 249 | 238 | 237 | 238 | 219 | 221 |
| Economizer Outlet | L | 329 | 330 | 332 | 314 | 319 | 319 | 302 | 312 |
| Economizer Outlet | LC | 333 | 333 | 336 | 315 | 322 | 321 | 304 | 313 |
| Economizer Outlet | RC | 331 | 331 | 333 | 313 | 319 | 318 | 301 | 312 |
| Economizer Outlet | R | 333 | 333 | 333 | 318 | 323 | 321 | 306 | 313 |
| SH DESH Inlet Link | R | 402 | 401 | 402 | 393 | 403 | 398 | 398 | 405 |
| SH DESH Inlet Link | L | 398 | 399 | 403 | 397 | 399 | 396 | 395 | 404 |
| SH DESH Outlet Link | L | 402 | 400 | 401 | 393 | 403 | 398 | 398 | 390 |
| SH DESH Outlet Link | R | 397 | 399 | 403 | 397 | 399 | 396 | 395 | 387 |
| SH Div Panel Outlet Link | L | 432 | 432 | 442 | 438 | 438 | 438 | 438 | 435 |
| SH Div Panel Outlet Link | R | 422 | 423 | 427 | 444 | 433 | 433 | 434 | 424 |
| SH Pend Spcd Front Inlet Link | L | 479 | 488 | 502 | 508 | 495 | 508 | 506 | 509 |
| SH Pend Spcd Front Inlet Link | C | 476 | 484 | 493 | 515 | 496 | 501 | 507 | 505 |
| SH Pend Spcd Front Inlet Link | R | 468 | 473 | 477 | 507 | 489 | 502 | 505 | 492 |
| SH Outlet | L | 521 | 529 | 543 | 546 | 536 | 544 | 540 | 547 |
| SH Outlet | R | 517 | 521 | 525 | 543 | 536 | 540 | 543 | 539 |
| RH DESH Inlet | L | 315 | 319 | 327 | 315 | 306 | 314 | 286 | 288 |
| RH DESH Inlet | R | 314 | 318 | 326 | 317 | 309 | 316 | 291 | NA |
| RH Radiant Wall Inlet | L | 313 | 317 | 314 | 314 | 301 | 309 | 284 | 287 |
| RH Radiant Wall Inlet | R | 314 | 318 | 316 | 317 | 306 | 312 | 292 | 294 |
| RH Radiant Wall Outlet Link | L | 351 | 356 | 359 | 353 | 337 | 349 | 329 | 336 |
| RH Radiant Wall Outlet Link | LC | 363 | 366 | 374 | 368 | 350 | 364 | 348 | 350 |
| RH Radiant Wall Outlet Link | RC | 348 | 348 | 344 | 356 | 342 | 352 | 337 | 335 |
| RH Radiant Wall Outlet Link | R | 349 | 344 | 341 | 354 | 336 | 346 | 333 | 329 |
| RH Outlet | L | 530 | 543 | 551 | 552 | 531 | 544 | 526 | 546 |
| RH Outlet | R | 542 | 538 | 531 | 527 | 543 | 547 | 542 | 543 |
| RH Outlet | Comb. | 538 | 542 | 543 | 541 | 539 | 546 | 536 | 548 |
| HP Heater Stm Inlet | | 314 | 318 | 327 | 316 | 308 | 316 | 289 | 292 |
| HP Heater Drain | | 217 | 217 | 217 | 205 | 206 | 207 | 189 | 192 |
| HP Heater FW In | | 211 | 212 | 211 | 202 | 201 | 202 | 187 | 188 |
| HP Heater FW Out | | 250 | 249 | 251 | 238 | 237 | 239 | 220 | 222 |
| SH DESH Spray Water | L | 133 | 139 | 131 | 126 | 123 | 124 | 117 | 147 |
| SH DESH Spray Water | R | 134 | 140 | 132 | 126 | 124 | 125 | 117 | 147 |
| RH DESH Spray Water | | 134 | 141 | 166 | 142 | 157 | 156 | 116 | 117 |
| **Air and Gas** | | | | | | | | | |
| AH Air Inlet | L | 37 | 37 | 37 | 43 | 42 | 46 | 49 | 48 |
| AH Air Inlet | R | 37 | 39 | 41 | 43 | 37 | 43 | 47 | 46 |
| AH Air Outlet | L | 279 | 277 | 280 | 261 | 265 | 261 | 244 | 248 |
| AH Air Outlet | R | 278 | 275 | 277 | 268 | 271 | 265 | 249 | 253 |
| AH Gas Inlet | L | 348 | 347 | 349 | 314 | 311 | 319 | 291 | 299 |
| AH Gas Inlet | R | 351 | 349 | 349 | 322 | 326 | 322 | 293 | 301 |
| AH Gas Outlet | L | 132 | 132 | 133 | 120 | 125 | 121 | 117 | 121 |
| AH Gas Outlet | R | 124 | 122 | 116 | 120 | 127 | 115 | 111 | 119 |

# BIASED FIRING OPERATION STUDY

## TEST DATA

| TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 9/17 | 9/18 | 9/18 | 10/11 | 12/13 | 12/13 | 7/23 | 7/24 |
| Unit Load | MW | 429 | 428 | 429 | 351 | 356 | 356 | 256 | 259 |
| **FLOWS** | kg/sec | | | | | | | | |
| Feedwater | | 375 | 370 | 369 | 295 | 299 | 299 | 201 | 204 |
| 1st Stage Steam | | 357 | 360 | 359 | 277 | 288 | 285 | 186 | 190 |
| **PRESSURES** | MPa | | | | | | | | |
| Economizer Inlet | | 19.174 | 19.154 | 19.098 | 18.381 | 18.368 | 18.416 | 17.264 | 17.299 |
| Drum | | 18.657 | 18.671 | 18.657 | 18.050 | 18.064 | 18.037 | 17.058 | 17.113 |
| SH Outlet | | 16.989 | 17.023 | 16.961 | 16.927 | 16.858 | 16.906 | 16.534 | 16.575 |
| Turbine 1st Stage | | 12.397 | 12.486 | 12.438 | 9.577 | 9.942 | 9.908 | 6.467 | 6.640 |
| RH Inlet | | 3.771 | 3.778 | 3.778 | 2.978 | 3.040 | 3.040 | 2.006 | 2.048 |
| RH Outlet | | 3.592 | 3.613 | 3.613 | 2.896 | 2.896 | 2.875 | 1.944 | 1.986 |
| SH Spray Water | | 18.457 | 18.416 | 18.485 | 17.699 | 18.023 | 17.975 | 17.588 | 17.637 |
| HP Htr FW Inlet | | 19.581 | 19.609 | 19.526 | 18.726 | 18.761 | 18.685 | 17.520 | 17.602 |
| HP Htr Stm Inlet | | 3.799 | 3.806 | 3.806 | 3.013 | 3.040 | 3.040 | 2.013 | 2.041 |
| **TEMPERATURES** | °C | | | | | | | | |
| **Water and Steam** | | | | | | | | | |
| Economizer Inlet | | 248 | 248 | 249 | 236 | 237 | 238 | 217 | 217 |
| Economizer Outlet | L | 331 | 334 | 336 | 322 | 318 | 319 | 304 | 304 |
| Economizer Outlet | LC | 336 | 337 | 339 | 326 | 318 | 319 | 307 | 306 |
| Economizer Outlet | RC | 334 | 334 | 336 | 322 | 316 | 320 | 305 | 303 |
| Economizer Outlet | R | 335 | 337 | 339 | 325 | 323 | 324 | 303 | 304 |
| SH DESH Inlet Link | R | 403 | 405 | 407 | 404 | 397 | 398 | 400 | 399 |
| SH DESH Inlet Link | L | 399 | 402 | 405 | 402 | 399 | 399 | 401 | 402 |
| SH DESH Outlet Link | L | 403 | 404 | 406 | 404 | 396 | 397 | 398 | 393 |
| SH DESH Outlet Link | R | 399 | 402 | 404 | 402 | 399 | 398 | 396 | 390 |
| SH Div Panel Outlet Link | L | 431 | 437 | 438 | 438 | 436 | 442 | 441 | 437 |
| SH Div Panel Outlet Link | R | 423 | 429 | 431 | 435 | 445 | 442 | 438 | 437 |
| SH Pend Spcd Front Inlet Link | L | 477 | 494 | 494 | 494 | 503 | 512 | 504 | 501 |
| SH Pend Spcd Front Inlet Link | C | 474 | 494 | 488 | 496 | 505 | 506 | 510 | 504 |
| SH Pend Spcd Front Inlet Link | R | 466 | 488 | 479 | 491 | 511 | 505 | 499 | 502 |
| SH Outlet | L | 518 | 537 | 537 | 537 | 542 | 547 | 545 | 543 |
| SH Outlet | R | 513 | 535 | 529 | 536 | 544 | 542 | 542 | 541 |
| RH DESH Inlet | L | 311 | 327 | 327 | 307 | 312 | 313 | 287 | 286 |
| RH DESH Inlet | R | 311 | NA | NA | 309 | 314 | 316 | 291 | 291 |
| RH Radiant Wall Inlet | L | 309 | 312 | 310 | 306 | 311 | 310 | 286 | 284 |
| RH Radiant Wall Inlet | R | 311 | 314 | 314 | 309 | 314 | 314 | 291 | 291 |
| RH Radiant Wall Outlet Link | L | 343 | 346 | 348 | 342 | 350 | 358 | 329 | 334 |
| RH Radiant Wall Outlet Link | LC | 357 | 360 | 358 | 354 | 359 | 364 | 346 | 351 |
| RH Radiant Wall Outlet Link | RC | 341 | 346 | 343 | 346 | 352 | 350 | 338 | 339 |
| RH Radiant Wall Outlet Link | R | 339 | 342 | 340 | 340 | 355 | 352 | 337 | 345 |
| RH Outlet | L | 518 | 533 | 542 | 534 | 547 | 549 | 532 | 536 |
| RH Outlet | R | 532 | 541 | 539 | 541 | 534 | 532 | 533 | NA |
| RH Outlet | Comb. | 530 | 539 | 542 | 539 | 540 | 540 | 538 | 537 |
| HP Heater Stm Inlet | | 311 | 327 | 326 | 308 | 313 | 314 | 289 | 289 |
| HP Heater Drain | | 217 | 217 | 217 | 206 | 205 | 205 | 187 | 188 |
| HP Heater FW In | | 211 | 211 | 211 | 201 | 201 | 201 | 185 | 185 |
| HP Heater FW Out | | 249 | 251 | 250 | 237 | 238 | 238 | 218 | 218 |
| SH DESH Spray Water | L | 134 | 133 | 152 | 127 | 131 | 140 | 143 | 143 |
| SH DESH Spray Water | R | 134 | 134 | 152 | 127 | 131 | 138 | 143 | 143 |
| RH DESH Spray Water | | 152 | 165 | 166 | 145 | 147 | 156 | 104 | 104 |
| **Air and Gas** | | | | | | | | | |
| AH Air Inlet | L | 36 | 37 | 37 | 43 | 43 | 43 | 40 | 40 |
| AH Air Inlet | R | 37 | 39 | 38 | 41 | 42 | 42 | 39 | 40 |
| AH Air Outlet | L | 279 | 277 | 280 | 263 | 262 | 262 | 247 | 248 |
| AH Air Outlet | R | 278 | 276 | 278 | 268 | 271 | 269 | 249 | 248 |
| AH Gas Inlet | L | 350 | 344 | 351 | 322 | 320 | 315 | 286 | 290 |
| AH Gas Inlet | R | 353 | 351 | 355 | 328 | 326 | 329 | 292 | 294 |
| AH Gas Outlet | L | 132 | 132 | 132 | 123 | 124 | 122 | 119 | 122 |
| AH Gas Outlet | R | 125 | 124 | 124 | 119 | 121 | 121 | 113 | 112 |

# OVERFIRE AIR OPERATION STUDY

## TEST DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 9/17 | 9/26 | 9/26 | 9/26 | 9/26 | 10/1 | 10/1 | 10/1 |
| UNIT LOAD | MW | 428 | 430 | 430 | 430 | 431 | 430 | 429 | 428 |
| **FLOWS** | KG/SEC | | | | | | | | |
| FEEDWATER | | 369 | 372 | 372 | 370 | 370 | 372 | 372 | 370 |
| 1ST STAGE STEAM | | 358 | 364 | 364 | 362 | 364 | 362 | 362 | 360 |
| **PRESSURES** | MPA | | | | | | | | |
| ECONOMIZER INLET | | 19.126 | 19.167 | 19.195 | 19.188 | 19.236 | 19.209 | 19.147 | 19.133 |
| DRUM | | 18.657 | 18.685 | 18.726 | 18.692 | 18.726 | 18.678 | 18.685 | 18.643 |
| SH OUTLET | | 16.975 | 17.009 | 17.023 | 17.009 | 17.037 | 16.961 | 17.009 | 16.989 |
| TURBINE 1ST STAGE | | 12.452 | 12.569 | 12.569 | 12.528 | 12.590 | 12.535 | 12.535 | 12.500 |
| RH INLET | | 3.765 | 3.771 | 3.785 | 3.792 | 3.806 | 3.771 | 3.771 | 3.765 |
| RH OUTLET | | 3.606 | 3.613 | 3.613 | 3.627 | 3.627 | 3.592 | 3.613 | 3.599 |
| SH SPRAY WATER | | 18.471 | 18.388 | 18.388 | 18.388 | 18.388 | 18.388 | 18.388 | 18.388 |
| HP HTR FW INLET | | 19.478 | 19.809 | 19.733 | 19.588 | 19.657 | 19.540 | 19.650 | 19.560 |
| HP HTR STM INLET | | 3.799 | 3.799 | 3.806 | 3.827 | 3.827 | 3.785 | 3.799 | 3.799 |
| **TEMPERATURES** | °C | | | | | | | | |
| **WATER AND STEAM** | | | | | | | | | |
| ECONOMIZER INLET | | 249 | 248 | 248 | 249 | 249 | 248 | 248 | 248 |
| ECONOMIZER OUTLET | L | 336 | 334 | 334 | 333 | 335 | 330 | 330 | 331 |
| ECONOMIZER OUTLET | LC | 339 | 337 | 337 | 337 | 339 | 334 | 334 | 335 |
| ECONOMIZER OUTLET | RC | 336 | 334 | 334 | 334 | 337 | 332 | 331 | 333 |
| ECONOMIZER OUTLET | R | 339 | 338 | 337 | 336 | 336 | 334 | 333 | 334 |
| SH DESH INLET LINK | R | 406 | 407 | 406 | 404 | 404 | 404 | 403 | 405 |
| SH DESH INLET LINK | L | 404 | 402 | 403 | 402 | 403 | 400 | 401 | 402 |
| SH DESH OUTLET LINK | L | 406 | 406 | 405 | 403 | 404 | 404 | 403 | 404 |
| SH DESH OUTLET LINK | R | 403 | 401 | 402 | 402 | 403 | 400 | 400 | 402 |
| SH DIV PANEL OUTLET LINK | L | 437 | 438 | 438 | 440 | 439 | 440 | 436 | 438 |
| SH DIV PANEL OUTLET LINK | R | 429 | 429 | 429 | 430 | 432 | 430 | 429 | 431 |
| SH PEND SPCD FRONT INLET LINK | L | 492 | 490 | 491 | 496 | 493 | 496 | 491 | 491 |
| SH PEND SPCD FRONT INLET LINK | C | 489 | 482 | 485 | 490 | 488 | 489 | 483 | 486 |
| SH PEND SPCD FRONT INLET LINK | R | 480 | 479 | 476 | 481 | 477 | 480 | 475 | 476 |
| SH OUTLET | L | 534 | 531 | 534 | 538 | 537 | 537 | 533 | 534 |
| SH OUTLET | R | 529 | 527 | 526 | 529 | 527 | 530 | 523 | 526 |
| RH DESH INLET | L | 324 | 322 | 322 | 326 | 324 | 326 | 321 | 322 |
| RH DESH INLET | R | 323 | NA | NA | 326 | 323 | NA | NA | 323 |
| RH RADIANT WALL INLET | L | 316 | 314 | 314 | 311 | 311 | 324 | 319 | 321 |
| RH RADIANT WALL INLET | R | 316 | 315 | 314 | 312 | 312 | 324 | 319 | 322 |
| RH RADIANT WALL OUTLET LINK | L | 351 | 350 | 348 | 346 | 347 | 359 | 354 | 358 |
| RH RADIANT WALL OUTLET LINK | LC | 363 | 357 | 359 | 361 | 360 | 368 | 362 | 364 |
| RH RADIANT WALL OUTLET LINK | RC | 346 | 347 | 348 | 347 | 345 | 359 | 354 | 356 |
| RH RADIANT WALL OUTLET LINK | R | 344 | 352 | 349 | 347 | 342 | 357 | 352 | 351 |
| RH OUTLET | L | 539 | 533 | 536 | 534 | 538 | 543 | 543 | 546 |
| RH OUTLET | R | 539 | 544 | 539 | 539 | 534 | 550 | 539 | 541 |
| RH OUTLET | COMB. | 540 | 538 | 538 | 539 | 539 | 548 | 542 | 545 |
| HP HEATER STM INLET | | 323 | 321 | 322 | 325 | 324 | 325 | 321 | 322 |
| HP HEATER DRAIN | | 217 | 216 | 216 | 217 | 217 | 216 | 216 | 216 |
| HP HEATER FW IN | | 211 | 211 | 211 | 211 | 211 | 211 | 211 | 211 |
| HP HEATER FW OUT | | 250 | 249 | 249 | 250 | 250 | 249 | 249 | 249 |
| SH DESH SPRAY WATER | L | 136 | 130 | 131 | 132 | 132 | 132 | 132 | 132 |
| SH DESH SPRAY WATER | R | 137 | 131 | 132 | 132 | 132 | 133 | 133 | 133 |
| RH DESH SPRAY WATER | | 166 | 166 | 166 | 166 | 166 | 132 | 132 | 132 |
| **AIR AND GAS** | | | | | | | | | |
| AH AIR INLET | L | 37 | 33 | 32 | 32 | 32 | 43 | 43 | 43 |
| AH AIR INLET | R | 38 | 44 | 43 | 43 | 43 | 30 | 31 | 30 |
| AH AIR OUTLET | L | 281 | 282 | 283 | 281 | 282 | 272 | 272 | 274 |
| AH AIR OUTLET | R | 279 | 276 | 276 | 273 | 274 | 285 | 284 | 284 |
| AH GAS INLET | L | 351 | 337 | 338 | 338 | 340 | 339 | 339 | 341 |
| AH GAS INLET | R | 356 | 348 | 348 | 346 | 346 | 349 | 348 | 347 |
| AH GAS OUTLET | L | 133 | 138 | 138 | 137 | 138 | 126 | 126 | 125 |
| AH GAS OUTLET | R | 125 | 122 | 122 | 120 | 121 | 129 | 129 | 131 |

# OVERFIRE AIR OPERATION STUDY

## TEST DATA

| TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 9/27 | 10/1 | 10/1 | 10/5 | 10/4 | 10/5 | 10/4 | 10/3 |
| Unit Load | MW | 428 | 429 | 430 | 427 | 434 | 422 | 429 | 427 |
| **FLOWS** | kg/sec | | | | | | | | |
| Feedwater | | 369 | 369 | 370 | 370 | 364 | 370 | 370 | 372 |
| 1st Stage Steam | | 365 | 362 | 362 | 360 | 360 | 359 | 362 | 360 |
| **PRESSURES** | MPa | | | | | | | | |
| Economizer Inlet | | 19.195 | 19.147 | 19.147 | 19.078 | 19.119 | 19.119 | 19.092 | 19.119 |
| Drum | | 18.726 | 18.685 | 18.678 | 18.685 | 18.650 | 18.678 | 18.657 | 18.630 |
| SH Outlet | | 16.975 | 16.989 | 17.003 | 16.989 | 16.996 | 16.947 | 16.996 | 16.989 |
| Turbine 1st Stage | | 12.604 | 12.535 | 12.521 | 12.500 | 12.500 | 12.466 | 12.535 | 12.486 |
| RH Inlet | | 3.771 | 3.751 | 3.758 | 3.751 | 3.778 | 3.751 | 3.771 | 3.771 |
| RH Outlet | | 3.599 | 3.627 | 3.585 | 3.599 | 3.606 | 3.585 | 3.606 | 3.599 |
| SH Spray Water | | 18.388 | 18.388 | 18.388 | 18.388 | 18.388 | 18.388 | 18.388 | 18.388 |
| HP Htr FW Inlet | | 19.664 | 19.595 | 19.560 | 19.588 | 19.595 | 19.595 | 19.526 | 19.547 |
| HP Htr Stm Inlet | | 3.799 | 3.758 | 3.765 | 3.806 | 3.827 | 3.792 | 3.799 | 3.799 |
| **TEMPERATURES** | °C | | | | | | | | |
| *Water and Steam* | | | | | | | | | |
| Economizer Inlet | | 248 | 248 | 248 | 248 | 249 | 248 | 248 | 248 |
| Economizer Outlet | L | 341 | 341 | 341 | 332 | 333 | 328 | 331 | 329 |
| Economizer Outlet | LC | 342 | 344 | 344 | 334 | 337 | 332 | 333 | 335 |
| Economizer Outlet | RC | 338 | 342 | 342 | 330 | 335 | 329 | 331 | 333 |
| Economizer Outlet | R | 343 | 342 | 342 | 332 | 338 | 329 | 333 | 332 |
| SH DESH Inlet Link | R | 406 | 409 | 409 | 400 | 408 | 398 | 401 | 402 |
| SH DESH Inlet Link | L | 404 | 407 | 408 | 401 | 402 | 398 | 399 | 398 |
| SH DESH Outlet Link | L | 406 | 409 | 409 | 399 | 407 | 398 | 401 | 402 |
| SH DESH Outlet Link | R | 403 | 407 | 408 | 401 | 402 | 398 | 398 | 398 |
| SH Div Panel Outlet Link | L | 436 | 438 | 441 | 432 | 446 | 432 | 438 | 435 |
| SH Div Panel Outlet Link | R | 428 | 436 | 437 | 428 | 436 | 425 | 429 | 430 |
| SH Pend Spcd Front Inlet Link | L | 489 | 489 | 489 | 487 | 503 | 485 | 494 | 484 |
| SH Pend Spcd Front Inlet Link | C | 484 | 492 | 493 | 482 | 500 | 500 | 491 | 492 |
| SH Pend Spcd Front Inlet Link | R | 479 | 483 | 482 | 479 | 489 | 489 | 480 | 481 |
| SH Outlet | L | 531 | 537 | 537 | 529 | 546 | 526 | 534 | 528 |
| SH Outlet | R | 525 | 533 | 533 | 523 | 539 | 514 | 527 | 530 |
| RH DESH Inlet | L | 321 | 326 | 326 | 319 | 333 | 315 | 323 | 322 |
| RH DESH Inlet | R | NA | NA | NA | NA | NA | NA | NA | NA |
| RH Radiant Wall Inlet | L | 319 | 324 | 324 | 317 | 320 | 313 | 322 | 314 |
| RH Radiant Wall Inlet | R | 319 | 325 | 325 | 318 | 321 | 314 | 322 | 315 |
| RH Radiant Wall Outlet Link | L | 351 | 354 | 354 | 355 | 352 | 350 | 354 | 348 |
| RH Radiant Wall Outlet Link | LC | 359 | 364 | 365 | 362 | 365 | 362 | 367 | 355 |
| RH Radiant Wall Outlet Link | RC | 347 | 352 | 354 | 349 | 357 | 343 | 355 | 348 |
| RH Radiant Wall Outlet Link | R | 346 | 349 | 348 | 345 | 352 | 337 | 353 | 341 |
| RH Outlet | L | 539 | 541 | 541 | 548 | 541 | 534 | 541 | 528 |
| RH Outlet | R | 540 | 539 | 539 | 532 | 554 | 516 | 545 | 538 |
| RH Outlet | Comb. | 539 | 543 | 543 | 540 | 550 | 529 | 544 | 538 |
| HP Heater Stm Inlet | | 320 | 325 | 325 | 318 | 332 | 314 | 323 | 322 |
| HP Heater Drain | | 216 | 216 | 216 | 216 | 217 | 216 | 216 | 216 |
| HP Heater FW In | | 210 | 210 | 210 | 211 | 211 | 209 | 211 | 211 |
| HP Heater FW Out | | 249 | 249 | 249 | 249 | 250 | 248 | 249 | 249 |
| SH DESH Spray Water | L | 131 | 131 | 132 | 138 | 137 | 143 | 141 | 151 |
| SH DESH Spray Water | R | 132 | 132 | 132 | 138 | 138 | 143 | 141 | 147 |
| RH DESH Spray Water | | 124 | 130 | 131 | 136 | 166 | 147 | 164 | 166 |
| *Air and Gas* | | | | | | | | | |
| AH Air Inlet | L | 34 | 41 | 41 | 39 | 39 | 41 | 40 | 35 |
| AH Air Inlet | R | 39 | 31 | 31 | 34 | 33 | 35 | 34 | 34 |
| AH Air Outlet | L | 280 | 277 | 278 | 277 | 277 | 274 | 275 | 274 |
| AH Air Outlet | R | 276 | 284 | 285 | 281 | 284 | 279 | 281 | 281 |
| AH Gas Inlet | L | 342 | 351 | 350 | 343 | 343 | 341 | 342 | 343 |
| AH Gas Inlet | R | 352 | 354 | 355 | 348 | 352 | 346 | 348 | 346 |
| AH Gas Outlet | L | 135 | 128 | 129 | 131 | 130 | 129 | 131 | 129 |
| AH Gas Outlet | R | 124 | 131 | 132 | 131 | 130 | 122 | 131 | 128 |

# OVERFIRE AIR OPERATION STUDY

TEST DATA

| TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 10/3 | 10/3 | 10/6 | 10/8 | 10/9 | 10/9 | 10/12 | 10/5 |
| UNIT LOAD | MW | 424 | 429 | 417 | 426 | 356 | 358 | 253 | 265 |
| **FLOWS** | KG/SEC | | | | | | | | |
| FEEDWATER | | 377 | 367 | 374 | 377 | 299 | 299 | 218 | 216 |
| 1ST STAGE STEAM | | 362 | 362 | 359 | 360 | 282 | 282 | 193 | 199 |
| **PRESSURES** | MPA | | | | | | | | |
| ECONOMIZER INLET | | 19.092 | 19.099 | 19.105 | 19.188 | 18.381 | 18.450 | 17.623 | 17.561 |
| DRUM | | 18.650 | 18.643 | 18.733 | 18.761 | 18.099 | 18.092 | 17.416 | 17.389 |
| SH OUTLET | | 16.968 | 16.996 | 16.996 | 16.996 | 16.996 | 16.927 | 16.927 | 16.727 |
| TURBINE 1ST STAGE | | 12.521 | 12.500 | 12.486 | 12.500 | 9.770 | 9.756 | 6.640 | 6.847 |
| RH INLET | | 3.778 | 3.778 | 3.751 | 3.765 | 3.034 | 3.054 | 2.213 | 2.199 |
| RH OUTLET | | 3.613 | 3.599 | 3.599 | 3.599 | 2.896 | 2.965 | 2.096 | 2.082 |
| SH SPRAY WATER | | 18.388 | 18.388 | 18.388 | 18.388 | 18.009 | 18.044 | 17.568 | 17.533 |
| HP HTR FW INLET | | 19.526 | 19.547 | 19.547 | 19.560 | 18.712 | 18.747 | 17.933 | 17.899 |
| HP HTR STM INLET | | 3.799 | 3.820 | 3.799 | 3.799 | 3.075 | 3.075 | 2.213 | 2.213 |
| **TEMPERATURES** | °C | | | | | | | | |
| **WATER AND STEAM** | | | | | | | | | |
| ECONOMIZER INLET | | 248 | 249 | 247 | 248 | 237 | 237 | 218 | 220 |
| ECONOMIZER OUTLET | L | 328 | 332 | 327 | 326 | 316 | 322 | 299 | 305 |
| ECONOMIZER OUTLET | LC | 332 | 336 | 328 | 329 | 318 | 326 | 300 | 307 |
| ECONOMIZER OUTLET | RC | 329 | 333 | 326 | 326 | 314 | 321 | 297 | 305 |
| ECONOMIZER OUTLET | R | 331 | 334 | 328 | 329 | 317 | 323 | 301 | 306 |
| SH DESH INLET LINK | R | 399 | 403 | 396 | 397 | 396 | 402 | 392 | 396 |
| SH DESH INLET LINK | L | 397 | 401 | 396 | 396 | 396 | 403 | 391 | 397 |
| SH DESH OUTLET LINK | L | 399 | 403 | 396 | 397 | 395 | 402 | 391 | 396 |
| SH DESH OUTLET LINK | R | 397 | 401 | 395 | 394 | 395 | 403 | 391 | 392 |
| SH DIV PANEL OUTLET LINK | L | 434 | 438 | 429 | 432 | 436 | 444 | 429 | 441 |
| SH DIV PANEL OUTLET LINK | R | 424 | 432 | 423 | 423 | 428 | 436 | 423 | 426 |
| SH PEND SPCD FRONT INLET LINK | L | 482 | 493 | 486 | 487 | 496 | 499 | 497 | 513 |
| SH PEND SPCD FRONT INLET LINK | C | 481 | 491 | 484 | 484 | 498 | 499 | 493 | 515 |
| SH PEND SPCD FRONT INLET LINK | R | 468 | 486 | 473 | 471 | 486 | 486 | 484 | 490 |
| SH OUTLET | L | 522 | 536 | 526 | 525 | 534 | 542 | 528 | 549 |
| SH OUTLET | R | 516 | 534 | 518 | 517 | 528 | 533 | 522 | 536 |
| RH DESH INLET | L | 313 | 327 | 316 | 315 | 303 | 308 | 271 | 286 |
| RH DESH INLET | R | NA | NA | 316 | 314 | 306 | 313 | 277 | 292 |
| RH RADIANT WALL INLET | L | 301 | 312 | 314 | 313 | 302 | 301 | 270 | 284 |
| RH RADIANT WALL INLET | R | 302 | 314 | 316 | 314 | 305 | 304 | 277 | 292 |
| RH RADIANT WALL OUTLET LINK | L | 334 | 351 | 352 | 348 | 339 | 342 | 313 | 329 |
| RH RADIANT WALL OUTLET LINK | LC | 346 | 358 | 362 | 361 | 359 | 357 | 327 | 342 |
| RH RADIANT WALL OUTLET LINK | RC | 332 | 347 | 346 | 344 | 341 | 339 | 313 | 326 |
| RH RADIANT WALL OUTLET LINK | R | 331 | 343 | 343 | 344 | 336 | 337 | 311 | 324 |
| RH OUTLET | L | 514 | 539 | 541 | 527 | 529 | 542 | 511 | 529 |
| RH OUTLET | R | 516 | 538 | 536 | 526 | 526 | 531 | 509 | 522 |
| RH OUTLET | COMB. | 518 | 541 | 536 | 528 | 529 | 539 | 511 | 530 |
| HP HEATER STM INLET | | 312 | 327 | 316 | 314 | 304 | 310 | 274 | 289 |
| HP HEATER DRAIN | | 216 | 217 | 215 | 216 | 206 | 206 | 189 | 191 |
| HP HEATER FW IN | | 210 | 211 | 209 | 210 | 202 | 202 | 186 | 187 |
| HP HEATER FW OUT | | 249 | 250 | 248 | 249 | 238 | 238 | 219 | 221 |
| SH DESH SPRAY WATER | L | 137 | 143 | 133 | 135 | 126 | 134 | 119 | 144 |
| SH DESH SPRAY WATER | R | 137 | 141 | 133 | 136 | 127 | 134 | 121 | 145 |
| RH DESH SPRAY WATER | | 164 | 165 | 144 | 131 | 135 | 157 | 118 | 122 |
| **AIR AND GAS** | | | | | | | | | |
| AH AIR INLET | L | 40 | 39 | 39 | 41 | 42 | 47 | 49 | 48 |
| AH AIR INLET | R | 34 | 34 | 34 | 36 | 42 | 43 | 49 | 44 |
| AH AIR OUTLET | L | 274 | 276 | 273 | 273 | 262 | 261 | 242 | 244 |
| AH AIR OUTLET | R | 280 | 281 | 278 | 278 | 267 | 268 | 247 | 251 |
| AH GAS INLET | L | 340 | 346 | 337 | 337 | 317 | 325 | 288 | 296 |
| AH GAS INLET | R | 345 | 348 | 346 | 346 | 322 | 328 | 290 | 298 |
| AH GAS OUTLET | L | 129 | 129 | 129 | 129 | 123 | 121 | 117 | 121 |
| AH GAS OUTLET | R | 128 | 128 | 128 | 127 | 123 | 121 | 116 | 116 |

# BASELINE OPERATION STUDY

TEST RESULTS

| TEST NO. | | 1 | 2 | 2A | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 5/7 | 5/5 | 5/7 | 5/7 | 10/10 | 7/16 | 7/15 | 7/16 | 5/5 | 4/30 |
| Unit Load | MW | 429 | 427 | 428 | 428 | 360 | 259 | 260 | 258 | 430 | 428 |
| **FLOWS** | kg/s | | | | | | | | | | |
| Feedwater (Measured) | | 375 | 375 | 377 | 377 | 295 | 201 | 198 | 195 | 375 | 377 |
| Auxiliary Steam - SH (Plant Instrumentation) | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 1.1 | 0.4 | 0.4 |
| SH Spray (Heat Balance) | | 1 | 5 | 0 | 3 | 4 | 3 | 5 | 8 | 3 | 0 |
| Main Steam (Calculated) | | 376 | 380 | 377 | 380 | 298 | 204 | 203 | 202 | 378 | 377 |
| Turbine Leakage (Turbine Heat Balance) | | 7 | 7 | 7 | 7 | 6 | 4 | 4 | 4 | 7 | 7 |
| HP Htr. Extraction (Heat Balance) | | 32 | 32 | 30 | 31 | 23 | 13 | 13 | 13 | 33 | 35 |
| RH Spray (Heat Balance) | | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 5 | 0 |
| RH Steam (Calculated) | | 337 | 343 | 339 | 342 | 272 | 186 | 186 | 185 | 342 | 335 |
| **UNIT ABSORPTION** | MJ/s | | | | | | | | | | |
| Economizer | | 153 | 171 | 177 | 189 | 141 | 82 | 87 | 100 | 162 | 160 |
| Furnace | | 371 | 353 | 352 | 340 | 294 | 241 | 232 | 214 | 361 | 363 |
| Drum - SH DESH | | 142 | 149 | 153 | 163 | 126 | 71 | 76 | 83 | 150 | 150 |
| SH DESH - SH Outlet | | 198 | 212 | 190 | 190 | 153 | 112 | 109 | 108 | 205 | 191 |
| Reheater | | 172 | 182 | 170 | 170 | 149 | 99 | 103 | 102 | 184 | 168 |
| Total | | 1036 | 1068 | 1041 | 1051 | 862 | 605 | 608 | 607 | 1063 | 1032 |
| **UNIT EFFICIENCY** | % | | | | | | | | | | |
| Dry Gas Loss | | 3.55 | 3.71 | 3.96 | 4.27 | 4.12 | 3.07 | 3.18 | 3.70 | 3.70 | 3.90 |
| Moisture in Fuel Loss | | 5.35 | 4.89 | 4.99 | 5.13 | 4.99 | 4.94 | 4.78 | 4.92 | 5.04 | 5.06 |
| Moisture in Air Loss | | 0.11 | 0.11 | 0.12 | 0.13 | 0.13 | 0.09 | 0.10 | 0.11 | 0.11 | 0.12 |
| Radiation Loss | | 0.19 | 0.18 | 0.18 | 0.18 | 0.22 | 0.31 | 0.31 | 0.31 | 0.18 | 0.19 |
| Ash Pit Loss | | 0.34 | 0.34 | 0.32 | 0.36 | 0.33 | 0.29 | 0.30 | 0.30 | 0.33 | 0.32 |
| Heat in Fly Ash Loss | | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 |
| Pyrite Rejection Loss | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Carbon Loss | | 0.52 | 0.37 | 0.22 | 0.31 | 0.12 | 0.23 | 0.30 | 0.12 | 0.68 | 0.29 |
| Total Losses | | 10.08 | 9.63 | 9.84 | 10.44 | 9.95 | 8.95 | 8.99 | 9.49 | 10.07 | 9.90 |
| Efficiency | | 89.92 | 90.37 | 90.16 | 89.56 | 90.05 | 91.05 | 91.05 | 90.51 | 89.93 | 90.10 |
| **HEAT INPUT** | MJ/s | | | | | | | | | | |
| Heat Input from Fuel | | 1152 | 1182 | 1155 | 1173 | 958 | 665 | 668 | 671 | 1182 | 1146 |
| **EXCESS AIR** | % | | | | | | | | | | |
| Air Heater Inlet | | 18.9 | 27.4 | 32.9 | 40.9 | 28.9 | 23.7 | 32.1 | 50.0 | 19.5 | 29.0 |
| Air Heater Outlet | | 26.7 | 37.2 | 42.8 | 52.1 | 52.1 | 40.0 | 40.9 | 67.9 | 33.7 | 40.1 |

# BASELINE OPERATION STUDY

TEST RESULTS

| TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 5/1 | 7/17 | 7/18 | 5/9 | 5/9 | 5/9 | 10/9 | 7/22 | 7/21 | 7/21 |
| Unit Load | MW | 428 | 256 | 259 | 433 | 433 | 433 | 361 | 258 | 260 | 258 |
| **FLOWS** | kg/s | | | | | | | | | | |
| Feedwater (Measured) | | 374 | 198 | 198 | 377 | 375 | 374 | 297 | 204 | 204 | 198 |
| Auxiliary Steam - SH (Plant Instrumentation) | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| SH Spray (Heat Balance) | | 2 | 5 | 9 | 0 | 0 | 2 | 1 | 0 | 2 | 6 |
| Main Steam (Calculated) | | 375 | 203 | 208 | 377 | 375 | 375 | 298 | 204 | 206 | 205 |
| Turbine Leakage (Turbine Heat Balance) | | 7 | 4 | 4 | 7 | 7 | 7 | 6 | 4 | 4 | 4 |
| HP Htr. Extraction (Heat Balance) | | 36 | 13 | 13 | 32 | 31 | 31 | 23 | 14 | 14 | 13 |
| RH Spray (Heat Balance) | | 0 | 0 | 0 | 5 | 6 | 7 | 0 | 0 | 0 | 0 |
| RH Steam (Calculated) | | 333 | 186 | 190 | 343 | 342 | 345 | 269 | 186 | 188 | 187 |
| **UNIT ABSORPTION** | MJ/s | | | | | | | | | | |
| Economizer | | 188 | 84 | 99 | 174 | 193 | 225 | 137 | 86 | 87 | 100 |
| Furnace | | 328 | 236 | 236 | 351 | 331 | 297 | 301 | 243 | 243 | 221 |
| Drum - SH DESH | | 156 | 74 | 81 | 149 | 150 | 167 | 127 | 74 | 76 | 84 |
| SH DESH - SH Outlet | | 199 | 110 | 106 | 191 | 191 | 184 | 148 | 102 | 104 | 105 |
| Reheater | | 172 | 102 | 96 | 184 | 183 | 187 | 151 | 101 | 104 | 103 |
| Total | | 1042 | 606 | 619 | 1049 | 1049 | 1059 | 864 | 606 | 613 | 613 |
| **UNIT EFFICIENCY** | % | | | | | | | | | | |
| Dry Gas Loss | | 4.37 | 3.05 | 3.50 | 3.53 | 3.63 | 3.94 | 3.53 | 3.35 | 3.60 | 3.85 |
| Moisture in Fuel Loss | | 5.09 | 4.93 | 4.88 | 4.90 | 4.87 | 4.93 | 4.93 | 4.95 | 4.96 | 4.85 |
| Moisture in Air Loss | | 0.13 | 0.09 | 0.11 | 0.11 | 0.11 | 0.12 | 0.11 | 0.10 | 0.11 | 0.12 |
| Radiation Loss | | 0.18 | 0.31 | 0.31 | 0.18 | 0.18 | 0.18 | 0.22 | 0.31 | 0.31 | 0.31 |
| Ash Pit Loss | | 0.33 | 0.29 | 0.30 | 0.34 | 0.34 | 0.34 | 0.32 | 0.31 | 0.32 | 0.33 |
| Heat in Fly Ash Loss | | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 |
| Pyrite Rejection Loss | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Carbon Loss | | 0.23 | 0.24 | 0.13 | 0.53 | 0.50 | 0.15 | 0.09 | 0.21 | 0.26 | 0.17 |
| Total Losses | | 10.36 | 8.93 | 9.25 | 9.62 | 9.66 | 9.70 | 9.22 | 9.26 | 9.57 | 9.66 |
| Efficiency | | 89.64 | 91.07 | 90.75 | 90.38 | 90.34 | 90.30 | 90.78 | 90.74 | 90.43 | 90.34 |
| **HEAT INPUT** | MJ/s | | | | | | | | | | |
| Heat Input from Fuel | | 1163 | 666 | 682 | 1161 | 1161 | 1172 | 951 | 668 | 678 | 678 |
| **EXCESS AIR** | % | | | | | | | | | | |
| Air Heater Inlet | | 40.9 | 27.4 | 48.8 | 15.0 | 20.2 | 35.5 | 23.0 | 25.2 | 28.9 | 47.8 |
| Air Heater Outlet | | 55.4 | 36.4 | 61.3 | 25.9 | 30.5 | 44.8 | 38.2 | 39.1 | 47.8 | 61.4 |

UTAH POWER & LIGHT COMPANY
HUNTINGTON CANYON #2

C-E POWER SYSTEMS
FIELD TESTING AND
PERFORMANCE RESULTS

# BASELINE OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 1 | 2 | 2A | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 5/7 | 5/5 | 5/7 | 5/7 | 10/10 | 7/16 | 7/15 | 7/16 | 5/5 | 4/30 |
| UNIT LOAD | MW | 429 | 427 | 428 | 428 | 360 | 259 | 260 | 258 | 430 | 428 |
| **PRODUCTS OF COMBUSTION** | µg/J | | | | | | | | | | |
| **AIR HEATER INLET** | | | | | | | | | | | |
| DRY AIR | | 425 | 438 | 458 | 489 | 487 | 442 | 452 | 533 | 430 | 447 |
| WET AIR | | 432 | 445 | 466 | 497 | 496 | 450 | 460 | 542 | 438 | 454 |
| DRY PRODUCTS | | 405 | 413 | 434 | 460 | 420 | 397 | 431 | 484 | 391 | 418 |
| WET PRODUCTS | | 414 | 419 | 439 | 466 | 426 | 404 | 437 | 489 | 397 | 426 |
| **AIR HEATER OUTLET** | | | | | | | | | | | |
| DRY AIR | | 335 | 319 | 321 | 321 | 321 | 316 | 321 | 317 | 322 | 319 |
| WET AIR | | 399 | 406 | 427 | 453 | 413 | 391 | 424 | 476 | 385 | 412 |
| DRY PRODUCTS | | 440 | 450 | 471 | 502 | 500 | 456 | 465 | 546 | 443 | 461 |
| WET PRODUCTS | | 468 | 477 | 498 | 530 | 528 | 483 | 491 | 574 | 470 | 488 |
| **GAS AND AIR FLOWS** | kg/s | | | | | | | | | | |
| GAS ENTERING AIR HEATER | | 508 | 526 | 538 | 579 | 434 | 286 | 309 | 346 | 500 | 518 |
| GAS LEAVING AIR HEATER | | 539 | 564 | 575 | 622 | 506 | 321 | 328 | 385 | 555 | 560 |
| AIR ENTERING AIR HEATER | | 498 | 526 | 538 | 583 | 475 | 299 | 307 | 363 | 517 | 521 |
| AIR LEAVING AIR HEATER | | 467 | 488 | 501 | 540 | 402 | 264 | 288 | 324 | 462 | 480 |
| AIR HEATER LEAKAGE | | 31 | 38 | 37 | 43 | 72 | 35 | 19 | 39 | 55 | 41 |
| **AIR HEATER PERFORMANCE** | | | | | | | | | | | |
| AIR HEATER LEAKAGE | % | 6.0 | 7.2 | 6.9 | 7.4 | 16.7 | 12.2 | 6.2 | 11.2 | 11.0 | 8.0 |
| GAS SIDE EFFICIENCY | % | 70.8 | 70.4 | 70.6 | 70.7 | 67.1 | 69.5 | 71.5 | 71.3 | 69.0 | 69.9 |
| GAS DROP | °C | 206 | 208 | 214 | 219 | 193 | 170 | 181 | 185 | 204 | 211 |
| AIR RISE | °C | 231 | 231 | 231 | 234 | 228 | 203 | 208 | 207 | 233 | 232 |
| TEMPERATURE HEAD | °C | 291 | 296 | 303 | 309 | 288 | 244 | 253 | 260 | 296 | 301 |
| **FUEL ANALYSIS** | | | | | | | | | | | |
| CARBON | % | 63.30 | 65.50 | 67.30 | 61.20 | 65.30 | 66.80 | 68.30 | 66.30 | 66.30 | 64.80 |
| HYDROGEN | % | 4.90 | 5.10 | 5.30 | 4.80 | 5.10 | 5.20 | 5.30 | 5.10 | 5.30 | 5.00 |
| NITROGEN | % | 0.90 | 1.20 | 0.80 | 0.80 | 1.30 | 1.10 | 1.30 | 1.20 | 0.90 | 0.90 |
| OXYGEN | % | 12.10 | 9.30 | 9.50 | 9.90 | 9.40 | 11.60 | 9.70 | 10.60 | 10.10 | 12.40 |
| SULFUR | % | 0.50 | 0.70 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| MOISTURE | % | 8.40 | 7.30 | 7.70 | 8.10 | 8.10 | 8.70 | 6.70 | 8.80 | 7.10 | 8.20 |
| ASH | % | 9.90 | 10.90 | 8.90 | 14.70 | 10.30 | 6.10 | 8.20 | 7.50 | 9.80 | 8.20 |
| HHV | kJ/kg | 25144 | 27889 | 28517 | 25726 | 27679 | 28424 | 28866 | 28168 | 27912 | 27075 |

# BASELINE OPERATION STUDY

TEST RESULTS

| TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 5/1 | 7/17 | 7/18 | 5/9 | 5/9 | 5/9 | 10/9 | 7/22 | 7/21 | 7/21 |
| UNIT LOAD | MW | 428 | 256 | 259 | 433 | 433 | 433 | 361 | 258 | 260 | 258 |
| **PRODUCTS OF COMBUSTION** | μg/J | | | | | | | | | | |
| **AIR HEATER INLET** | | | | | | | | | | | |
| DRY AIR | | 499 | 432 | 516 | 401 | 415 | 464 | 446 | 443 | 473 | 520 |
| WET AIR | | 508 | 440 | 525 | 407 | 422 | 472 | 454 | 450 | 481 | 529 |
| DRY PRODUCTS | | 460 | 411 | 484 | 372 | 389 | 442 | 404 | 405 | 420 | 484 |
| WET PRODUCTS | | 466 | 417 | 489 | 380 | 396 | 448 | 410 | 412 | 426 | 489 |
| **AIR HEATER OUTLET** | | | | | | | | | | | |
| DRY AIR | | 321 | 317 | 320 | 318 | 318 | 320 | 323 | 318 | 320 | 322 |
| WET AIR | | 453 | 404 | 476 | 366 | 382 | 434 | 397 | 398 | 413 | 476 |
| DRY PRODUCTS | | 512 | 446 | 529 | 414 | 429 | 478 | 459 | 456 | 486 | 533 |
| WET PRODUCTS | | 540 | 473 | 557 | 440 | 454 | 505 | 486 | 483 | 513 | 561 |
| **GAS AND AIR FLOWS** | kg/s | | | | | | | | | | |
| GAS ENTERING AIR HEATER | | 573 | 295 | 352 | 470 | 489 | 556 | 415 | 292 | 306 | 350 |
| GAS LEAVING AIR HEATER | | 628 | 315 | 380 | 511 | 528 | 592 | 462 | 323 | 348 | 380 |
| AIR ENTERING AIR HEATER | | 590 | 293 | 358 | 473 | 490 | 553 | 431 | 300 | 326 | 359 |
| AIR LEAVING AIR HEATER | | 535 | 273 | 330 | 432 | 451 | 518 | 384 | 270 | 285 | 329 |
| AIR HEATER LEAKAGE | | 55 | 19 | 28 | 41 | 39 | 35 | 48 | 30 | 42 | 30 |
| **AIR HEATER PERFORMANCE** | | | | | | | | | | | |
| AIR HEATER LEAKAGE | % | 9.6 | 6.6 | 7.9 | 8.7 | 7.9 | 6.4 | 11.4 | 10.3 | 13.6 | 8.6 |
| GAS SIDE EFFICIENCY | % | 70.1 | 70.9 | 72.2 | 68.8 | 69.7 | 71.9 | 70.3 | 67.9 | 67.3 | 70.1 |
| GAS DROP | °C | 216 | 176 | 184 | 202 | 208 | 222 | 200 | 170 | 171 | 182 |
| AIR RISE | °C | 234 | 206 | 202 | 221 | 231 | 228 | 222 | 207 | 209 | 209 |
| TEMPERATURE HEAD | °C | 309 | 249 | 255 | 293 | 299 | 309 | 284 | 250 | 254 | 260 |
| **FUEL ANALYSIS** | | | | | | | | | | | |
| CARBON | % | 65.60 | 66.50 | 67.30 | 64.20 | 64.80 | 63.80 | 67.70 | 66.80 | 67.50 | 67.00 |
| HYDROGEN | % | 5.20 | 5.10 | 5.30 | 4.90 | 4.90 | 4.90 | 5.20 | 5.10 | 5.30 | 5.20 |
| NITROGEN | % | 0.90 | 1.30 | 1.20 | 1.10 | 1.20 | 1.00 | 1.20 | 1.30 | 1.30 | 1.20 |
| OXYGEN | % | 10.60 | 10.60 | 9.50 | 10.30 | 10.10 | 10.20 | 9.40 | 10.80 | 9.70 | 9.50 |
| SULFUR | % | 0.40 | 0.50 | 0.50 | 0.50 | 0.50 | 0.80 | 0.50 | 0.50 | 0.50 | 0.50 |
| MOISTURE | % | 8.00 | 9.00 | 7.70 | 7.50 | 7.80 | 7.60 | 8.40 | 9.00 | 8.00 | 7.00 |
| ASH | % | 9.30 | 7.00 | 8.50 | 11.50 | 10.70 | 11.70 | 7.60 | 6.50 | 7.70 | 9.60 |
| HHV | kJ/kg | 27633 | 28238 | 28633 | 27051 | 27331 | 26865 | 28447 | 28214 | 28633 | 28214 |

Utah Power & Light Company
Huntington Canyon #2

C-E Power Systems
Field Testing and
Performance Results

# BIASED FIRING OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 9/17 | 9/18 | 9/20 | 12/13 | 10/11 | 10/12 | 10/12 | 10/5 | 9/17 | 9/10 | 9/18 | 10/11 | 12/13 | 12/13 | 7/23 | 7/24 |
| Unit Load | MW | 430 | 426 | 434 | 356 | 351 | 360 | 257 | 270 | 429 | 428 | 429 | 351 | 356 | 356 | 256 | 259 |
| **FLOWS** | kg/s | | | | | | | | | | | | | | | | |
| Feedwater (Measured) | | 375 | 370 | 369 | 297 | 295 | 299 | 218 | 207 | 375 | 370 | 369 | 295 | 299 | 299 | 201 | 204 |
| Auxiliary Steam - SH (Plant Instrumentation) | | 0.4 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.4 | 0.4 |
| SH Spray (Heat Balance) | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6 |
| Main Steam (Calculated) | | 375 | 371 | 368 | 297 | 295 | 299 | 218 | 214 | 375 | 370 | 369 | 295 | 299 | 299 | 203 | 210 |
| Turbine Leakage (Turbine Heat Balance) | | 7 | 7 | 7 | 6 | 6 | 6 | 5 | 4 | 7 | 7 | 7 | 6 | 6 | 6 | 4 | 4 |
| HP Htr. Extraction (Heat Balance) | | 32 | 30 | 32 | 23 | 23 | 23 | 15 | 14 | 32 | 32 | 31 | 23 | 24 | 24 | 13 | 14 |
| RH Spray (Heat Balance) | | 1 | 0 | 4 | 0 | 1 | 1 | 0 | 0 | 0 | 5 | 6 | 0 | 0 | 1 | 0 | 0 |
| RH Steam (Calculated) | | 336 | 334 | 334 | 268 | 268 | 271 | 199 | 196 | 336 | 336 | 336 | 266 | 270 | 270 | 185 | 192 |
| **UNIT ABSORPTION** | MJ/s | | | | | | | | | | | | | | | | |
| Economizer | | 164 | 163 | 166 | 114 | 126 | 124 | 90 | 93 | 170 | 172 | 175 | 132 | 124 | 125 | 87 | 88 |
| Furnace | | 360 | 357 | 350 | 323 | 310 | 318 | 256 | 233 | 355 | 347 | 340 | 305 | 319 | 316 | 237 | 241 |
| Drum - SH DESH | | 150 | 149 | 152 | 107 | 117 | 111 | 79 | 83 | 152 | 155 | 159 | 119 | 114 | 113 | 76 | 77 |
| SH DESH - SH Outlet | | 173 | 177 | 180 | 161 | 144 | 157 | 112 | 120 | 165 | 180 | 172 | 141 | 157 | 158 | 103 | 117 |
| Reheater | | 177 | 175 | 178 | 138 | 144 | 147 | 109 | 112 | 171 | 178 | 182 | 141 | 142 | 142 | 101 | 106 |
| Total | | 1023 | 1020 | 1025 | 843 | 841 | 857 | 646 | 641 | 1014 | 1031 | 1028 | 839 | 855 | 854 | 604 | 629 |
| **UNIT EFFICIENCY** | % | | | | | | | | | | | | | | | | |
| Dry Gas Loss | | 4.13 | 3.71 | 3.85 | 3.63 | 3.97 | 3.26 | 2.97 | 3.34 | 4.28 | 4.35 | 3.98 | 3.79 | 4.06 | 3.89 | 3.47 | 3.52 |
| Moisture in Fuel Loss | | 5.01 | 4.99 | 5.00 | 4.90 | 4.91 | 4.89 | 4.83 | 4.85 | 4.96 | 4.76 | 5.07 | 5.06 | 4.89 | 4.99 | 4.86 | 4.93 |
| Moisture in Air Loss | | 0.13 | 0.11 | 0.12 | 0.11 | 0.12 | 0.10 | 0.09 | 0.10 | 0.13 | 0.13 | 0.12 | 0.12 | 0.13 | 0.12 | 0.11 | 0.11 |
| Radiation Loss | | 0.19 | 0.19 | 0.19 | 0.23 | 0.23 | 0.22 | 0.29 | 0.30 | 0.19 | 0.19 | 0.19 | 0.23 | 0.22 | 0.22 | 0.31 | 0.30 |
| Ash Pit Loss | | 0.35 | 0.32 | 0.31 | 0.36 | 0.32 | 0.32 | 0.34 | 0.32 | 0.34 | 0.33 | 0.32 | 0.34 | 0.32 | 0.31 | 0.33 | 0.32 |
| Heat in Fly Ash Loss | | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 |
| Pyrite Rejection Loss | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Carbon Loss | | 0.26 | 0.25 | 0.55 | 0.61 | 0.20 | 0.22 | 0.46 | 0.22 | 0.28 | 0.24 | 0.18 | 0.22 | 0.38 | 0.41 | 0.12 | 0.20 |
| Total Losses | | 10.09 | 9.60 | 10.03 | 9.86 | 9.77 | 9.03 | 9.01 | 9.16 | 10.20 | 10.03 | 9.87 | 9.79 | 10.03 | 9.96 | 9.23 | 9.42 |
| Efficiency | | 89.91 | 90.40 | 89.97 | 90.14 | 90.23 | 90.97 | 90.99 | 90.84 | 89.80 | 89.97 | 90.13 | 90.21 | 89.97 | 90.04 | 90.77 | 90.58 |
| **HEAT INPUT** | MJ/s | | | | | | | | | | | | | | | | |
| Heat Input from Fuel | | 1138 | 1128 | 1140 | 935 | 932 | 942 | 710 | 706 | 1129 | 1147 | 1141 | 930 | 950 | 948 | 665 | 694 |
| **EXCESS AIR** | % | | | | | | | | | | | | | | | | |
| Air Heater Inlet | | 19.8 | 21.5 | 20.9 | 16.8 | 19.9 | 20.8 | 22.6 | 24.4 | 26.3 | 27.4 | 29.3 | 29.3 | 28.0 | 31.7 | 25.1 | 24.7 |
| Air Heater Outlet | | 36.4 | 26.2 | 36.4 | 35.4 | 37.3 | 34.2 | 37.3 | 38.1 | 40.0 | 47.4 | 31.7 | 41.9 | 48.7 | 49.9 | 39.5 | 38.1 |

# BIASED FIRING OPERATION STUDY

TEST RESULTS

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 9/17 | 9/18 | 9/20 | 12/13 | 10/11 | 10/12 | 10/12 | 10/5 | 9/17 | 9/10 | 9/18 | 10/11 | 12/13 | 12/13 | 7/23 | 7/24 |
| Unit Load | MW | 430 | 426 | 434 | 356 | 351 | 360 | 257 | 270 | 429 | 428 | 429 | 351 | 356 | 356 | 256 | 259 |
| **PRODUCTS OF COMBUSTION** | μg/J | | | | | | | | | | | | | | | | |
| **Air Heater Inlet** | | | | | | | | | | | | | | | | | |
| Dry Air | | 436 | 406 | 436 | 457 | 446 | 431 | 434 | 441 | 446 | 467 | 425 | 466 | 498 | 479 | 442 | 443 |
| Wet Air | | 444 | 413 | 443 | 464 | 454 | 438 | 442 | 448 | 454 | 475 | 432 | 474 | 506 | 487 | 450 | 450 |
| Dry Products | | 396 | 404 | 399 | 406 | 404 | 401 | 402 | 410 | 416 | 418 | 430 | 438 | 441 | 433 | 409 | 413 |
| Wet Products | | 422 | 430 | 425 | 432 | 429 | 427 | 427 | 436 | 442 | 444 | 457 | 465 | 467 | 460 | 435 | 439 |
| **Air Heater Outlet** | | | | | | | | | | | | | | | | | |
| Dry Air | | 383 | 391 | 386 | 394 | 390 | 388 | 388 | 397 | 403 | 404 | 418 | 425 | 429 | 421 | 397 | 400 |
| Wet Air | | 390 | 398 | 393 | 401 | 396 | 395 | 395 | 403 | 409 | 411 | 425 | 432 | 436 | 428 | 403 | 407 |
| Dry Products | | 449 | 419 | 449 | 468 | 460 | 444 | 448 | 454 | 460 | 482 | 438 | 480 | 510 | 491 | 455 | 456 |
| Wet Products | | 477 | 445 | 476 | 495 | 487 | 470 | 475 | 480 | 487 | 508 | 465 | 507 | 538 | 519 | 482 | 482 |
| **GAS AND AIR FLOWS** | kg/s | | | | | | | | | | | | | | | | |
| Gas Entering Air Heater | | 480 | 485 | 485 | 404 | 400 | 402 | 304 | 307 | 499 | 508 | 522 | 433 | 444 | 436 | 290 | 304 |
| Gas Leaving Air Heater | | 542 | 502 | 542 | 463 | 454 | 443 | 337 | 339 | 549 | 582 | 531 | 472 | 511 | 492 | 320 | 335 |
| Air Entering Air Heater | | 505 | 466 | 505 | 434 | 423 | 413 | 314 | 316 | 512 | 545 | 494 | 441 | 481 | 462 | 299 | 312 |
| Air Leaving Air Heater | | 444 | 449 | 448 | 375 | 369 | 372 | 280 | 285 | 462 | 471 | 484 | 402 | 414 | 406 | 268 | 282 |
| Air Heater Leakage | | 61 | 17 | 57 | 60 | 54 | 41 | 34 | 32 | 50 | 74 | 9 | 39 | 67 | 56 | 31 | 30 |
| **AIR HEATER PERFORMANCE** | | | | | | | | | | | | | | | | | |
| Air Heater Leakage | % | 12.7 | 3.6 | 11.9 | 14.7 | 13.4 | 10.2 | 11.1 | 10.2 | 10.1 | 14.5 | 1.7 | 9.0 | 15.0 | 12.8 | 10.7 | 9.9 |
| Gas Side Efficiency | % | 67.3 | 70.5 | 69.5 | 68.2 | 65.4 | 71.0 | 70.3 | 68.4 | 67.9 | 67.2 | 70.9 | 69.8 | 67.8 | 68.5 | 66.5 | 66.6 |
| Gas Drop | °C | 211 | 218 | 215 | 188 | 182 | 196 | 172 | 173 | 214 | 208 | 224 | 198 | 190 | 191 | 166 | 168 |
| Air Rise | °C | 242 | 238 | 240 | 222 | 228 | 218 | 199 | 204 | 243 | 239 | 242 | 223 | 224 | 223 | 208 | 208 |
| Temperature Head | °C | 313 | 309 | 310 | 275 | 279 | 276 | 244 | 253 | 316 | 310 | 316 | 283 | 281 | 279 | 249 | 252 |
| **FUEL ANALYSIS** | | | | | | | | | | | | | | | | | |
| Carbon | % | 66.80 | 67.50 | 65.90 | 70.30 | 68.00 | 67.80 | 66.50 | 67.00 | 66.80 | 65.30 | 67.60 | 67.20 | 71.80 | 66.10 | 66.30 | 67.20 |
| Hydrogen | % | 5.20 | 5.30 | 5.10 | 5.40 | 5.20 | 5.30 | 5.10 | 5.20 | 5.10 | 4.80 | 5.30 | 5.20 | 5.50 | 5.20 | 5.20 | 5.30 |
| Nitrogen | % | 1.20 | 1.30 | 1.20 | 1.00 | 1.40 | 1.20 | 1.30 | 1.30 | 1.30 | 1.20 | 1.40 | 1.30 | 1.30 | 1.20 | 1.40 | 1.20 |
| Oxygen | % | 9.70 | 9.70 | 10.00 | 5.70 | 10.80 | 9.60 | 10.60 | 9.70 | 10.60 | 10.70 | 9.80 | 10.00 | 5.80 | 9.50 | 9.40 | 9.60 |
| Sulfur | % | 0.50 | 0.40 | 0.40 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.40 | 0.40 | 0.40 | 0.50 | 0.40 | 0.50 | 0.50 |
| Moisture | % | 8.00 | 7.40 | 8.10 | 6.50 | 6.90 | 7.60 | 8.30 | 7.80 | 8.00 | 7.40 | 8.00 | 8.10 | 7.10 | 8.10 | 7.40 | 7.40 |
| Ash | % | 8.60 | 8.40 | 9.30 | 10.60 | 7.20 | 8.00 | 7.70 | 8.50 | 7.70 | 10.20 | 7.50 | 7.80 | 8.00 | 9.50 | 9.80 | 8.80 |
| HHV | kJ/kg | 28307 | 28470 | 27786 | 28656 | 28145 | 28680 | 28214 | 28470 | 28168 | 27447 | 28424 | 27656 | 29517 | 28075 | 28447 | 28517 |

# OVERFIRE AIR OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 9/17 | 9/26 | 9/26 | 9/26 | 9/26 | 10/1 | 10/1 | 10/1 | 9/27 | 10/1 | 10/1 | 10/5 |
| UNIT LOAD | MW | 428 | 430 | 430 | 430 | 431 | 430 | 429 | 428 | 428 | 429 | 430 | 427 |
| **FLOWS** | KG/S | | | | | | | | | | | | |
| FEEDWATER (MEASURED) | | 369 | 372 | 372 | 370 | 370 | 372 | 372 | 370 | 369 | 369 | 370 | 370 |
| AUXILIARY STEAM - SH (PLANT INSTRUMENTATION) | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| SH SPRAY (HEAT BALANCE) | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MAIN STEAM (CALCULATED) | | 369 | 372 | 372 | 370 | 370 | 372 | 372 | 370 | 369 | 368 | 370 | 370 |
| TURBINE LEAKAGE (TURBINE HEAT BALANCE) | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| HP HTR. EXTRACTION (HEAT BALANCE) | | 31 | 32 | 32 | 32 | 32 | 31 | 32 | 31 | 31 | 32 | 32 | 31 |
| RH SPRAY (HEAT BALANCE) | | 3 | 3 | 3 | 5 | 5 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| RH STEAM (CALCULATED) | | 333 | 336 | 336 | 336 | 335 | 333 | 334 | 332 | 331 | 330 | 331 | 332 |
| **UNIT ABSORPTION** | MJ/S | | | | | | | | | | | | |
| ECONOMIZER | | 174 | 173 | 173 | 171 | 174 | 165 | 166 | 167 | 185 | 188 | 189 | 164 |
| FURNACE | | 341 | 348 | 347 | 346 | 343 | 356 | 356 | 352 | 330 | 328 | 329 | 354 |
| DRUM - SH DESH | | 157 | 158 | 158 | 154 | 156 | 153 | 153 | 156 | 158 | 163 | 165 | 149 |
| SH DESH - SH OUTLET | | 173 | 174 | 174 | 179 | 175 | 181 | 177 | 174 | 169 | 169 | 169 | 177 |
| REHEATER | | 175 | 178 | 177 | 179 | 178 | 174 | 174 | 174 | 172 | 166 | 167 | 174 |
| TOTAL | | 1020 | 1030 | 1029 | 1029 | 1026 | 1029 | 1025 | 1023 | 1014 | 1015 | 1019 | 1018 |
| **UNIT EFFICIENCY** | % | | | | | | | | | | | | |
| DRY GAS LOSS | | 4.52 | 3.96 | 4.07 | 4.06 | 3.97 | 3.91 | 3.94 | 3.63 | 4.58 | 4.86 | 4.64 | 4.03 |
| MOISTURE IN FUEL LOSS | | 5.07 | 5.10 | 5.11 | 4.96 | 5.03 | 5.09 | 5.11 | 5.03 | 5.08 | 4.96 | 5.04 | 4.95 |
| MOISTURE IN AIR LOSS | | 0.14 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.11 | 0.14 | 0.15 | 0.14 | 0.12 |
| RADIATION LOSS | | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| ASH PIT LOSS | | 0.34 | 0.33 | 0.33 | 0.34 | 0.33 | 0.33 | 0.32 | 0.32 | 0.32 | 0.35 | 0.32 | 0.32 |
| HEAT IN FLY ASH LOSS | | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 |
| PYRITE REJECTION LOSS | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CARBON LOSS | | 0.20 | 0.14 | 0.24 | 0.30 | 0.28 | 0.24 | 0.59 | 0.24 | 0.22 | 0.27 | 0.16 | 0.25 |
| TOTAL LOSSES | | 10.49 | 9.87 | 10.08 | 10.01 | 9.95 | 9.91 | 10.30 | 9.54 | 10.56 | 10.82 | 10.52 | 9.89 |
| EFFICIENCY | | 89.51 | 90.13 | 89.92 | 89.99 | 90.05 | 90.09 | 89.70 | 90.46 | 89.44 | 89.18 | 89.48 | 90.11 |
| **HEAT INPUT** | MJ/S | | | | | | | | | | | | |
| HEAT INPUT FROM FUEL | | 1140 | 1143 | 1145 | 1143 | 1139 | 1142 | 1143 | 1130 | 1133 | 1138 | 1140 | 1130 |
| **EXCESS AIR** | % | | | | | | | | | | | | |
| AIR HEATER INLET | | 27.0 | 28.2 | 26.2 | 25.5 | 25.2 | 18.5 | 19.2 | 19.2 | 32.1 | 33.8 | 33.8 | 23.1 |
| AIR HEATER OUTLET | | 46.8 | 31.8 | 32.9 | 35.6 | 32.6 | 29.3 | 30.1 | 27.8 | 48.3 | 57.8 | 49.5 | 29.2 |

# OVERFIRE AIR OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 10/4 | 10/5 | 10/4 | 10/3 | 10/3 | 10/3 | 10/6 | 10/8 | 10/9 | 10/9 | 10/12 | 10/5 |
| UNIT LOAD | MW | 434 | 422 | 429 | 427 | 424 | 429 | 417 | 426 | 356 | 358 | 253 | 265 |
| **FLOWS** | KG/S | | | | | | | | | | | | |
| FEEDWATER (MEASURED) | | 364 | 370 | 370 | 372 | 377 | 367 | 374 | 377 | 299 | 299 | 218 | 216 |
| AUXILIARY STEAM - SH (PLANT INSTRUMENTATION) | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| SH SPRAY (HEAT BALANCE) | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| MAIN STEAM (CALCULATED) | | 364 | 370 | 370 | 372 | 377 | 367 | 374 | 377 | 299 | 299 | 218 | 217 |
| TURBINE LEAKAGE (TURBINE HEAT BALANCE) | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 | 6 | 5 | 3 |
| HP HTR. EXTRACTION (HEAT BALANCE) | | 30 | 32 | 31 | 32 | 32 | 31 | 31 | 32 | 23 | 23 | 15 | 15 |
| RH SPRAY (HEAT BALANCE) | | 4 | 1 | 0 | 3 | 5 | 5 | 0 | 0 | 0 | 2 | 0 | 0 |
| RH STEAM (CALCULATED) | | 331 | 332 | 332 | 336 | 342 | 334 | 335 | 338 | 270 | 272 | 199 | 197 |
| **UNIT ABSORPTION** | MJ/S | | | | | | | | | | | | |
| ECONOMIZER | | 169 | 158 | 163 | 166 | 161 | 166 | 155 | 157 | 119 | 130 | 87 | 91 |
| FURNACE | | 339 | 361 | 356 | 356 | 367 | 348 | 369 | 370 | 323 | 311 | 261 | 251 |
| DRUM - SH DESH | | 155 | 145 | 148 | 148 | 147 | 151 | 142 | 143 | 109 | 120 | 73 | 78 |
| SH DESH - SH OUTLET | | 182 | 145 | 181 | 180 | 176 | 181 | 183 | 184 | 151 | 144 | 108 | 114 |
| REHEATER | | 176 | 166 | 172 | 173 | 175 | 178 | 177 | 170 | 140 | 147 | 107 | 105 |
| TOTAL | | 1022 | 1005 | 1019 | 1023 | 1026 | 1023 | 1025 | 1024 | 842 | 853 | 634 | 638 |
| **UNIT EFFICIENCY** | % | | | | | | | | | | | | |
| DRY GAS LOSS | | 4.21 | 3.74 | 4.18 | 4.13 | 4.06 | 4.09 | 4.09 | 4.02 | 3.71 | 3.50 | 3.02 | 3.32 |
| MOISTURE IN FUEL LOSS | | 5.10 | 4.97 | 5.05 | 5.05 | 5.05 | 5.12 | 5.05 | 5.04 | 4.98 | 4.95 | 4.95 | 4.95 |
| MOISTURE IN AIR LOSS | | 0.13 | 0.11 | 0.13 | 0.13 | 0.12 | 0.13 | 0.13 | 0.12 | 0.11 | 0.11 | 0.09 | 0.10 |
| RADIATION LOSS | | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.23 | 0.22 | 0.30 | 0.30 |
| ASH PIT LOSS | | 0.32 | 0.33 | 0.33 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.33 | 0.32 | 0.34 | 0.32 |
| HEAT IN FLY ASH LOSS | | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 |
| PYRITE REJECTION LOSS | | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| CARBON LOSS | | 0.21 | 0.30 | 0.28 | 0.26 | 0.22 | 0.63 | 0.40 | 0.43 | 0.20 | 0.22 | 0.47 | 0.22 |
| TOTAL LOSSES | | 10.17 | 9.68 | 10.18 | 10.10 | 9.99 | 10.49 | 10.21 | 10.15 | 9.59 | 9.35 | 9.21 | 9.24 |
| EFFICIENCY | | 89.83 | 90.32 | 89.82 | 89.90 | 90.01 | 89.51 | 89.79 | 89.85 | 90.41 | 90.65 | 90.79 | 90.76 |
| **HEAT INPUT** | MJ/S | | | | | | | | | | | | |
| HEAT INPUT FROM FUEL | | 1137 | 1113 | 1135 | 1138 | 1140 | 1143 | 1142 | 1140 | 931 | 941 | 698 | 703 |
| **EXCESS AIR** | % | | | | | | | | | | | | |
| AIR HEATER INLET | | 25.1 | 22.0 | 25.1 | 21.3 | 23.5 | 21.7 | 18.5 | 19.6 | 19.3 | 21.5 | 22.8 | 23.9 |
| AIR HEATER OUTLET | | 36.7 | 29.9 | 31.8 | 31.4 | 33.6 | 31.6 | 32.8 | 35.1 | 39.6 | 37.4 | 34.8 | 36.7 |

# OVERFIRE AIR OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 9/17 | 9/26 | 9/26 | 9/26 | 9/26 | 10/1 | 10/1 | 10/1 | 9/27 | 10/1 | 10/1 | 10/5 |
| Unit Load | MW | 428 | 430 | 430 | 430 | 431 | 430 | 429 | 428 | 428 | 429 | 430 | 427 |
| **PRODUCTS OF COMBUSTION** | μg/J | | | | | | | | | | | | |
| **Air Heater Inlet** | | | | | | | | | | | | | |
| Dry Air | | 479 | 417 | 427 | 433 | 421 | 416 | 422 | 411 | 477 | 503 | 478 | 412 |
| Wet Air | | 487 | 424 | 434 | 440 | 428 | 423 | 429 | 417 | 485 | 511 | 486 | 419 |
| Dry Products | | 427 | 419 | 418 | 415 | 411 | 394 | 399 | 396 | 437 | 439 | 440 | 406 |
| Wet Products | | 454 | 446 | 445 | 441 | 437 | 420 | 425 | 421 | 464 | 466 | 467 | 432 |
| **Air Heater Outlet** | | | | | | | | | | | | | |
| Dry Air | | 414 | 406 | 406 | 401 | 397 | 381 | 386 | 383 | 424 | 426 | 427 | 392 |
| Wet Air | | 421 | 412 | 412 | 408 | 404 | 387 | 393 | 389 | 432 | 434 | 434 | 399 |
| Dry Products | | 492 | 430 | 440 | 447 | 434 | 428 | 434 | 423 | 490 | 516 | 490 | 426 |
| Wet Products | | 519 | 457 | 466 | 473 | 461 | 455 | 461 | 450 | 517 | 543 | 518 | 452 |
| **GAS AND AIR FLOWS** | kg/s | | | | | | | | | | | | |
| Gas Entering Air Heater | | 517 | 509 | 509 | 504 | 498 | 479 | 486 | 476 | 526 | 530 | 532 | 488 |
| Gas Leaving Air Heater | | 592 | 522 | 534 | 541 | 525 | 520 | 527 | 508 | 586 | 618 | 590 | 510 |
| Air Entering Air Heater | | 555 | 484 | 497 | 504 | 488 | 483 | 490 | 472 | 549 | 582 | 553 | 473 |
| Air Leaving Air Heater | | 480 | 471 | 472 | 466 | 460 | 442 | 449 | 440 | 489 | 494 | 495 | 451 |
| Air Heater Leakage | | 75 | 13 | 25 | 37 | 27 | 40 | 41 | 32 | 60 | 88 | 58 | 22 |
| **AIR HEATER PERFORMANCE** | | | | | | | | | | | | | |
| Air Heater Leakage | % | 14.5 | 2.6 | 4.9 | 7.4 | 5.5 | 8.4 | 8.5 | 6.7 | 11.4 | 16.7 | 10.9 | 4.6 |
| Gas Side Efficiency | % | 67.2 | 69.1 | 68.5 | 68.3 | 68.7 | 68.2 | 68.2 | 70.5 | 66.9 | 65.8 | 67.2 | 68.2 |
| Gas Drop | °C | 212 | 210 | 209 | 208 | 210 | 210 | 209 | 216 | 208 | 208 | 213 | 210 |
| Air Rise | °C | 243 | 241 | 241 | 239 | 241 | 242 | 241 | 242 | 241 | 245 | 246 | 242 |
| Temperature Head | °C | 316 | 304 | 306 | 304 | 306 | 309 | 307 | 307 | 311 | 316 | 317 | 309 |
| **FUEL ANALYSIS** | | | | | | | | | | | | | |
| Carbon | % | 65.40 | 63.70 | 65.90 | 63.90 | 65.10 | 66.20 | 67.20 | 67.50 | 66.80 | 63.90 | 67.00 | 66.60 |
| Hydrogen | % | 5.10 | 4.90 | 5.20 | 4.80 | 5.00 | 5.20 | 5.30 | 5.30 | 5.20 | 4.90 | 5.20 | 5.10 |
| Nitrogen | % | 1.10 | 1.30 | 1.20 | 1.20 | 1.30 | 1.20 | 1.30 | 1.20 | 1.10 | 1.20 | 1.30 | 1.30 |
| Oxygen | % | 9.40 | 10.20 | 9.50 | 9.70 | 10.40 | 9.50 | 9.60 | 9.70 | 9.70 | 9.00 | 9.70 | 10.60 |
| Sulfur | % | 0.50 | 0.50 | 0.40 | 0.40 | 0.40 | 0.50 | 0.40 | 0.40 | 0.50 | 0.40 | 0.50 | 0.50 |
| Moisture | % | 7.40 | 9.40 | 8.30 | 8.30 | 8.70 | 8.30 | 7.80 | 8.00 | 8.50 | 7.80 | 8.40 | 7.70 |
| Ash | % | 11.10 | 10.00 | 9.50 | 11.70 | 9.10 | 9.10 | 8.50 | 7.90 | 8.20 | 12.80 | 7.90 | 8.20 |
| HHV | kJ/kg | 27214 | 27121 | 27889 | 26842 | 27586 | 27982 | 28098 | 28540 | 28191 | 27121 | 28447 | 28098 |

# OVERFIRE AIR OPERATION STUDY

## TEST RESULTS

| TEST NO. | | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 10/4 | 10/5 | 10/4 | 10/3 | 10/3 | 10/3 | 10/6 | 10/8 | 10/9 | 10/9 | 10/12 | 10/5 |
| UNIT LOAD | MW | 434 | 422 | 429 | 427 | 424 | 429 | 417 | 426 | 356 | 358 | 253 | 265 |
| **PRODUCTS OF COMBUSTION** | μg/J | | | | | | | | | | | | |
| **AIR HEATER INLET** | | | | | | | | | | | | | |
| DRY AIR | | 437 | 412 | 427 | 424 | 428 | 429 | 430 | 435 | 442 | 443 | 432 | 442 |
| WET AIR | | 444 | 419 | 434 | 431 | 436 | 435 | 437 | 442 | 450 | 450 | 440 | 449 |
| DRY PRODUCTS | | 412 | 400 | 419 | 404 | 409 | 410 | 396 | 398 | 391 | 404 | 406 | 414 |
| WET PRODUCTS | | 439 | 426 | 446 | 430 | 435 | 437 | 422 | 424 | 417 | 430 | 433 | 440 |
| **AIR HEATER OUTLET** | | | | | | | | | | | | | |
| DRY AIR | | 400 | 487 | 406 | 391 | 396 | 397 | 383 | 385 | 378 | 391 | 394 | 401 |
| WET AIR | | 407 | 393 | 412 | 398 | 403 | 403 | 390 | 391 | 384 | 398 | 401 | 408 |
| DRY PRODUCTS | | 450 | 425 | 441 | 436 | 441 | 443 | 442 | 448 | 456 | 455 | 445 | 455 |
| WET PRODUCTS | | 477 | 451 | 468 | 463 | 468 | 470 | 469 | 475 | 482 | 482 | 472 | 482 |
| **GAS AND AIR FLOWS** | kg/s | | | | | | | | | | | | |
| GAS ENTERING AIR HEATER | | 499 | 474 | 506 | 489 | 496 | 499 | 482 | 483 | 388 | 405 | 302 | 309 |
| GAS LEAVING AIR HEATER | | 542 | 502 | 531 | 527 | 534 | 537 | 536 | 541 | 449 | 454 | 330 | 339 |
| AIR ENTERING AIR HEATER | | 505 | 466 | 493 | 490 | 497 | 499 | 499 | 504 | 419 | 424 | 307 | 316 |
| AIR LEAVING AIR HEATER | | 462 | 438 | 468 | 453 | 459 | 461 | 445 | 446 | 358 | 375 | 280 | 287 |
| AIR HEATER LEAKAGE | | 43 | 28 | 25 | 38 | 38 | 38 | 54 | 58 | 61 | 49 | 27 | 30 |
| **AIR HEATER PERFORMANCE** | | | | | | | | | | | | | |
| AIR HEATER LEAKAGE | % | 8.6 | 6.0 | 4.9 | 7.7 | 7.6 | 7.5 | 11.2 | 12.0 | 15.7 | 12.1 | 9.0 | 9.5 |
| GAS SIDE EFFICIENCY | % | 67.7 | 69.7 | 68.0 | 67.4 | 67.9 | 68.2 | 66.7 | 67.3 | 66.6 | 69.9 | 69.5 | 68.5 |
| GAS DROP | °C | 211 | 213 | 210 | 209 | 207 | 212 | 204 | 204 | 185 | 197 | 167 | 172 |
| AIR RISE | °C | 243 | 239 | 241 | 243 | 239 | 242 | 239 | 237 | 222 | 220 | 196 | 202 |
| TEMPERATURE HEAD | °C | 311 | 306 | 308 | 310 | 305 | 310 | 305 | 303 | 277 | 282 | 240 | 251 |
| **FUEL ANALYSIS** | | | | | | | | | | | | | |
| CARBON | % | 67.20 | 64.90 | 65.90 | 68.40 | 66.90 | 67.20 | 67.40 | 66.70 | 65.00 | 67.20 | 67.20 | 67.30 |
| HYDROGEN | % | 5.30 | 5.00 | 5.10 | 5.40 | 5.20 | 5.20 | 5.30 | 5.20 | 5.00 | 5.30 | 5.30 | 5.30 |
| NITROGEN | % | 1.40 | 1.30 | 1.10 | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | 1.30 | 1.40 | 1.30 | 1.30 |
| OXYGEN | % | 9.60 | 10.30 | 10.50 | 9.80 | 9.70 | 10.80 | 9.70 | 9.70 | 10.40 | 9.70 | 9.60 | 9.70 |
| SULFUR | % | 0.50 | 0.50 | 0.50 | 0.40 | 0.50 | 0.50 | 0.50 | 0.40 | 0.50 | 0.50 | 0.40 | 0.40 |
| MOISTURE | % | 8.60 | 8.10 | 7.50 | 7.50 | 8.40 | 8.00 | 7.50 | 8.00 | 8.90 | 7.60 | 8.30 | 7.60 |
| ASH | % | 7.40 | 9.90 | 9.40 | 7.30 | 8.10 | 7.10 | 8.40 | 8.80 | 8.90 | 8.30 | 7.90 | 8.40 |
| HHV | kJ/kg | 28610 | 27563 | 27400 | 28842 | 28284 | 27703 | 28284 | 28052 | 27633 | 28377 | 28424 | 28284 |

# BASELINE OPERATION STUDY

BOARD AND COMPUTER DATA

| | Test No. | | 1 | 2 | 2A | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1975 | 5/7 | 5/5 | 5/7 | 5/7 | 10/10 | 7/16 | 7/15 | 7/16 | 5/5 | 4/30 |
| | Time | | 09:25 | 17:23 | 16:50 | 14:15 | 03:30 | 11:30 | 15:05 | 15:45 | 13:40 | 15:07 |
| C* | Load | MW | 429 | 427 | 428 | 428 | 360 | 259 | 260 | 258 | 430 | 428 |
| | **Flows** | $10^3$ LB/HR | | | | | | | | | | |
| C | Feedwater | | 2913 | 2945 | 2910 | 2912 | 2249 | 1535 | 1520 | 1503 | 2900 | 2898 |
| B* | Main Steam | | 3050 | 3000 | 3050 | 3000 | 2350 | 1525 | 1520 | 1502 | 3040 | 3000 |
| C | Superheat Spray L | | 0 | 0 | 0 | 0 | 14.1 | 10.2 | 23.2 | 31.5 | 0 | 0 |
| C | Superheat Spray R | | 0 | 0 | 0 | 0 | 12.0 | 1.4 | 13.5 | 21.9 | 0 | 0 |
| C | Reheat Spray | | 0 | 0 | 0 | 0 | 7.1 | 0 | 0 | 0 | 16.5 | 0 |
| C | Ext. Stm. to Stm. AH 2-1 | | 58.9 | 58.9 | 58.9 | 58.9 | 58.8 | 13.3 | 9.3 | 18.5 | 58.9 | 58.9 |
| C | Ext. Stm. to Stm. AH 2-2 | | 58.9 | 58.9 | 58.9 | 58.9 | 58.8 | 13.25 | 9.2 | 18.5 | 58.9 | 58.9 |
| C | Aux. Stm. to Stm. AH 2-1 | | 0 | 0 | 0 | 0 | 1.2 | 0 | 0 | 0 | 0 | 0 |
| C | Aux. Stm. to Stm. AH 2-2 | | 0 | 0 | 0 | 0 | 1.2 | 0 | 0 | 0 | 0 | 0 |
| C | Aux. Steam to STAE | | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.0 | 3.0 | 3.0 | 3.1 | 3.0 |
| B | Air Flow to Boiler | | 3240 | 3350 | 3510 | 3820 | 2720 | 1700 | 1750 | 2200 | 3140 | 3380 |
| | **Pressures** | | | | | | | | | | | |
| | **Steam & Water** | PSIG | | | | | | | | | | |
| C | Feedwater to Econ. | | 2825 | 2810 | 2825 | 2825 | 2689 | 2532 | 2515 | 2523 | 2818 | 2811 |
| C | Boiler Drum | | 2737 | 2719 | 2740 | 2737 | 2615 | 2485 | 2473 | 2481 | 2724 | 2723 |
| C | Turbine Throttle | | 2449 | 2441 | 2452 | 2450 | 2406 | 2385 | 2374 | 2384 | 2445 | 2435 |
| C | Turbine 1st Stage | | 1841 | 1834 | 1841 | 1841 | 1435 | 939 | 938 | 935 | 1841 | 1832 |
| C | RH Inlet, Left | | 572 | 568 | 570 | 570 | 465 | 311 | 313 | 311 | 574 | 569 |
| C | RH Inlet, Right | | 576 | 572 | 574 | 574 | 469 | 314 | 314 | 312 | 578 | 573 |
| C | RH Inlet, Avg. | | 574 | 570 | 572 | 572 | 467 | 313 | 314 | 312 | 576 | 571 |
| C | RH Outlet | | 533 | 529 | 530 | 530 | 429 | 278 | 279 | 278 | 534 | 528 |
| C | HP Htr. 2-7 Steam In | | 550 | 548 | 550 | 548 | 382 | 412 | 412 | 412 | 553 | 548 |
| | **Air & Gas** | "$H_2O$ | | | | | | | | | | |
| B | FD Fan 2-1 Discharge R | | 8.4 | 9.6 | 11.6 | 12.9 | 8.2 | 4.0 | 4.5 | 6.6 | 9.6 | 9.9 |
| B | FD Fan 2-2 Discharge L | | 8.6 | 9.6 | 11.6 | 12.9 | 8.2 | 3.9 | 4.5 | 6.6 | 9.6 | 9.9 |
| B | FD Fan Discharge Avg. | | 8.5 | 9.6 | 11.6 | 12.9 | 8.2 | 4.0 | 4.5 | 6.6 | 9.6 | 9.9 |
| C | AH 2-1 Air Diff. Press. R | | 3.5 | 3.7 | 4.1 | 4.6 | 2.7 | 1.19 | 1.26 | 1.77 | 3.5 | 3.8 |
| C | AH 2-2 Air Diff. Press. L | | 3.6 | 3.9 | 4.2 | 4.8 | 3.1 | 1.37 | 1.45 | 1.88 | 3.6 | 3.9 |
| C | AH Air Diff. Press. Avg. | | 3.6 | 3.8 | 4.2 | 4.7 | 2.9 | 1.28 | 1.36 | 1.83 | 3.6 | 3.9 |
| B | Windbox Pressure R | | 3.2 | 3.5 | 5.5 | 5.7 | 4.1 | 2.2 | 2.5 | 3.9 | 4.5 | 4.3 |
| B | Windbox Pressure L | | 3.3 | 3.6 | 5.5 | 5.7 | 4.1 | 2.2 | 2.5 | 3.9 | 4.5 | 4.3 |
| B | Windbox Pressure Avg. | | 3.3 | 3.6 | 5.5 | 5.7 | 4.1 | 2.2 | 2.5 | 3.9 | 4.5 | 4.3 |
| B | Furnace Draft | | -0.5 | -0.6 | -0.5 | -0.5 | -1.0 | NA | -0.6 | -0.4 | -0.6 | -0.4 |
| C | SH Draft Diff. | | 1.80 | 2.10 | 2.12 | 2.43 | 1.6 | 0.32 | 0.46 | 0.64 | 1.82 | 1.96 |
| C | Econ. Draft Diff. | | 2.28 | 2.52 | 2.78 | 3.06 | 1.98 | 0.65 | 0.67 | 1.05 | 2.23 | 2.47 |
| B | AH 2-1 Gas Out Press. R | | -12.7 | -13.3 | -15.0 | -15+ | -10.4 | -5.6 | -5.4 | -6.8 | -12.5 | -13.0 |
| B | AH 2-2 Gas Out Press. L | | -11.5 | -12.6 | -13.5 | -15+ | -11.2 | -5.1 | -5.1 | -6.2 | -11.4 | -12.0 |
| B | AH Gas Out Pressure Avg. | | -12.1 | -13.0 | -14.2 | -15+ | -10.8 | -5.4 | -5.3 | -6.5 | -12.0 | -12.5 |
| B | ID Fan 2-1 Inlet Press. R | | -15.6 | -16.6 | -18.4 | -20.0 | -13.1 | -6.8 | -7.1 | -8.0 | -15.6 | -16.3 |
| B | ID Fan 2-2 Inlet Press. L | | -13.5 | -15.0 | -16.1 | -17.7 | -11.1 | -5.4 | -5.7 | -7.2 | -13.5 | -14.8 |
| B | ID Fan Inlet Pressure Avg. | | -14.6 | -15.8 | -17.3 | -18.9 | -12.1 | -6.1 | -6.4 | -7.6 | -14.6 | -15.6 |

* C = Computer Data; B = Board Data

# BASELINE OPERATION STUDY

BOARD AND COMPUTER DATA

| | TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 5/1 | 7/17 | 7/18 | 5/9 | 5/9 | 5/9 | 10/9 | 7/22 | 7/21 | 7/21 |
| | TIME | | 17:50 | 11:15 | 10:00 | 15:30 | 10:15 | 18:15 | 03:00 | 11:15 | 16:30 | 14:00 |
| C* | LOAD | MW | 428 | 256 | 259 | 433 | 433 | 433 | 361 | 258 | 260 | 258 |
| | **FLOWS** | $10^3$LB/HR | | | | | | | | | | |
| C | FEEDWATER | | 2895 | 1517 | 1482 | 2930 | 2915 | 2905 | 2258 | 1571 | 1573 | 1529 |
| B* | MAIN STEAM | | 3050 | 1504 | 1503 | 3038 | 3012 | 3012 | 2350 | 1508 | 1532 | 1505 |
| C | SUPERHEAT SPRAY L | | 0 | 20.7 | 33.0 | 0 | 0 | 0 | 4.4 | 0 | 9.8 | 26.3 |
| C | SUPERHEAT SPRAY R | | 0 | 13.0 | 25.6 | 0 | 0 | 0 | 1.2 | 0 | 2.5 | 19.2 |
| C | REHEAT SPRAY | | 0 | 0 | 0 | 27.5 | 31.0 | 27.3 | 22.7 | 0 | 0 | 0 |
| C | EXT. STM. TO STM. AH 2-1 | | 58.9 | 14.2 | 19.1 | 58.9 | 58.9 | 58.9 | 58.8 | 7.2 | 8.4 | 12.0 |
| C | EXT. STM. TO STM. AH 2-2 | | 58.9 | 14.3 | 19.3 | 58.9 | 58.9 | 58.9 | 58.8 | 7.3 | 8.5 | 12.1 |
| C | AUX. STM. TO STM. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 1.2 | 0 | 0 | 0 |
| C | AUX. STM. TO STM. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 1.2 | 0 | 0 | 0 |
| C | AUX. STEAM TO STAE | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.1 | 3.0 | 3.0 | 3.0 |
| B | AIR FLOW TO BOILER | | 3720 | 1700 | 2100 | 2980 | 3120 | 3620 | 2720 | 1660 | 1710 | 2020 |
| | **PRESSURES** | | | | | | | | | | | |
| | STEAM AND WATER | PSIG | | | | | | | | | | |
| C | FEEDWATER TO ECON. | | 2812 | 2513 | 2143 | 2828 | 2826 | 2826 | 2699 | 2537 | 2504 | 2501 |
| C | BOILER DRUM | | 2725 | 2472 | 2108 | 2738 | 2738 | 2737 | 2623 | 2492 | 2458 | 2458 |
| C | TURBINE THROTTLE | | 2438 | 2374 | 1978 | 2453 | 2456 | 2454 | 2417 | 2363 | 2359 | 2362 |
| C | TURBINE 1ST STAGE | | 1834 | 931 | 952 | 1846 | 1845 | 1845 | 1430 | 932 | 931 | 926 |
| C | RH INLET, LEFT | | 568 | 310 | 313 | 579 | 577 | 575 | 466 | 310 | 311 | 309 |
| C | RH INLET, RIGHT | | 571 | 311 | 314 | 583 | 581 | 579 | 468 | 311 | 315 | 311 |
| C | RH INLET, AVG. | | 570 | 311 | 314 | 581 | 579 | 577 | 467 | 311 | 313 | 310 |
| C | RH OUTLET | | 528 | 278 | 280 | 539 | 538 | 536 | 429 | 278 | 279 | 277 |
| C | HP HTR. 2-7 STEAM IN | | 546 | 409 | 412 | 556 | 556 | 554 | 385 | 412 | 409 | 412 |
| | AIR AND GAS | "$H_2O$ | | | | | | | | | | |
| B | FD FAN 2-1 DISCHARGE R | | 12.0 | 3.8 | 6.4 | 8.2 | 9.0 | 11.5 | 8.8 | 3.4 | 3.2 | 5.6 |
| B | FD FAN 2-2 DISCHARGE L | | 12.0 | 3.7 | 6.4 | 8.2 | 9.0 | 11.6 | 8.5 | 3.4 | 3.2 | 5.2 |
| B | FD FAN DISCHARGE AVG. | | 12.0 | 3.8 | 6.4 | 8.2 | 9.0 | 11.6 | 8.6 | 3.4 | 3.2 | 5.4 |
| C | AH 2-1 AIR DIFF. PRESS. R | | 4.4 | 1.21 | 1.73 | 3.1 | 3.4 | 4.2 | 2.6 | 1.18 | 1.22 | 1.60 |
| C | AH 2-2 AIR DIFF. PRESS. L | | 4.6 | 1.38 | 1.83 | 3.3 | 3.5 | 4.4 | 3.0 | 1.37 | 1.42 | 1.75 |
| C | AH AIR DIFF. PRESS. AVG. | | 4.5 | 1.30 | 1.78 | 3.2 | 3.5 | 4.3 | 2.8 | 1.28 | 1.32 | 1.68 |
| B | WINDBOX PRESSURE R | | 4.8 | 1.8 | 3.9 | 3.6 | 3.7 | 5.0 | 4.6 | 1.5 | 1.7 | 2.8 |
| B | WINDBOX PRESSURE L | | 4.8 | 1.8 | 3.9 | 3.6 | 3.7 | 5.0 | 4.6 | 1.5 | 1.7 | 2.8 |
| B | WINDBOX PRESSURE AVG. | | 4.8 | 1.8 | 3.9 | 3.6 | 3.7 | 5.0 | 4.6 | 1.5 | 1.7 | 2.8 |
| B | FURNACE DRAFT | | -0.5 | -0.7 | -0.5 | -0.5 | -0.6 | -0.6 | -1.0 | -0.4 | -0.6 | -0.6 |
| C | SH DRAFT DIFF. | | 2.28 | 0.38 | 0.5 | 1.54 | 1.64 | 2.19 | 1.45 | 0.39 | 0.38 | 0.67 |
| C | ECON. DRAFT DIFF. | | 2.95 | 0.75 | 1.04 | 2.0 | 2.27 | 2.90 | 1.89 | 0.59 | 0.84 | 0.94 |
| B | AH 2-1 GAS OUT PRESS. R | | -15+ | -5.2 | -6.5 | -12.0 | -13.1 | -15+ | -10.3 | -5.2 | -5.6 | -6.5 |
| B | AH 2-2 GAS OUT PRESS. L | | -15+ | -4.8 | -5.8 | -10.9 | -12.1 | -15+ | -10.1 | -4.5 | -5.0 | -5.9 |
| B | AH GAS OUT PRESSURE AVG. | | -15+ | -5.0 | -6.2 | -11.5 | -12.6 | -15+ | -10.2 | -4.9 | -5.3 | -6.2 |
| B | ID FAN 2-1 INLET PRESS. R | | -18.9 | -6.8 | -8.2 | -14.6 | -16.1 | -18.8 | -12.1 | -6.4 | -6.9 | -8.1 |
| B | ID FAN 2-2 INLET PRESS. L | | -17.5 | -5.4 | -6.5 | -12.5 | -13.6 | -16.0 | -11.0 | -5.1 | -5.5 | -6.4 |
| B | ID FAN INLET PRESSURE AVG. | | -18.2 | -6.1 | -7.4 | -13.6 | -14.9 | -17.4 | -11.6 | -5.8 | -6.2 | -7.3 |

* C = COMPUTER DATA; B = BOARD DATA

# BASELINE OPERATION STUDY

BOARD AND COMPUTER DATA

| | TEST NO. | | 1 | 2 | 2A | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 5/7 | 5/5 | 5/7 | 5/7 | 10/10 | 7/16 | 7/15 | 7/16 | 5/5 | 4/30 |
| | TIME | | 09:25 | 17:23 | 16:50 | 14:15 | 03:30 | 11:30 | 15:05 | 15:45 | 13:40 | 15:07 |
| C | LOAD | MW | 429 | 427 | 428 | 428 | 360 | 259 | 260 | 258 | 430 | 428 |
| | **TEMPERATURES** | | | | | | | | | | | |
| | **AIR AND GAS** | °F | | | | | | | | | | |
| C | AH 2-1 AIR IN | | 99 | 96 | 97 | 94 | 106 | 104 | 106 | 102 | 96 | 96 |
| C | AH 2-2 AIR IN | | 87 | 88 | 87 | 88 | 106 | 103 | 110 | 98 | 88 | 89 |
| C | AH AVG. AIR IN | | 94 | 92 | 92 | 91 | 106 | 104 | 108 | 100 | 92 | 93 |
| C | AH 2-1 AIR OUT | | 499 | 504 | 503 | 504 | 510 | 466 | 471 | 466 | 506 | 505 |
| C | AH 2-2 AIR OUT | | 526 | 528 | 533 | 534 | 520 | 470 | 478 | 480 | 530 | 528 |
| C | AH AVG. AIR OUT | | 512 | 516 | 518 | 519 | 515 | 468 | 475 | 473 | 518 | 516 |
| C | AH 2-1 GAS IN | | 693 | 700 | 714 | 718 | 680 | 589 | 599 | 614 | 700 | 704 |
| C | AH 2-2 GAS IN | | 700 | 706 | 722 | 733 | 675 | 583 | 592 | 612 | 708 | 710 |
| C | AH AVG. GAS IN | | 697 | 703 | 718 | 726 | 678 | 586 | 596 | 613 | 704 | 707 |
| C | AH 2-1 GAS OUT | | 253 | 257 | 257 | 260 | 265 | 245 | 244 | 240 | 256 | 258 |
| C | AH 2-2 GAS OUT (1) | | NA | NA | NA | NA | 268 | NA | NA | NA | NA | NA |
| C | AH AVG. GAS OUT | | 253 | 257 | 257 | 260 | 266 | 245 | 244 | 240 | 256 | 258 |
| | **STEAM AND WATER** | °F | | | | | | | | | | |
| C | FW IN TEMP. TO ECON. | | 484 | 484 | 484 | 484 | 465 | 428 | 428 | 428 | 485 | 484 |
| C | ECON. OUT AVG. | | 575 | 579 | 586 | 592 | 551 | 493 | 499 | 508 | 576 | 581 |
| C | BOILER DOWNCOMER | | 678 | 678 | 679 | 679 | 672 | 666 | 664 | 665 | 678 | 677 |
| C | SH DESH INLET L | | 739 | 741 | 748 | 759 | 757 | 738 | 750 | 767 | 743 | 743 |
| C | SH DESH INLET R | | 739 | 751 | 748 | 753 | 763 | 736 | 746 | 759 | 750 | 748 |
| C | SH DESH INLET AVG. | | 739 | 746 | 748 | 756 | 760 | 737 | 748 | 763 | 747 | 746 |
| C | SH DESH OUTLET L | | 744 | 747 | 753 | 759 | 753 | 730 | 741 | 734 | 748 | 748 |
| C | SH DESH OUTLET R | | 742 | 748 | 752 | 757 | 757 | 734 | 735 | 740 | 748 | 751 |
| C | SH DESH OUTLET AVG. | | 743 | 748 | 753 | 758 | 755 | 732 | 738 | 737 | 748 | 750 |
| C | SH OUTLET | | 982 | 982 | 988 | 991 | 1010 | 1008 | 1003 | 1006 | 991 | 986 |
| C | THROTTLE STEAM | | 971 | 976 | 978 | 980 | 999 | 999 | 995 | 996 | 980 | 975 |
| C | RH TURBINE L | | 613 | 617 | 618 | 620 | 601 | 552 | 550 | 551 | 623 | 616 |
| C | RH TURBINE R | | 614 | 617 | 618 | 620 | 606 | 562 | 560 | 560 | 622 | 617 |
| C | RH TURBINE AVG. | | 614 | 617 | 618 | 620 | 603 | 557 | 555 | 556 | 623 | 617 |
| C | RH BOILER L | | 611 | 610 | 616 | 617 | 584 | 550 | 547 | 549 | 604 | 615 |
| C | RH BOILER R | | 609 | 607 | 614 | 616 | 582 | 558 | 556 | 556 | 594 | 612 |
| C | RH BOILER AVG. | | 610 | 609 | 615 | 617 | 583 | 554 | 552 | 553 | 599 | 614 |
| C | RH OUTLET | | 1003 | 1000 | 1002 | 1002 | 1021 | 981 | 992 | 992 | 1003 | 1002 |
| C | HP HTR. 2-7 STEAM IN | | 611 | 616 | 616 | 620 | 602 | 558 | 555 | 556 | 620 | 616 |
| C | HP HTR. 2-7 FW IN | | 413 | 413 | 413 | 413 | 400 | 368 | 369 | 368 | 413 | 412 |
| C | HP HTR. 2-7 DRAIN | | 423 | 422 | 423 | 423 | 406 | 372 | 372 | 371 | 423 | 422 |
| C | AUX. STEAM TEMP. | | 545 | 549 | 558 | 562 | 550 | 567 | 556 | 578 | 552 | 556 |
| | **FAN DAMPER POSITION** | % OPEN | | | | | | | | | | |
| B | FD FANS | | 68 | 70 | 75 | 80 | 65 | 46 | 48 | 56 | 68 | 72 |
| B | ID FANS | | 62 | 63 | 65 | 72 | 58 | 38 | 40 | 46 | 61 | 62 |
| | **SPRAY VALVE POSITION** | % OPEN | | | | | | | | | | |
| B | SH SPRAY | | 0 | 0 | 0 | 0 | 11 | 11 | 23 | 31 | 0 | 0 |
| B | RH SPRAY | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21 | 0 |

C = COMPUTER DATA; B = BOARD DATA
(1) TC READING OPEN

# BASELINE OPERATION STUDY

## BOARD AND COMPUTER DATA

| | TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 5/1 | 7/17 | 7/18 | 5/9 | 5/9 | 5/9 | 10/9 | 7/22 | 7/21 | 7/21 |
| | TIME | | 17:50 | 11:15 | 10:00 | 15:30 | 10:15 | 18:15 | 03:00 | 11:15 | 16:30 | 14:00 |
| C | LOAD | MW | 428 | 256 | 259 | 433 | 433 | 433 | 361 | 258 | 260 | 258 |
| | **TEMPERATURES** | | | | | | | | | | | |
| | AIR AND GAS | °F | | | | | | | | | | |
| C | AH 2-1 AIR IN | | 93 | 104 | 104 | 96 | 97 | 92 | 109 | 104 | 103 | 104 |
| C | AH 2-2 AIR IN | | 89 | 112 | 105 | 88 | 86 | 87 | 112 | 112 | 112 | 101 |
| C | AH AVG. AIR IN | | 91 | 108 | 105 | 92 | 92 | 89 | 110 | 108 | 108 | 103 |
| C | AH 2-1 AIR OUT | | 506 | 470 | 465 | 510 | 508 | 514 | 508 | 470 | 473 | 473 |
| C | AH 2-2 AIR OUT | | 531 | 473 | 480 | 532 | 533 | 538 | 514 | 476 | 477 | 484 |
| C | AH AVG. AIR OUT | | 518 | 472 | 473 | 521 | 520 | 526 | 511 | 473 | 475 | 479 |
| C | AH 2-1 GAS IN | | 719 | 596 | 617 | 699 | 703 | 728 | 677 | 599 | 602 | 618 |
| C | AH 2-2 GAS IN | | 717 | 586 | 611 | 704 | 709 | 722 | 679 | 597 | 596 | 614 |
| C | AH AVG. GAS IN | | 718 | 591 | 614 | 702 | 706 | 725 | 678 | 598 | 599 | 616 |
| C | AH 2-1 GAS OUT | | 260 | 246 | 237 | 257 | 257 | 262 | 262 | 244 | 246 | 244 |
| C | AH 2-2 GAS OUT (1) | | NA | NA | NA | NA | NA | NA | 260 | NA | NA | NA |
| C | AH AVG. GAS OUT | | 260 | 246 | 237 | 257 | 257 | 262 | 261 | 244 | 246 | 244 |
| | STEAM AND WATER | °F | | | | | | | | | | |
| C | FW IN TEMP. TO ECON. | | 484 | 428 | 429 | 485 | 485 | 485 | 465 | 426 | 427 | 427 |
| C | ECON. OUT AVG. | | 591 | 495 | 503 | 575 | 579 | 593 | 548 | 494 | 496 | 505 |
| C | BOILER DOWNCOMER | | 679 | 664 | 642 | 678 | 679 | 679 | 673 | 665 | 663 | 663 |
| C | SH DESH INLET L | | 749 | 747 | 763 | 744 | 746 | 760 | 758 | 744 | 745 | 765 |
| C | SH DESH INLET R | | 754 | 744 | 758 | 745 | 748 | 763 | 767 | 739 | 746 | 766 |
| C | SH DESH INLET AVG. | | 752 | 746 | 761 | 745 | 747 | 762 | 762 | 742 | 746 | 766 |
| C | SH DESH OUTLET L | | 754 | 730 | 724 | 750 | 751 | 765 | 761 | 746 | 739 | 740 |
| C | SH DESH OUTLET R | | 758 | 734 | 729 | 750 | 752 | 768 | 767 | 747 | 744 | 745 |
| C | SH DESH OUTLET AVG. | | 756 | 732 | 727 | 750 | 752 | 767 | 764 | 747 | 742 | 743 |
| C | SH OUTLET | | 992 | 1006 | 1005 | 985 | 991 | 997 | 1014 | 1001 | 1002 | 1004 |
| C | THROTTLE STEAM | | 982 | 996 | 998 | 974 | 981 | 987 | 1004 | 993 | 993 | 996 |
| C | RH TURBINE L | | 621 | 551 | 581 | 619 | 623 | 626 | 605 | 547 | 548 | 550 |
| C | RH TURBINE R | | 622 | 561 | 600 | 619 | 624 | 628 | 612 | 557 | 559 | 562 |
| C | RH TURBINE AVG. | | 622 | 556 | 591 | 619 | 624 | 628 | 608 | 552 | 554 | 556 |
| C | RH BOILER L | | 618 | 548 | 574 | 576 | 573 | 591 | 553 | 544 | 547 | 548 |
| C | RH BOILER R | | 617 | 556 | 591 | 570 | 572 | 582 | 545 | 552 | 556 | 557 |
| C | RH BOILER AVG. | | 618 | 552 | 583 | 573 | 573 | 587 | 543 | 548 | 565 | 553 |
| C | RH OUTLET | | 1000 | 1001 | 1001 | 1003 | 1002 | 1004 | 1018 | 1000 | 1000 | 1001 |
| C | HP HTR. 2-7 STEAM IN | | 618 | 556 | 585 | 618 | 621 | 626 | 608 | 552 | 555 | 556 |
| C | HP HTR. 2-7 FW IN | | 412 | 368 | 369 | 414 | 414 | 414 | 400 | 368 | 368 | 368 |
| C | HP HTR. 2-7 DRAIN | | 422 | 371 | 369 | 424 | 424 | 424 | 406 | 372 | 371 | 372 |
| C | AUX. STEAM TEMP. | | 563 | 567 | 606 | 548 | 556 | 564 | 563 | 572 | 565 | 567 |
| | **FAN DAMPER POSITION** | % OPEN | | | | | | | | | | |
| B | FD FANS | | 78 | 45 | 56 | 68 | 70 | 76 | 63 | 45 | 47 | 54 |
| B | ID FANS | | 69 | 39 | 46 | 59 | 63 | 67 | 55 | 38 | 40 | 43 |
| | **SPRAY VALVE POSITION** | % OPEN | | | | | | | | | | |
| B | SH SPRAY | | 0 | 22 | 35 | 0 | 0 | 0 | 0 | 0 | 8 | 28 |
| B | RH SPRAY | | 0 | 0 | 0 | 30 | 35 | 30 | 26 | 0 | 0 | 0 |

C = COMPUTER DATA; B = BOARD DATA
(1) TC READING OPEN

# BASELINE OPERATION STUDY

## BOARD AND COMPUTER DATA

| | Test No. | | 1 | 2 | 2A | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1975 | 5/7 | 5/5 | 5/7 | 5/7 | 10/10 | 7/16 | 7/15 | 7/16 | 5/5 | 4/30 |
| | Time | | 09:25 | 17:23 | 16:50 | 14:15 | 03:30 | 11:30 | 15:05 | 15:45 | 13:40 | 15:07 |
| C | Load | MW | 429 | 427 | 428 | 428 | 360 | 259 | 260 | 258 | 430 | 428 |
| | **Mill Data** | | | | | | | | | | | |
| C | Mill 2-1 | Amps | 92 | 91 | 92 | 92 | NA | 81 | 81 | 81 | 90 | 90 |
| C | Mill 2-2 | Amps | 93 | 96 | 94 | 93 | NA | 81 | 79 | 81 | 95 | 87 |
| C | Mill 2-3 | Amps | 88 | 88 | 88 | 89 | NA | 80 | 82 | 80 | 88 | 92 |
| C | Mill 2-4 | Amps | 88 | 89 | 89 | 89 | NA | 80 | 82 | 82 | 88 | 91 |
| C | Mill 2-5 | Amps | 87 | 89 | 87 | 87 | NA | 0 | 0 | 0 | 88 | 90 |
| C | Coal Air Temp. Mill 2-1 | °F | 148 | 149 | 148 | 148 | 148 | 147 | 147 | 147 | 148 | 149 |
| C | Coal Air Temp. Mill 2-2 | °F | 148 | 146 | 147 | 147 | 148 | 147 | 147 | 147 | 147 | 148 |
| C | Coal Air Temp. Mill 2-3 | °F | 147 | 147 | 147 | 147 | 148 | 148 | 148 | 148 | 147 | 147 |
| C | Coal Air Temp. Mill 2-4 | °F | 147 | 147 | 147 | 147 | 146 | 146 | 146 | 146 | 147 | 147 |
| C | Coal Air Temp. Mill 2-5 | °F | 149 | 149 | 150 | 149 | 149 | 85 | 90 | 85 | 150 | 150 |
| B | Mill 2-1 Exh. Discharge | "$H_2O$ | 8.3 | 8.1 | 8.4 | 8.5 | 7.0 | 7.1 | 6.5 | 6.2 | 8.0 | 8.5 |
| B | Mill 2-2 Exh. Discharge | "$H_2O$ | 7.6 | 7.8 | 7.9 | 7.9 | 6.4 | 6.3 | 6.2 | 6.5 | 7.8 | 7.5 |
| B | Mill 2-3 Exh. Discharge | "$H_2O$ | 7.1 | 7.0 | 7.5 | 7.4 | 6.8 | 7.0 | 7.4 | 7.1 | 7.0 | 7.8 |
| B | Mill 2-4 Exh. Discharge | "$H_2O$ | 6.9 | 7.1 | 7.2 | 7.0 | 7.1 | 6.2 | 6.5 | 6.5 | 7.2 | 7.4 |
| B | Mill 2-5 Exh. Discharge | "$H_2O$ | 7.3 | 7.2 | 7.3 | 7.3 | 6.6 | 0 | 0 | 0 | 7.6 | 7.8 |
| B | Mill 2-1 Suction | "$H_2O$ | -1.76 | -1.8 | -1.6 | -1.3 | -2.0 | -2.3 | -2.5 | -2.0 | -1.8 | -1.7 |
| B | Mill 2-2 Suction | "$H_2O$ | -1.6 | -1.5 | -1.4 | -1.3 | -2.2 | -2.2 | -2.5 | -2.1 | -1.5 | -1.8 |
| B | Mill 2-3 Suction | "$H_2O$ | -1.86 | -1.9 | -1.6 | -1.5 | -1.95 | -2.1 | -2.2 | -2.0 | -1.8 | -1.8 |
| B | Mill 2-4 Suction | "$H_2O$ | -2.0 | -1.9 | -1.8 | -1.8 | -2.0 | -2.5 | -2.4 | -2.2 | -1.8 | -1.8 |
| B | Mill 2-5 Suction | "$H_2O$ | -2.0 | -2.0 | -1.8 | -1.6 | -2.25 | 0 | 0 | 0 | -1.8 | -1.8 |
| B | Mill 2-1 Coal Flow | $10^3$LB/HR | 70 | 63 | 69 | 70 | 58 | 48 | 43 | 48 | 63 | 65 |
| B | Mill 2-2 Coal Flow | $10^3$LB/HR | 62 | 60 | 61 | 61 | 48 | 44 | 40 | 44 | 60 | 65 |
| B | Mill 2-3 Coal Flow | $10^3$LB/HR | 61 | 60 | 61 | 61 | 58 | 43 | 47 | 44 | 59 | 63 |
| B | Mill 2-4 Coal Flow | $10^3$LB/HR | 61 | 60 | 60 | 61 | 58 | 46 | 48 | 44 | 60 | 64 |
| B | Mill 2-5 Coal Flow | $10^3$LB/HR | 62 | 60 | 62 | 62 | 59 | 0 | 0 | 0 | 62 | 65 |
| B | Mill 2-1 Feeder Speed (1) | % | 80 | 73 | 78 | 80 | 67 | 56 | 48 | 56 | 73 | 75 |
| B | Mill 2-2 Feeder Speed | % | 74 | 72 | 74 | 74 | 56 | 52 | 48 | 54 | 72 | 78 |
| B | Mill 2-3 Feeder Speed | % | 72 | 71 | 72 | 73 | 69 | 52 | 57 | 54 | 71 | 77 |
| B | Mill 2-4 Feeder Speed | % | 74 | 71 | 74 | 75 | 69 | 53 | 58 | 54 | 72 | 78 |
| B | Mill 2-5 Feeder Speed | % | 74 | 73 | 74 | 75 | 70 | 0 | 0 | 0 | 74 | 79 |
| | **Burner Tilt** | ± Degrees | | | | | | | | | | |
| B | Position LF | | 14 | 13 | 12 | 14 | 0 | 16 | 10 | 4 | 10 | NA |
| B | Position LR | | 14 | 12 | 13 | 15 | 1 | 16 | 10 | 6 | 8 | NA |
| B | Position RF | | 15 | 13 | 14 | 15 | 0 | 18 | 10 | 6 | 10 | NA |
| B | Position RR | | 18 | 12 | 13 | 15 | 0 | 18 | 10 | 5 | 8 | NA |
| | **Miscellaneous** | | | | | | | | | | | |
| B | Drum Level, In. ± Norm. $H_2O$ Level | | 0 | 0 | 0 | 0 | 0 | -1.0 | -1.0 | -1.0 | 0 | 0 |
| C | FD Fan 2-1 | Amps | 224 | 231 | 247 | 262 | 201 | 173 | 175 | 190 | 227 | 232 |
| C | FD Fan 2-2 | Amps | 212 | 216 | 227 | 238 | 216 | 171 | 173 | 185 | 213 | 216 |
| C | ID Fan 2-1 | Amps | 378 | 392 | 406 | 437 | 360 | 307 | 311 | 330 | 379 | 392 |
| C | ID Fan 2-2 | Amps | 379 | 389 | 406 | 430 | 364 | 307 | 311 | 328 | 378 | 388 |
| C | Flue Gas $SO_2$ in Stack | PPM | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| C | Flue Gas Combustibles L | % | 0 | 0 | 0 | 0 | .10 | 0 | 0 | 0 | 0 | 0 |
| C | Flue Gas Combustibles R | % | 0 | 0 | 0 | 0 | .05 | 0 | 0 | 0 | 0 | 0 |
| C | Flue Gas $O_2$ L | % | 3.01 | 4.24 | 4.37 | 5.65 | 4.26 | 2.75 | 3.46 | 5.31 | 2.69 | 4.45 |
| C | Flue Gas $O_2$ R | % | 3.08 | 3.96 | 4.88 | 5.96 | 3.83 | 3.62 | 4.33 | 6.44 | 3.20 | 3.36 |
| C | Flue Gas $O_2$ Avg. | % | 3.05 | 4.10 | 4.63 | 5.81 | 4.04 | 3.19 | 3.90 | 5.88 | 2.95 | 3.91 |
| B | Ambient Temp. | °F | 37 | 33 | 45 | 43 | 39 | 72 | 78 | 62 | 40 | 54 |
| B | Ambient Rel. Humidity | % | 63 | 62 | 51 | 58 | 56 | 62 | 52 | 63 | 48 | 44 |
| B | Barometric Pressure | "Hg | 23.59 | 23.48 | 23.66 | 23.65 | 23.94 | 23.85 | 23.85 | 23.81 | 23.43 | 23.73 |

C = Computer Data; B = Board Data
(1) Feeder Speed in % of Control Signal.

# BASELINE OPERATION STUDY

BOARD AND COMPUTER DATA

| | TEST NO. | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 5/1 | 7/17 | 7/18 | 5/9 | 5/9 | 5/9 | 10/9 | 7/22 | 7/21 | 7/21 |
| | TIME | | 17:50 | 11:15 | 10:00 | 15:30 | 10:15 | 18:15 | 03:00 | 11:15 | 16:30 | 14:00 |
| C | LOAD | MW | 428 | 256 | 259 | 433 | 433 | 433 | 361 | 258 | 260 | 258 |
| | MILL DATA | | | | | | | | | | | |
| C | MILL 2-1 | AMPS | 91 | 79 | 81 | 91 | 91 | 92 | NA | 80 | 80 | 80 |
| C | MILL 2-2 | AMPS | 89 | 80 | 76 | 96 | 95 | 96 | NA | 0 | 0 | 0 |
| C | MILL 2-3 | AMPS | 91 | 81 | 84 | 90 | 89 | 89 | NA | 78 | 81 | 81 |
| C | MILL 2-4 | AMPS | 91 | 82 | 80 | 88 | 89 | 89 | NA | 80 | 81 | 82 |
| C | MILL 2-5 | AMPS | 91 | 0 | 0 | 89 | 90 | 90 | NA | 82 | 83 | 83 |
| C | COAL AIR TEMP. MILL 2-1 | °F | 149 | 146 | 147 | 149 | 149 | 149 | 149 | 147 | 147 | 147 |
| C | COAL AIR TEMP. MILL 2-2 | °F | 147 | 146 | 147 | 148 | 148 | 147 | 148 | 86 | 85 | 86 |
| C | COAL AIR TEMP. MILL 2-3 | °F | 147 | 148 | 149 | 148 | 148 | 147 | 147 | 148 | 149 | 148 |
| C | COAL AIR TEMP. MILL 2-4 | °F | 147 | 145 | 146 | 147 | 147 | 147 | 78 | 146 | 146 | 146 |
| C | COAL AIR TEMP. MILL 2-5 | °F | 150 | 86 | 87 | 149 | 150 | 150 | 149 | 149 | 149 | 148 |
| B | MILL 2-1 EXH. DISCHARGE | "$H_2O$ | 8.5 | 5.9 | 5.7 | 8.3 | 8.1 | 8.2 | 7.4 | 5.8 | 5.6 | 5.9 |
| B | MILL 2-2 EXH. DISCHARGE | "$H_2O$ | 7.6 | 6.4 | 9.5 | 8.0 | 8.0 | 8.3 | 6.5 | 0 | 0 | 0 |
| B | MILL 2-3 EXH. DISCHARGE | "$H_2O$ | 7.8 | 7.8 | 10.1 | 7.0 | 7.2 | 7.4 | 6.9 | 7.3 | 7.4 | 7.5 |
| B | MILL 2-4 EXH. DISCHARGE | "$H_2O$ | 7.9 | 6.5 | 7 | 7.1 | 7.4 | 7.2 | 0 | 6.5 | 6.9 | 6.8 |
| B | MILL 2-5 EXH. DISCHARGE | "$H_2O$ | 8.0 | 0 | 0 | 7.6 | 7.3 | 7.6 | 7.0 | 6.9 | 6.8 | 7.0 |
| B | MILL 2-1 SUCTION | "$H_2O$ | -1.6 | -2.2 | -2.1 | -1.9 | -1.8 | -1.8 | -1.9 | -2.2 | -2.3 | -2.2 |
| B | MILL 2-2 SUCTION | "$H_2O$ | -1.7 | -2.3 | -2.0 | -1.6 | -1.6 | -1.5 | -1.8 | 0 | 0 | 0 |
| B | MILL 2-3 SUCTION | "$H_2O$ | -1.6 | -2.2 | -1.7 | -2.0 | -1.9 | -1.9 | -1.7 | -2.2 | -2.2 | -2.1 |
| B | MILL 2-4 SUCTION | "$H_2O$ | -1.8 | -2.5 | -2.1 | -2.0 | -2.0 | -1.9 | 0 | -2.4 | -2.4 | -2.3 |
| B | MILL 2-5 SUCTION | "$H_2O$ | -1.6 | 0 | 0 | -2.0 | -2.0 | -1.9 | -1.9 | -2.3 | -2.3 | -2.2 |
| B | MILL 2-1 COAL FLOW | $10^3$LB/HR | 64 | 44 | 44 | 66 | 66 | 65 | 64 | 47 | 46 | 44 |
| B | MILL 2-2 COAL FLOW | $10^3$LB/HR | 65 | 44 | 44 | 62 | 62 | 62 | 70 | 0 | 0 | 0 |
| B | MILL 2-3 COAL FLOW | $10^3$LB/HR | 63 | 46 | 50 | 61 | 62 | 61 | 68 | 43 | 48 | 48 |
| B | MILL 2-4 COAL FLOW | $10^3$LB/HR | 64 | 45 | 53 | 62 | 62 | 62 | 0 | 49 | 49 | 50 |
| B | MILL 2-5 COAL FLOW | $10^3$LB/HR | 65 | 0 | 0 | 63 | 62 | 63 | 70 | 50 | 50 | 52 |
| B | MILL 2-1 FEEDER SPEED (1) | % | 74 | 50 | 52 | 75 | 76 | 76 | 74 | 54 | 53 | 52 |
| B | MILL 2-2 FEEDER SPEED | % | 78 | 54 | 53 | 75 | 75 | 75 | 82 | 0 | 0 | 0 |
| B | MILL 2-3 FEEDER SPEED | % | 78 | 57 | 61 | 74 | 74 | 74 | 80 | 53 | 58 | 59 |
| B | MILL 2-4 FEEDER SPEED | % | 78 | 53 | 64 | 75 | 75 | 75 | 0 | 59 | 59 | 60 |
| B | MILL 2-5 FEEDER SPEED | % | 79 | 0 | 0 | 75 | 74 | 75 | 83 | 60 | 60 | 62 |
| | BURNER TILT | ± DEGREES | | | | | | | | | | |
| B | POSITION LF | | NA | 6 | 3 | 3 | 8 | 2 | 0 | 11 | 13 | 12 |
| B | POSITION LR | | NA | 9 | 5 | 5 | 10 | 3 | 1 | 12 | 14 | 14 |
| B | POSITION RF | | NA | 8 | 5 | 5 | 10 | 4 | 0 | 12 | 16 | 14 |
| B | POSITION RR | | NA | 7 | 3 | 3 | 8 | 2 | 0 | 12 | 14 | 14 |
| | MISCELLANEOUS | | | | | | | | | | | |
| B | DRUM LEVEL, IN. ± NORM. $H_2O$ LEVEL | | 0 | -1 | -1 | 0 | 0 | 0 | 0 | -1 | -1 | -1 |
| C | FD FAN 2-1 | AMPS | 252 | 172 | 189 | 216 | 224 | 248 | 201 | 171 | 174 | 186 |
| C | FD FAN 2-2 | AMPS | 230 | 171 | 184 | 205 | 210 | 227 | 217 | 170 | 172 | 182 |
| C | ID FAN 2-1 | AMPS | 424 | 307 | 328 | 374 | 385 | 423 | 358 | 307 | 313 | 324 |
| C | ID FAN 2-2 | AMPS | 417 | 306 | 326 | 372 | 387 | 417 | 356 | 307 | 312 | 324 |
| C | FLUE GAS $SO_2$ IN STACK | PPM | NA | NA | NA | 501 | 255 | 328 | NA | NA | NA | NA |
| C | FLUE GAS COMBUSTIBLES L | % | 0 | 0 | 0 | 0 | 0 | 0 | .10 | 0 | 0 | 0 |
| C | FLUE GAS COMBUSTIBLES R | % | 0 | 0 | 0 | 0 | 0 | 0 | .05 | 0 | 0 | 0 |
| C | FLUE GAS $O_2$ L | % | 6.32 | 3.14 | 5.74 | 3.80 | 4.88 | 7.36 | 2.55 | 2.77 | 3.17 | 5.21 |
| C | FLUE GAS $O_2$ R | % | 4.73 | 3.51 | 6.73 | 1.88 | 3.17 | 4.42 | 4.00 | 3.71 | 3.96 | 6.10 |
| C | FLUE GAS $O_2$ AVG. | % | 5.53 | 3.33 | 6.24 | 2.84 | 4.03 | 5.89 | 3.28 | 3.24 | 3.57 | 5.66 |
| B | AMBIENT TEMP. | °F | 50 | 70 | 78 | 63 | 61 | 60 | 72 | 82 | 79 | 80 |
| B | AMBIENT REL. HUMIDITY | % | 50 | 67 | 33 | 43 | 44 | 42 | 66 | 41 | 36 | 41 |
| B | BAROMETRIC PRESSURE | "HG | 23.77 | 23.88 | 23.92 | 23.91 | 23.91 | 23.0 | 23.98 | 23.95 | 23.95 | 23.96 |

C = COMPUTER DATA; B = BOARD DATA
(1) FEEDER SPEED IN % OF CONTROL SIGNAL.

# BIASED FIRING OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 9/18 | 9/18 | 9/20 | 12/13 | 10/11 | 10/12 | 10/12 | 10/5 |
| | TIME | | 17:00 | 17:25 | 13:15 | 14:00 | 16:30 | 15:00 | 10:00 | 21:30 |
| C | LOAD | MW | 430 | 426 | 431 | 356 | 351 | 360 | 257 | 271 |
| | FLOWS | $10^3$LB/HR | | | | | | | | |
| C | FEEDWATER | | 2945 | 2889 | 2871 | 2291 | 2261 | 2336 | 1648 | 1603 |
| B | MAIN STEAM | | 3050 | 3030 | 2975 | 2350 | 2350 | 2400 | 1600 | 1650 |
| C | SUPERHEAT SPRAY L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29.0 |
| C | SUPERHEAT SPRAY R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25.6 |
| C | REHEAT SPRAY | | 0 | 0 | 21.3 | 0 | 0 | 0 | 0 | 0 |
| C | EXT. STM. TO STM. AH 2-1 | | 58.8 | 58.8 | 58.8 | 31.0 | 14.4 | 25.3 | 25.4 | 58.8 |
| C | EXT. STM. TO STM. AH 2-2 | | 58.8 | 58.8 | 58.8 | 36.2 | 14.2 | 25.3 | 25.5 | 58.8 |
| C | AUX. STM. TO STM. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | AUX. STM. TO STM. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | AUX. STM. TO SJAE | | 3.0 | 3.0 | 3.0 | 2.0 | 2.9 | 3.0 | 3.0 | 3.0 |
| B | AIR FLOW TO BOILER | | 3200 | 3210 | 3260 | 2510 | 2410 | 2650 | 1750 | 1850 |
| | PRESSURES | | | | | | | | | |
| | STEAM AND WATER | PSIG | | | | | | | | |
| C | FEEDWATER TO ECONOMIZER | | 2808 | 2814 | 2798 | 2717 | 2691 | 2694 | 2592 | 2591 |
| C | BOILER DRUM | | 2713 | 2708 | 2703 | 2625 | 2624 | 2615 | 2536 | 2535 |
| C | TURBINE THROTTLE | | 2434 | 2411 | 2417 | 2420 | 2422 | 2406 | 2416 | 2420 |
| C | TURBINE 1ST STAGE | | 1820 | 1814 | 1816 | 1444 | NA | NA | NA | 1009 |
| C | RH INLET, LEFT | | 571 | 568 | 572 | 462 | NA | NA | NA | 339 |
| C | RH INLET, RIGHT | | 575 | 573 | 576 | 465 | NA | NA | NA | 340 |
| C | RH INLET, AVERAGE | | 573 | 571 | 574 | 464 | NA | NA | NA | 340 |
| C | RH OUTLET | | 535 | 532 | 532 | 422 | 420 | 436 | 294 | 306 |
| C | HP HTR. 2-7 STM. IN | | 358 | 361 | 360 | 382 | 383 | 374 | 406 | 409 |
| | AIR AND GAS | "$H_2O$ | | | | | | | | |
| B | FD FAN DISCHARGE R | | 9.5 | 9.6 | 8.6 | 7.1 | 6.3 | 8.4 | 2.8 | 4.0 |
| B | FD FAN DISCHARGE L | | 9.5 | 9.6 | 8.5 | 7.0 | 6.3 | 8.4 | 2.8 | 4.0 |
| B | FD FAN DISCHARGE AVG. | | 9.5 | 9.6 | 8.6 | 7.0 | 6.3 | 8.4 | 2.8 | 4.0 |
| C | AH 2-1 AIR DIFF. PRESS. R | | 3.4 | 3.4 | 3.5 | 2.5 | 2.3 | 2.5 | 1.4 | 1.4 |
| C | AH 2-2 AIR DIFF. PRESS. L | | 3.9 | 3.9 | 4.0 | 2.9 | 2.6 | 3.0 | 1.6 | 1.6 |
| C | AH AIR DIFF. PRESS. AVG. | | 3.7 | 3.7 | 3.7 | 2.7 | 2.4 | 2.8 | 1.5 | 1.5 |
| B | WINDBOX PRESS. R | | 4.0 | 3.9 | 3.3 | 3.5 | 2.8 | 4.4 | 0.6 | 1.5 |
| B | WINDBOX PRESS. L | | 4.0 | 3.9 | 3.3 | 3.5 | 2.8 | 4.4 | 0.3 | 1.5 |
| B | WINDBOX PRESS. AVG. | | 4.0 | 3.9 | 3.3 | 3.5 | 2.8 | 4.4 | 0.5 | 1.5 |
| B | FURNACE DRAFT | | -0.6 | -0.6 | -1.1 | -1 | -1 | -1 | -1 | -1 |
| C | SH DRAFT DIFF. | | 1.91 | 1.93 | 1.93 | 1.2 | 1.05 | 1.33 | 0.45 | 0.54 |
| C | ECON. DRAFT DIFF. | | 2.37 | 2.37 | 2.50 | 2.21 | 1.65 | 1.83 | 0.92 | 1.05 |
| B | AH 2-1 GAS OUT PRESS. R | | -12.7 | -12.6 | -13.7 | -10.1 | -10.2 | -10.5 | -6.6 | -6.9 |
| B | AH 2-2 GAS OUT PRESS. L | | -11.3 | -11.5 | -12.5 | -9.1 | -9.4 | -9.8 | -6.1 | -6.9 |
| B | AH GAS OUT PRESS. AVG. | | -12.2 | -12.1 | -13.1 | -9.6 | -9.8 | -10.2 | -6.4 | -6.9 |
| B | ID FAN 2-1 INLET PRESS. R | | -15.4 | -15.6 | -16.8 | -12.6 | -11.8 | -12.2 | -7.6 | -7.8 |
| B | ID FAN 2-2 INLET PRESS. L | | -12.6 | -12.6 | -13.1 | -10.1 | -10.1 | -10.5 | -6.6 | -7.1 |
| B | ID FAN INLET PRESS. AVG. | | -14.0 | -14.1 | -15.0 | -11.4 | -11.0 | -11.4 | -7.1 | -7.5 |

C = COMPUTER DATA; B = BOARD DATA

# BIASED FIRING OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 9/19 | 9/18 | 9/18 | 10/11 | 12/13 | 12/13 | 7/23 | 7/24 |
| | TIME | | 14:35 | 09:45 | 14:10 | 14:45 | 12:00 | 10:15 | 10:40 | 09:55 |
| C | LOAD | MW | 427 | 429 | 430 | 351 | 356 | 357 | 256 | 259 |
| | FLOWS | $10^3$LB/HR | | | | | | | | |
| C | FEEDWATER | | 2938 | 2897 | 2882 | 2273 | 2321 | 2302 | 1557 | 1584 |
| B | MAIN STEAM | | 3050 | 3000 | 3000 | 2350 | 2367 | 2350 | 1500 | 1500 |
| C | SUPERHEAT SPRAY L | | 0 | 0 | 0 | 0 | 0 | 0 | 4.7 | 19.2 |
| C | SUPERHEAT SPRAY R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9.1 |
| C | REHEAT SPRAY | | 0 | 26.2 | 30.5 | 0 | 0 | 2.7 | 0 | 0 |
| C | EXT. STM. TO STM. AH 2-1 | | 58.8 | 58.8 | 58.8 | 58.8 | 44.6 | 43.9 | 6.3 | 9.3 |
| C | EXT. STM. TO STM. AH 2-2 | | 58.8 | 58.8 | 58.8 | 58.8 | 44.2 | 43.8 | 6.2 | 9.3 |
| C | AUX. STM. TO STM. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | AUX. STM. TO STM. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | AUX. STM. TO SJAE | | 3.0 | 3.0 | 3.0 | 2.9 | 2.0 | 2.0 | 3.0 | 3.0 |
| B | AIR FLOW TO BOILER | | 3400 | 3480 | 3430 | 2610 | 2730 | 2860 | 1700 | 1700 |
| | PRESSURES | | | | | | | | | |
| | STEAM AND WATER | PSIG | | | | | | | | |
| C | FEEDWATER TO ECONOMIZER | | 2826 | 2813 | 2805 | 2668 | 2739 | 2738 | 2536 | 2544 |
| C | BOILER DRUM | | 2718 | 2721 | 2722 | 2622 | 2612 | 2625 | 2489 | 2495 |
| C | TURBINE THROTTLE | | 2420 | 2414 | 2417 | 2397 | 2434 | 2425 | 2392 | 2397 |
| C | TURBINE 1ST STAGE | | 1824 | 1829 | 1823 | NA | 1438 | 1441 | 927 | 939 |
| C | RH INLET, LEFT | | 571 | 575 | 574 | NA | 460 | 460 | 307 | 312 |
| C | RH INLET, RIGHT | | 576 | 579 | 579 | NA | 463 | 463 | 308 | 314 |
| C | RH INLET, AVERAGE | | 574 | 577 | 577 | NA | 462 | 462 | 308 | 313 |
| C | RH OUTLET | | 533 | 535 | 535 | 420 | 426 | 425 | 274 | 280 |
| C | HP HTR. 2-7 STM. IN | | 359 | 359 | 360 | 383 | 381 | 381 | 412 | 406 |
| | AIR AND GAS. | "$H_2O$ | | | | | | | | |
| B | FD FAN DISCHARGE R | | 9.9 | 10.4 | 10.4 | 8.2 | 7.8 | 8.0 | 3.1 | 3.1 |
| B | FD FAN DISCHARGE L | | 9.9 | 10.4 | 10.4 | 8.2 | 7.5 | 8.0 | 3.1 | 3.0 |
| B | FD FAN DISCHARGE AVG. | | 9.9 | 10.4 | 10.4 | 8.2 | 7.6 | 8.0 | 3.1 | 3.1 |
| C | AH 2-1 AIR DIFF. PRESS. R | | 3.6 | 3.8 | 3.8 | 2.6 | 2.94 | 3.02 | 1.3 | 1.2 |
| C | AH 2-2 AIR DIFF. PRESS. L | | 4.2 | 4.3 | 4.3 | 3.0 | 3.38 | 3.51 | 1.4 | 1.4 |
| C | AH AIR DIFF. PRESS. AVG. | | 3.9 | 4.0 | 4.1 | 2.8 | 3.16 | 3.26 | 1.4 | 1.3 |
| B | WINDBOX PRESS. R | | 4.0 | 3.9 | 4.0 | 4.0 | 4.2 | 4.2 | 1.2 | 1.1 |
| B | WINDBOX PRESS. L | | 4.0 | 3.9 | 4.0 | 4.0 | 4.2 | 4.2 | 1.2 | 1.1 |
| B | WINDBOX PRESS. AVG. | | 4.0 | 3.9 | 4.0 | 4.0 | 4.2 | 4.2 | 1.2 | 1.1 |
| B | FURNACE DRAFT | | -0.8 | -0.8 | -0.4 | -1 | -1.1 | -1.0 | -0.5 | -0.5 |
| C | SH DRAFT DIFF. | | 2.11 | 2.06 | 2.11 | 1.25 | 1.48 | 1.38 | 0.40 | 0.48 |
| C | ECON. DRAFT DIFF. | | 2.55 | 2.72 | 2.72 | 1.84 | 2.48 | 2.55 | 0.77 | 0.61 |
| B | AH 2-1 GAS OUT PRESS. R | | -13.9 | -14.5 | -13.95 | -11.1 | -11.6 | -12.1 | -5.6 | -5.7 |
| B | AH 2-2 GAS OUT PRESS. L | | -12.6 | -13.1 | -12.0 | -10.4 | -10.5 | -11.3 | -5.1 | -5.1 |
| B | AH GAS OUT PRESS. AVG. | | -13.3 | -13.8 | -13.3 | -10.8 | -11.0 | -11.7 | -5.4 | -5.4 |
| B | ID FAN 2-1 INLET PRESS. R | | -16.8 | -17.8 | -17.2 | -12.9 | -14.3 | -14.9 | -6.7 | -7.1 |
| B | ID FAN 2-2 INLET PRESS. L | | -13.8 | -14.3 | -13.7 | -11.2 | -11.5 | -12.2 | -5.4 | -5.6 |
| B | ID FAN INLET PRESS. AVG. | | -15.3 | -16.0 | -15.4 | -12.1 | -12.9 | -13.6 | -6.1 | -5.9 |

C = COMPUTER DATA; B = BOARD DATA

# BIASED FIRING OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1975 | 9/18 | 9/18 | 9/20 | 12/13 | 10/11 | 10/12 | 10/12 | 10/5 |
| | Time | | 17:00 | 17:25 | 13:15 | 14:00 | 16:30 | 15:00 | 10:00 | 21:30 |
| C | Load | MW | 430 | 426 | 431 | 356 | 351 | 360 | 257 | 271 |
| | TEMPERATURES | | | | | | | | | |
| | Air and Gas | °F | | | | | | | | |
| C | AH 2-1 Air In | | 106 | 106 | 105 | 105 | 109 | 112 | 117 | 114 |
| C | AH 2-2 Air In | | 99 | 100 | 98 | 104 | 108 | 113 | 118 | 117 |
| C | Avg. Air In | | 103 | 103 | 102 | 104 | 108 | 112 | 118 | 116 |
| C | AH 2-1 Air Out | | 520 | 515 | 516 | 498 | 511 | 499 | 472 | 481 |
| C | AH 2-2 Air Out | | 540 | 537 | 542 | 502 | 515 | 507 | 474 | 482 |
| C | Avg. Air Out | | 530 | 526 | 529 | 500 | 513 | 503 | 473 | 482 |
| C | AH 2-1 Gas In | | 715 | 705 | 707 | 657 | 664 | 660 | 598 | 614 |
| C | AH 2-2 Gas In | | 716 | 706 | 718 | 626 | 664 | 660 | 597 | 616 |
| C | Avg. Gas In | | 716 | 706 | 713 | 642 | 664 | 660 | 598 | 615 |
| C | AH 2-1 Gas Out | | 266 | 264 | 265 | 255 | 264 | 258 | 249 | 254 |
| C | AH 2-2 Gas Out (1) | | 278 | 277 | 278 | 258 | 267 | 261 | 252 | 253 |
| C | Avg. Gas Out | | 272 | 271 | 272 | 256 | 266 | 260 | 251 | 254 |
| | Steam and Water | °F | | | | | | | | |
| C | FW In Temp. to Econ. | | 484 | 484 | 485 | 463 | 462 | 466 | 430 | 436 |
| C | Econ. Out Avg. | | 571 | 570 | 571 | 534 | 542 | 543 | 501 | 508 |
| C | Boiler Downcomer | | 678 | 678 | 677 | 673 | --- | 672 | 667 | 669 |
| C | SH DESH Inlet L | | 744 | 744 | 750 | 733 | 749 | 744 | 738 | 751 |
| C | SH DESH Inlet R | | 756 | 754 | 753 | 733 | 753 | 745 | 746 | 759 |
| C | SH DESH Inlet Avg | | 750 | 748 | 752 | 733 | 751 | 745 | 742 | 755 |
| C | SH DESH Outlet L | | 751 | 749 | 757 | 737 | 750 | 744 | 744 | 729 |
| C | SH DESH Outlet R | | 759 | 752 | 755 | 737 | 758 | 749 | 750 | 736 |
| C | SH DESH Outlet Avg | | 755 | 751 | 756 | 737 | 754 | 747 | 747 | 732 |
| C | SH Outlet | | 967 | 976 | 995 | 1005 | 994 | 1006 | 1006 | 1006 |
| C | Throttle Steam | | 955 | 964 | 981 | 998 | 985 | 996 | 994 | 999 |
| C | RH Turbine L | | 599 | 607 | 621 | 598 | NA | NA | NA | 554 |
| C | RH Turbine R | | 599 | 607 | 622 | 601 | NA | NA | NA | 566 |
| C | RH Turbine Avg | | 599 | 607 | 622 | 600 | NA | NA | NA | 560 |
| C | RH Boiler L | | 595 | 604 | 596 | NA | 575 | 592 | 543 | 551 |
| C | RH Boiler R | | 595 | 603 | 585 | NA | 578 | 593 | 554 | 561 |
| C | RH Boiler Avg | | 595 | 604 | 591 | NA | 577 | 593 | 550 | 556 |
| C | RH Outlet | | 993 | 1008 | 1014 | 1001 | 994 | 1017 | 1000 | 1018 |
| C | HP Htr 2-7 Stm. In | | 601 | 606 | 623 | 599 | 589 | 602 | 552 | 561 |
| C | HP Htr 2-7 FW In | | 416 | 415 | 415 | 398 | 398 | 400 | 372 | 372 |
| C | HP Htr. 2-7 Drain | | 424 | 423 | 424 | 403 | 404 | 407 | 376 | 380 |
| C | Aux. Steam Temp. | | 514 | 508 | 518 | 571 | 545 | 546 | 552 | 533 |
| | FAN DAMPER POSITION | % Open | | | | | | | | |
| B | FD Fans | | 72 | 71 | 70 | 60 | 60 | 64 | 46 | 48 |
| B | ID Fans | | 62 | 62 | 65 | 53 | 52 | 55 | 41 | 43 |
| | SPRAY VALVE POSITION | % Open | | | | | | | | |
| B | SH Spray | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 |
| B | RH Spray | | 0 | 1 | 24 | 0 | 9 | 8 | 0 | 0 |

C = Computer Data; B = Board Data
(1) TC Reading Open

# BIASED FIRING OPERATION STUDY

BOARD & COMPUTER DATA

| | TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 9/19 | 9/18 | 9/18 | 10/11 | 12/13 | 12/13 | 7/23 | 7/24 |
| | TIME | | 14:35 | 09:45 | 14:10 | 14:45 | 12:00 | 10:15 | 10:40 | 09:55 |
| C | LOAD | MW | 427 | 429 | 430 | 351 | 356 | 357 | 256 | 259 |
| | TEMPERATURES | | | | | | | | | |
| | AIR AND GAS | °F | | | | | | | | |
| C | AH 2-1 AIR IN | | 105 | 103 | 104 | 110 | 100 | 103 | 102 | 104 |
| C | AH 2-2 AIR IN | | 105 | 99 | 98 | 110 | 103 | 104 | 108 | 104 |
| C | AVG. AIR IN | | 105 | 101 | 101 | 110 | 102 | 104 | 105 | 104 |
| C | AH 2-1 AIR OUT | | 520 | 516 | 520 | 504 | 498 | 499 | 474 | 472 |
| C | AH 2-2 AIR OUT | | 542 | 537 | 542 | 513 | 504 | 505 | 477 | 478 |
| C | AVG. AIR OUT | | 531 | 527 | 531 | 509 | 501 | 502 | 476 | 475 |
| C | AH 2-1 GAS IN | | 719 | 710 | 717 | 661 | 671 | 673 | 602 | 599 |
| C | AH 2-2 GAS IN | | 719 | 707 | 717 | 662 | 671 | 639 | 594 | 589 |
| C | AVG. GAS IN | | 719 | 709 | 717 | 662 | 671 | 656 | 598 | 594 |
| C | AH 2-1 GAS OUT | | 268 | 267 | 267 | 260 | 254 | 257 | 248 | 246 |
| C | AH 2-2 GAS OUT (1) | | 278 | 276 | 279 | 265 | 260 | 259 | NA | NA |
| C | AVG. GAS OUT | | 273 | 272 | 273 | 263 | 257 | 258 | 248 | 246 |
| | STEAM AND WATER | °F | | | | | | | | |
| C | FW IN TEMP. TO ECON. | | 484 | 486 | 485 | 462 | 463 | 463 | 425 | 428 |
| C | ECON. OUT AVG. | | 574 | 575 | 576 | 544 | 539 | 540 | 494 | 496 |
| C | BOILER DOWNCOMER | | 678 | 679 | 678 | 671 | 674 | 674 | 665 | 665 |
| C | SH DESH INLET L | | 744 | 745 | 755 | 752 | 743 | 743 | 745 | 750 |
| C | SH DESH INLET R | | 754 | 751 | 765 | 754 | 740 | 740 | 745 | 751 |
| C | SH DESH INLET AVG | | 749 | 751 | 760 | 753 | 742 | 742 | 745 | 751 |
| C | SH DESH OUTLET L | | 751 | 753 | 761 | 753 | 746 | 744 | 742 | 735 |
| C | SH DESH OUTLET R | | 759 | 760 | 765 | 759 | 744 | 743 | 747 | 741 |
| C | SH DESH OUTLET AVG | | 755 | 757 | 763 | 756 | 745 | 744 | 745 | 738 |
| C | SH OUTLET | | 964 | 992 | 990 | 995 | 1000 | 1008 | 1006 | 1002 |
| C | THROTTLE STEAM | | 955 | 980 | 981 | 988 | 995 | 998 | 998 | 995 |
| C | RH TURBINE L | | 599 | 622 | 623 | NA | 596 | 596 | 552 | 549 |
| C | RH TURBINE R | | 600 | 622 | 623 | NA | 601 | 602 | 560 | 558 |
| C | RH TURBINE AVG | | 600 | 622 | 623 | NA | 598 | 599 | 549 | 554 |
| C | RH BOILER L | | 596 | 588 | 572 | 584 | 573 | 590 | 549 | 547 |
| C | RH BOILER R | | 596 | 575 | 566 | 588 | 582 | 581 | 556 | 555 |
| C | RH BOILER AVG | | 596 | 582 | 569 | 586 | 578 | 586 | 553 | 551 |
| C | RH OUTLET | | 995 | 998 | 1007 | 1005 | 1000 | 1005 | 1000 | 1000 |
| C | HP HTR 2-7 STM. IN | | 600 | 619 | 621 | 591 | 591 | 598 | 555 | 554 |
| C | HP HTR 2-7 FW IN | | 415 | 415 | 415 | 398 | 397 | 398 | 367 | 368 |
| C | HP HTR 2-7 DRAIN | | 423 | 423 | 424 | 404 | 403 | 403 | 370 | 371 |
| C | AUX. STEAM TEMP. | | 512 | 521 | 525 | 554 | 571 | 565 | 573 | 569 |
| | FAN DAMPER POSITION | % OPEN | | | | | | | | |
| B | FD FANS | | 74 | 75 | 74 | 66 | 64 | 65 | 46 | 46 |
| B | ID FANS | | 63 | 65 | 65 | 57 | 56 | 58 | 40 | 40 |
| | SPRAY VALVE POSITION | % OPEN | | | | | | | | |
| B | SH SPRAY | | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 16 |
| B | RH SPRAY | | 0 | 30 | 34 | 0 | 0 | 3 | 0 | 0 |

C = COMPUTER DATA; B = BOARD DATA
(1) TC READING OPEN

# BIASED FIRING OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1975 | 9/18 | 9/18 | 9/20 | 12/13 | 10/11 | 10/12 | 10/12 | 10/5 |
| | Time | | 17:00 | 17:25 | 13:15 | 14:00 | 16:30 | 15:00 | 10:00 | 21:30 |
| C | Load | MW | 430 | 426 | 431 | 356 | 351 | 360 | 257 | 271 |
| | **MILL DATA** | | | | | | | | | |
| C | Mill 2-1 | AMPS | NA | NA | NA | 60.3 | NA | NA | NA | NA |
| C | Mill 2-2 | AMPS | NA | NA | NA | 93.0 | NA | NA | NA | NA |
| C | Mill 2-3 | AMPS | NA | NA | NA | 87.4 | NA | NA | NA | NA |
| C | Mill 2-4 | AMPS | NA | NA | NA | 88.0 | NA | NA | NA | NA |
| C | Mill 2-5 | AMPS | NA | NA | NA | 87.6 | NA | NA | NA | NA |
| C | Coal Air Temp. Mill 2-1 | °F | 154 | 148 | 148 | 157 | 149 | 148 | 75 | 148 |
| C | Coal Air Temp. Mill 2-2 | °F | 148 | 154 | 148 | 149 | 148 | 148 | 146 | 112 |
| C | Coal Air Temp. Mill 2-3 | °F | 147 | 146 | 147 | 149 | 88 | 148 | 146 | 147 |
| C | Coal Air Temp. Mill 2-4 | °F | 148 | 148 | 148 | 148 | 147 | 97 | 145 | 145 |
| C | Coal Air Temp. Mill 2-5 | °F | 149 | 148 | 147 | 151 | 150 | 150 | 149 | 149 |
| B | Mill 2-1 Exh. Discharge | "$H_2O$ | 5.5 | 8.2 | 7.1 | 4.5 | 7.9 | 7.5 | NA | 7.0 |
| B | Mill 2-2 Exh. Discharge | "$H_2O$ | 7.4 | 7.6 | 7.1 | 7.1 | NA | 6.5 | 6.6 | 6.5 |
| B | Mill 2-3 Exh. Discharge | "$H_2O$ | 8.4 | 5.5 | 8.0 | 7.0 | 7.3 | 7.4 | 6.2 | NA |
| B | Mill 2-4 Exh. Discharge | "$H_2O$ | 10.1 | 10.5 | 10.0 | 7.5 | 7.5 | NA | 6.5 | 6.5 |
| B | Mill 2-5 Exh. Discharge | "$H_2O$ | 8.4 | 8.5 | NA | 7.4 | 7.5 | 6.8 | 6.2 | 6.5 |
| B | Mill 2-1 Suction | "$H_2O$ | -3.2 | -1.5 | -1.5 | -2.9 | -1.8 | -1.9 | NA | -2.3 |
| B | Mill 2-2 Suction | "$H_2O$ | -1.6 | -1.7 | -1.4 | -1.8 | NA | -1.8 | -2.4 | -2.3 |
| B | Mill 2-3 Suction | "$H_2O$ | -1.5 | -2.7 | -1.4 | -1.7 | -1.8 | -1.6 | -2.4 | NA |
| B | Mill 2-4 Suction | "$H_2O$ | -1.4 | -1.4 | -1.4 | -1.8 | -2.0 | NA | -2.4 | -2.4 |
| B | Mill 2-5 Suction | "$H_2O$ | -1.6 | -1.6 | NA | -1.9 | -1.7 | -1.6 | -2.3 | -2.4 |
| B | Mill 2-1 Coal Flow | $10^3$LB/HR | 0 | 85 | 86 | 0 | 71 | 72 | 0 | 55 |
| B | Mill 2-2 Coal Flow | $10^3$LB/HR | 80 | 81 | 84 | 68 | 0 | 70 | 51 | 50 |
| B | Mill 2-3 Coal Flow | $10^3$LB/HR | 79 | 0 | 82 | 62 | 68 | 69 | 50 | 0 |
| B | Mill 2-4 Coal Flow | $10^3$LB/HR | 79 | 79 | 82 | 61 | 66 | 0 | 50 | 48 |
| B | Mill 2-5 Coal Flow | $10^3$LB/HR | 80 | 80 | 0 | 62 | 67 | 70 | 51 | 50 |
| B | Mill 2-1 Feeder Speed (1) | % | 26 | 95 | 96 | 24 | 82 | 83 | NA | 64 |
| B | Mill 2-2 Feeder Speed | % | 95 | 96 | 96 | 82 | NA | 83 | 62 | 60 |
| B | Mill 2-3 Feeder Speed | % | 94 | NA | 94 | 80 | 80 | 82 | 60 | NA |
| B | Mill 2-4 Feeder Speed | % | 94 | 95 | 95 | 80 | 80 | NA | 60 | 58 |
| B | Mill 2-5 Feeder Speed | % | 94 | 94 | NA | 80 | 80 | 84 | 60 | 60 |
| | **BURNER TILT** | ± Degrees | | | | | | | | |
| B | Position LF | | +6 | -3 | -8 | +17 | -10 | -10 | +6 | -8 |
| B | Position LR | | +8 | -1 | -4 | +17 | -7 | -6 | +6 | -5 |
| B | Position RF | | +6 | -4 | -7 | +13 | -9 | -11 | +5 | -8 |
| B | Position RR | | +6 | -3 | -6 | +18 | -9 | -9 | +6 | -8 |
| | **MISCELLANEOUS** | | | | | | | | | |
| B | Drum Level, In. ± Norm. $H_2O$ Level | | -1 | -1 | 0.0 | -0.5 | -1 | -1 | -1 | 0 |
| C | FD Fan 2-1 | AMPS | 209 | 209 | 208 | 342 | NA | NA | NA | NA |
| C | FD Fan 2-2 | AMPS | 230 | 231 | 228 | 349 | NA | NA | NA | NA |
| C | ID Fan 2-1 | AMPS | 380 | 380 | 385 | 342 | 345 | 350 | 312 | 171 |
| C | ID Fan 2-2 | AMPS | 388 | 389 | 393 | 348 | 348 | 352 | 312 | 181 |
| B | Flue Gas $SO_2$ in Stack | PPM | NA | NA | NA | NA | NA | NA | NA | 28 |
| B | Flue Gas $NO_x$ in Stack | PPM | NA | NA | NA | NA | 400 | NA | 400 | 380 |
| C | Flue Gas Combustibles L | % | 0.06 | 0.05 | 0.06 | 0.17 | 0.07 | 0.09 | 0.1 | 0.08 |
| C | Flue Gas Combustibles R | % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | Flue Gas $O_2$ L | % | 3.33 | 2.85 | 2.16 | 2.27 | 3.11 | 2.85 | 3.97 | 3.08 |
| C | Flue Gas $O_2$ R | % | 2.49 | 3.41 | 4.00 | 2.70 | 2.58 | 2.89 | 3.02 | 3.85 |
| C | Flue Gas $O_2$ Avg. | % | 2.91 | 3.3 | 3.08 | 2.48 | 2.85 | 2.87 | 3.50 | 3.47 |
| B | Ambient Temp. | °F | 72 | 65 | 71 | 31 | 62 | 54 | 53 | 56 |
| B | Ambient Rel. Humidity | % | 24 | 28 | 21 | 82 | 20 | 45 | 47 | 37 |
| B | Barometric Pressure | "HG | 23.76 | 23.81 | 24.20 | 23.30 | 23.65 | 23.58 | 23.66 | 23.96 |

C = Computer Data; B = Board Data
(1) Feeder Speed in % of Control Signal

# BIASED FIRING OPERATION STUDY

## BOARD & COMPUTER DATA

| | TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 9/19 | 9/18 | 9/18 | 10/11 | 12/13 | 12/13 | 7/23 | 7/24 |
| | TIME | | 14:35 | 09:45 | 14:10 | 14:45 | 12:00 | 10:15 | 10:40 | 09:55 |
| C | LOAD | MW | 427 | 429 | 430 | 351 | 356 | 357 | 256 | 259 |
| | **MILL DATA** | | | | | | | | | |
| C | MILL 2-1 | AMPS | NA | NA | NA | NA | 94.8 | 95.6 | 79.6 | 81.0 |
| C | MILL 2-2 | AMPS | NA | NA | NA | NA | 91.4 | 91.8 | NA | 76.4 |
| C | MILL 2-3 | AMPS | NA | NA | NA | NA | 64.7 | 86.5 | 77.6 | 80.0 |
| C | MILL 2-4 | AMPS | NA | NA | NA | NA | 86.7 | 86.8 | 79.8 | NA |
| C | MILL 2-5 | AMPS | NA | NA | NA | NA | 85.5 | 61.9 | 85.3 | 84.5 |
| C | COAL AIR TEMP. MILL 2-1 | °F | 117 | 148 | 149 | 156 | 150 | 150 | 148 | 147 |
| C | COAL AIR TEMP. MILL 2-2 | °F | 148 | 148 | 148 | 149 | 160 | 149 | NA | NA |
| C | COAL AIR TEMP. MILL 2-3 | °F | 146 | 147 | 147 | 149 | 148 | 148 | 148 | 148 |
| C | COAL AIR TEMP. MILL 2-4 | °F | 147 | 147 | 147 | 147 | 147 | 148 | 146 | 88 |
| C | COAL AIR TEMP. MILL 2-5 | °F | 148 | 147 | 149 | 150 | 150 | 147 | 148 | 149 |
| B | MILL 2-1 EXH. DISCHARGE | "$H_2O$ | 5.5 | 8.1 | 8.5 | NA | 8.0 | 8.1 | 5.5 | 5.5 |
| B | MILL 2-2 EXH. DISCHARGE | "$H_2O$ | 7.5 | 5.5 | 7.5 | 5.8 | 7.5 | 7.5 | NA | 6.1 |
| B | MILL 2-3 EXH. DISCHARGE | "$H_2O$ | 8.2 | 8.4 | 8.2 | 7.3 | 5.0 | 7.1 | 7.2 | 7.6 |
| B | MILL 2-4 EXH. DISCHARGE | "$H_2O$ | 10.0 | 10.3 | 8.0 | 7.4 | 7.2 | 7.5 | 6.5 | NA |
| B | MILL 2-5 EXH. DISCHARGE | "$H_2O$ | 8.5 | 8.6 | 8.5 | 7.3 | 7.3 | 4.1 | 7.0 | 7.1 |
| B | MILL 2-1 SUCTION | "$H_2O$ | -3.1 | -1.5 | -1.6 | NA | -1.7 | -1.6 | -2.3 | -2.2 |
| B | MILL 2-2 SUCTION | "$H_2O$ | -1.6 | -3.0 | -1.7 | -3.2 | -1.8 | -1.8 | NA | -2.6 |
| B | MILL 2-3 SUCTION | "$H_2O$ | -1.4 | -1.4 | -1.5 | -1.5 | -2.8 | -1.7 | -2.3 | -2.2 |
| B | MILL 2-4 SUCTION | "$H_2O$ | -1.4 | -1.4 | -3.0 | -1.7 | -1.8 | -1.8 | -2.5 | NA |
| B | MILL 2-5 SUCTION | "$H_2O$ | -1.5 | -1.6 | -1.6 | -1.5 | -1.9 | -2.9 | -2.3 | -2.3 |
| B | MILL 2-1 COAL FLOW | $10^3$LB/HR | 0 | 79 | 84 | 0 | 75 | 75 | 43 | 48 |
| B | MILL 2-2 COAL FLOW | $10^3$LB/HR | 84 | 0 | 80 | 76 | 64 | 65 | 0 | 35 |
| B | MILL 2-3 COAL FLOW | $10^3$LB/HR | 83 | 79 | 79 | 76 | 0 | 58 | 40 | 45 |
| B | MILL 2-4 COAL FLOW | $10^3$LB/HR | 82 | 78 | 0 | 74 | 58 | 59 | 47 | 0 |
| B | MILL 2-5 COAL FLOW | $10^3$LB/HR | 81 | 79 | 80 | 75 | 59 | 0 | 56 | 55 |
| B | MILL 2-1 FEEDER SPEED (1) | % | 26 | 90 | 94 | NA | 79 | 78 | 49 | 56 |
| B | MILL 2-2 FEEDER SPEED | % | 100 | NA | 94 | 91 | 79 | 78 | NA | 42 |
| B | MILL 2-3 FEEDER SPEED | % | 99 | 94 | 94 | 90 | NA | 76 | 49 | 55 |
| B | MILL 2-4 FEEDER SPEED | % | 96 | 94 | NA | 91 | 76 | 76 | 58 | NA |
| B | MILL 2-5 FEEDER SPEED | % | 90 | 94 | 94 | 89 | 78 | NA | 68 | 67 |
| | **BURNER TILT** | ± DEGREES | | | | | | | | |
| B | POSITION LF | | +16 | +9 | +2 | +5 | +7 | -8 | +11 | +10 |
| B | POSITION LR | | +17 | +10 | +4 | +6 | +10 | -6 | +12 | +12 |
| B | POSITION RF | | +15 | +9 | +2 | +5 | +7 | -9 | +13 | +13 |
| B | POSITION RR | | +18 | +9 | +2 | +6 | +9 | -8 | +13 | +11 |
| | **MISCELLANEOUS** | | | | | | | | | |
| B | DRUM LEVEL, IN. ± NORM. $H_2O$ LEVEL | | -1 | -1.1 | -1 | -1 | -0.5 | -0.5 | -1 | -0.5 |
| C | FD FAN 2-1 | AMPS | NA | NA | NA | NA | 358 | 358 | 171 | 171 |
| C | FD FAN 2-2 | AMPS | NA | NA | NA | NA | 364 | 366 | 171 | 170 |
| C | ID FAN 2-1 | AMPS | 212 | 216 | 215 | 348 | 358 | 357 | 311 | 312 |
| C | ID FAN 2-2 | AMPS | 236 | 241 | 239 | 352 | 364 | 366 | 310 | 310 |
| B | FLUE GAS $SO_2$ IN STACK | PPM | NA | NA | NA | NA | NA | NA | NA | NA |
| B | FLUE GAS $NO_x$ IN STACK | PPM | NA | NA | NA | 396 | NA | NA | NA | NA |
| C | FLUE GAS COMBUSTIBLES L | % | 0.08 | 0.11 | 0.07 | 0.05 | 0.16 | 0.16 | 0.1 | 0.09 |
| C | FLUE GAS COMBUSTIBLES R | % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | FLUE GAS $O_2$ L | % | 4.09 | 4.74 | 4.09 | 3.77 | 3.52 | 3.06 | 3.54 | 3.28 |
| C | FLUE GAS $O_2$ R | % | 3.76 | 3.83 | 4.01 | 3.87 | 4.6 | 5.16 | 4.10 | 3.90 |
| C | FLUE GAS $O_2$ AVG. | % | 3.92 | 4.29 | 4.05 | 3.82 | 4.06 | 4.11 | 3.85 | 3.59 |
| B | AMBIENT TEMP. | °F | 79 | 67 | 74 | 68 | 31 | 30 | 87 | 79 |
| B | AMBIENT REL. HUMIDITY | % | 27 | 38 | 27 | 20 | 81 | 85 | 28 | 36 |
| B | BAROMETRIC PRESSURE | "HG | 23.80 | 23.83 | 23.83 | 23.66 | 23.33 | 23.38 | 24.00 | 24.05 |

C = COMPUTER DATA; B = BOARD DATA
(1) FEEDER SPEED IN % OF CONTROL SIGNAL

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 9/17 | 9/26 | 9/26 | 9/26 | 9/26 | 10/1 | 10/1 | 10/1 |
| Time | | 10:20 | 09:40 | 11:30 | 15:30 | 17:15 | 18:00 | 19:30 | 21:00 |
| C Load | MW | 428 | 430 | 430 | 430 | 431 | 430 | 428 | 428 |
| FLOWS | $10^3$LB/HR | | | | | | | | |
| C Feedwater | | 2876 | 2893 | 2900 | 2895 | 2901 | 2893 | 2910 | 2903 |
| B Main Steam | | 3000 | 3040 | 3038 | 3025 | 3050 | 3038 | 3040 | 3040 |
| C Superheat Spray L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C Superheat Spray R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C Reheat Spray | | 9.1 | 7.8 | 7.2 | 28.2 | 22.4 | 0 | 0 | 0 |
| C Ext. Stm. to Stm. AH 2-1 | | 12.2 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C Ext. Stm. to Stm. AH 2-2 | | 12.2 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C Aux. Stm. to Stm. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C Aux. Stm. to Stm. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C Aux. Stm. to SJAE | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| B Air Flow to Boiler | | 3460 | 3380 | 3380 | 3380 | 3380 | 3060 | 3130 | 3150 |
| PRESSURES STEAM & WATER | PSIG | | | | | | | | |
| C Feedwater to Econ. | | 2806 | 2815 | 2820 | 2816 | 2821 | 2814 | 2815 | 2811 |
| C Boiler Drum | | 2716 | 2720 | 2721 | 2720 | 2725 | 2717 | 2716 | 2715 |
| C Turbine Throttle | | 2409 | 2422 | 2420 | 2420 | 2427 | 2418 | 2416 | 2413 |
| C Turbine 1st Stage | | 1826 | 1828 | 1828 | 1828 | 1833 | 1826 | 1825 | 1824 |
| C RH Inlet Left | | 572 | 573 | 573 | 575 | 577 | 572 | 571 | 571 |
| C RH Inlet Right | | 575 | 578 | 578 | 579 | 581 | 575 | 575 | 575 |
| C RH Inlet Avg. | | 574 | 575 | 575 | 577 | 579 | 574 | 573 | 573 |
| C RH Outlet | | 531 | 535 | 534 | 536 | 538 | 532 | 533 | 532 |
| C HP Htr. 2-7 Stm. In | | 360 | 359 | 360 | 360 | 359 | 360 | 359 | 362 |
| PRESSURES AIR & GAS | "$H_2O$ | | | | | | | | |
| B FD Fan Discharge R | | 10.3 | 9.5 | 9.5 | 10.0 | 10.0 | 9.5 | 9.2 | 8.8 |
| B FD Fan Discharge L | | 10.3 | 9.5 | 9.5 | 10.0 | 10.0 | 9.5 | 9.2 | 8.8 |
| B FD Fan Discharge Avg. | | 10.3 | 9.5 | 9.5 | 10.0 | 10.0 | 9.5 | 9.2 | 8.8 |
| C AH 2-1 Air Diff. Press. R | | 3.80 | 3.73 | 3.70 | 3.70 | 3.70 | 3.25 | 3.28 | 3.30 |
| C AH 2-2 Air Diff. Press. L | | 4.34 | 4.21 | 4.19 | 4.21 | 4.22 | 3.65 | 3.70 | 3.72 |
| C AH Air Diff. Press. Avg. | | 4.07 | 3.97 | 3.94 | 3.96 | 3.96 | 3.45 | 3.49 | 3.51 |
| B Windbox Press. R | | 4.0 | 3.5 | 3.4 | 3.3 | 3.3 | 4.5 | 3.7 | 3.2 |
| B Windbox Press. L | | 4.0 | 3.5 | 3.4 | 3.3 | 3.3 | 4.5 | 3.7 | 3.2 |
| B Windbox Press. Avg. | | 4.0 | 3.5 | 3.4 | 3.3 | 3.3 | 4.5 | 3.7 | 3.2 |
| B Furnace Draft | | -0.68 | -1.0 | -1.1 | -1.0 | -1.1 | -1.0 | -1.0 | -1.0 |
| C SH Draft Diff. | | 1.95 | 2.19 | 2.01 | 1.91 | 2.13 | 1.81 | 1.91 | 1.95 |
| C Econ. Draft Diff. | | 2.66 | 2.53 | 2.69 | 2.75 | 2.81 | 2.24 | 2.49 | 2.44 |
| B AH 2-1 Gas Out. Press. R | | -14.5 | -15.0 | -15.0 | -15.0 | -15.0 | -12.5 | -12.8 | -12.9 |
| B AH 2-2 Gas Out. Press. L | | -12.8 | -13.0 | -12.9 | -13.0 | -12.8 | -13.5 | -13.8 | -13.7 |
| B AH Gas Out. Press. Avg. | | -13.6 | -14.0 | -14.0 | -14.0 | -13.9 | -13.0 | -13.3 | -13.3 |
| B ID Fan 2-1 Inlet Press. R | | -17.3 | -18.5 | -19.0 | -18.5 | -18.5 | -15.0 | -15.0 | -15.0 |
| B ID Fan 2-2 Inlet Press. L | | -14.0 | -14.0 | -14.0 | -14.0 | -14.0 | -15.0 | -15.1 | -15.1 |
| B ID Fan Inlet Press. Avg. | | -15.6 | -16.2 | -16.5 | -16.2 | -16.2 | -15.0 | -15.0 | -15.0 |

B = Board Data
C = Computer Data

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| | TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1975 | 9/27 | 9/27 | 9/27 | 10/5 | 10/4 | 10/5 | 10/4 | 10/3 |
| | Time | | 13:30 | 12:00 | 14:00 | 13:45 | 16:00 | 12:00 | 14:15 | 18:30 |
| C | Load | MW | 428 | 429 | 429 | 427 | 434 | 422 | 429 | 427 |
| | FLOWS | $10^3$LB/HR | | | | | | | | |
| C | Feedwater | | 2885 | 2881 | 2891 | 2909 | 2853 | 2889 | 2882 | 2904 |
| B | Main Steam | | 3033 | 3050 | 3050 | 3000 | 3000 | 3000 | 3000 | 3050 |
| C | Superheat Spray L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | Superheat Spray R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | Reheat Spray | | 0 | 0 | 0 | 0 | 17.3 | 0 | 0 | 7.9 |
| C | Ext. Stm. to Stm. AH 2-1 | | 58.8 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C | Ext. Stm. to Stm. AH 2-2 | | 58.8 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C | Aux. Stm. to Stm. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | Aux. Stm. to Stm. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | Aux. Stm. to SJAE | | 3.0 | 3.1 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| B | Air Flow to Boiler | | 3770 | 3710 | 3730 | 3130 | 3250 | 3140 | 3200 | 3190 |
| | PRESSURES STEAM & WATER | PSIG | | | | | | | | |
| C | Feedwater to Econ. | | 2810 | 2818 | 2818 | 2813 | 2814 | 2807 | 2812 | 2808 |
| C | Boiler Drum | | 2703 | 2716 | 2719 | 2719 | 2718 | 2705 | 2713 | 2713 |
| C | Turbine Throttle | | 2423 | 2417 | 2420 | 2415 | 2420 | 2411 | 2417 | 2415 |
| C | Turbine 1st Stage | | 1812 | 1827 | 1828 | 1829 | 1829 | 1806 | 1823 | 1824 |
| C | RH Inlet Left | | 567 | 569 | 570 | 573 | 576 | 565 | 572 | 573 |
| C | RH Inlet Right | | 571 | 573 | 573 | 577 | 579 | 569 | 575 | 577 |
| C | RH Inlet Avg. | | 569 | 571 | 572 | 575 | 578 | 567 | 574 | 575 |
| C | RH Outlet | | 531 | 530 | 531 | 533 | 536 | 528 | 533 | 534 |
| C | HP Htr. 2-7 Stm. In | | 366 | 362 | 359 | 360 | 359 | 362 | 361 | 360 |
| | PRESSURES AIR & GAS | "$H_2O$ | | | | | | | | |
| B | FD Fan Discharge R | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| B | FD Fan Discharge L | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| B | FD Fan Discharge Avg. | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| C | AH 2-1 Air Diff. Press. R | | 4.42 | 4.41 | 4.40 | 3.37 | 3.56 | 3.33 | 3.42 | 3.44 |
| C | AH 2-2 Air Diff. Press. L | | 5.02 | 4.84 | 4.84 | 3.81 | 3.98 | 3.73 | 3.90 | 3.90 |
| C | AH Air Diff. Press. Avg. | | 4.72 | 4.62 | 4.62 | 3.59 | 3.77 | 3.53 | 3.66 | 3.67 |
| B | Windbox Press. R | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B | Windbox Press. L | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B | Windbox Press. Avg. | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B | Furnace Draft | | -1.0 | -1.0 | -1.0 | -1.0 | -1.2 | -1.0 | -1.0 | -1.0 |
| C | SH Draft Diff. | | 2.54 | 2.26 | 2.36 | 1.82 | 1.95 | 1.73 | 1.84 | 1.82 |
| C | Econ. Draft Diff. | | 3.16 | 3.08 | 3.11 | 2.44 | 2.51 | 2.31 | 2.41 | 2.39 |
| B | AH 2-1 Gas Out. Press. R | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.5 | -13.6 | -13.5 |
| B | AH 2-2 Gas Out. Press. L | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.4 | -13.6 | -13.4 |
| B | AH Gas Out. Press. Avg. | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.4 | -13.6 | -13.4 |
| B | ID Fan 2-1 Inlet Press. R | | -21.5 | -19.1 | -19.0 | -15.8 | -16.9 | -15.6 | -16.0 | -16.0 |
| B | ID Fan 2-2 Inlet Press. L | | -17.5 | -19.1 | -19.0 | -14.8 | -15.4 | -14.5 | -14.8 | -14.5 |
| B | ID Fan Inlet Press. Avg. | | -19.5 | -19.1 | -19.0 | -15.3 | -16.2 | -15.0 | -15.4 | -15.2 |

B = Board Data
C = Computer Data

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| | TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 10/3 | 10/3 | 10/6 | 10/8 | 10/10 | 10/9 | 10/12 | 10/5 |
| | TIME | | 22:30 | 20:30 | 19:00 | 10:30 | 01:45 | 01:15 | 08:15 | 18:45 |
| C | LOAD | MW | 423 | 430 | 417 | 426 | 356 | 358 | 253 | 266 |
| | FLOWS | $10^3$LB/HR | | | | | | | | |
| C | FEEDWATER | | 2926 | 2885 | 2900 | 2908 | 2333 | 2307 | 1665 | 1657 |
| B | MAIN STEAM | | 3100 | 3038 | 3050 | 3050 | 2400 | 2400 | 1650 | 1650 |
| C | SUPERHEAT SPRAY L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | SUPERHEAT SPRAY R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | REHEAT SPRAY | | 22.9 | 18.7 | 0 | 0 | 0 | 4.5 | 0 | 0 |
| C | EXT. STM. TO STM. AH 2-1 | | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 28.2 | 58.8 |
| C | EXT. STM. TO STM. AH 2-2 | | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 28.5 | 58.8 |
| C | AUX. STM. TO STM. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | AUX. STM. TO STM. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | AUX. STM. TO SJAE | | 3.0 | 3.0 | 3.0 | 3.2 | 3.0 | 3.1 | 3.0 | 3.0 |
| B | AIR FLOW TO BOILER | | 3180 | 3240 | 3100 | 3110 | 2460 | 2640 | 1800 | 1810 |
| | PRESSURES STEAM & WATER | PSIG | | | | | | | | |
| C | FEEDWATER TO ECON. | | 2813 | 2806 | 2813 | 2816 | 2705 | 2701 | 2592 | 2593 |
| C | BOILER DRUM | | 2715 | 2711 | 2715 | 2720 | 2628 | 2631 | 2537 | 2532 |
| C | TURBINE THROTTLE | | 2418 | 2413 | 2415 | 2419 | 2416 | 2420 | 2416 | 2414 |
| C | TURBINE 1ST STAGE | | 1826 | 1824 | 1824 | 1829 | 1442 | 1438 | NA | 1008 |
| C | RH INLET LEFT | | 574 | 574 | 572 | 571 | 464 | 465 | NA | 334 |
| C | RH INLET RIGHT | | 578 | 579 | 576 | 575 | 468 | 469 | NA | 336 |
| C | RH INLET AVG. | | 576 | 576 | 574 | 573 | 460 | 467 | NA | 335 |
| C | RH OUTLET | | 535 | 535 | 524 | 532 | 428 | 429 | 293 | 301 |
| C | HP HTR. 2-7 STM. IN | | 357 | 360 | 359 | 363 | 380 | 384 | 404 | 408 |
| | PRESSURES AIR & GAS | "$H_2O$ | | | | | | | | |
| B | FD FAN DISCHARGE R | | 9.0 | 9.4 | 8.8 | 8.5 | 4.8 | 6.8 | 2.5 | 2.5 |
| B | FD FAN DISCHARGE L | | 8.9 | 9.4 | 8.8 | 8.5 | 4.6 | 6.6 | 2.5 | 2.5 |
| B | FD FAN DISCHARGE AVG. | | 9.0 | 9.4 | 8.8 | 8.5 | 4.7 | 6.7 | 2.5 | 2.5 |
| C | AH 2-1 AIR DIFF. PRESS. R | | 3.35 | 3.44 | 3.23 | 3.30 | 2.21 | 2.50 | 1.36 | 1.38 |
| C | AH 2-2 AIR DIFF. PRESS. L | | 3.79 | 3.88 | 3.64 | 3.72 | 2.58 | 2.87 | 1.52 | 1.57 |
| C | AH AIR DIFF. PRESS. AVG. | | 3.57 | 3.66 | 3.44 | 3.51 | 2.40 | 2.68 | 1.44 | 1.48 |
| B | WINDBOX PRESS. R | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | WINDBOX PRESS. L | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | WINDBOX PRESS. AVG. | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | FURNACE DRAFT | | -1.2 | -1.2 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| C | SH DRAFT DIFF. | | 1.93 | 2.00 | 1.85 | 1.77 | 1.13 | 1.33 | 0.53 | 0.60 |
| C | ECON. DRAFT DIFF. | | 2.45 | 2.61 | 2.43 | 2.45 | 1.71 | 1.80 | 0.98 | 0.88 |
| B | AH 2-1 GAS OUT. PRESS. R | | -13.5 | -13.8 | -13.3 | -13.8 | -10.6 | -10.0 | -6.8 | -6.8 |
| B | AH 2-2 GAS OUT. PRESS. L | | -13.5 | -13.8 | -12.8 | -13.2 | -9.8 | -10.0 | -6.0 | -6.6 |
| B | AH GAS OUT. PRESS. AVG. | | -13.5 | -13.8 | -13.0 | -13.5 | -10.2 | -10.0 | -6.4 | -6.7 |
| B | ID FAN 2-1 INLET PRESS. R | | -15.8 | -16.0 | -15.5 | -15.5 | -11.6 | -11.8 | -7.5 | -8.0 |
| B | ID FAN 2-2 INLET PRESS. L | | -14.8 | -15.0 | -14.0 | -14.0 | -10.6 | -10.5 | -6.8 | -7.6 |
| B | ID FAN INLET PRESS. AVG. | | -15.3 | -15.5 | -14.8 | -14.8 | -11.1 | -11.2 | -7.2 | -7.8 |

B = BOARD DATA
C = COMPUTER DATA

# OVERFIRE AIR OPERATION STUDY

## BOARD AND COMPUTER DATA

| TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 9/27 | 9/27 | 9/27 | 10/5 | 10/4 | 10/5 | 10/4 | 10/3 |
| Time | | 13:30 | 12:00 | 14:00 | 13:45 | 16:00 | 12:00 | 14:15 | 18:30 |
| C Load | MW | 428 | 429 | 429 | 427 | 434 | 422 | 429 | 427 |
| **FLOWS** | $10^3$ LB/HR | | | | | | | | |
| C Feedwater | | 2885 | 2881 | 2891 | 2909 | 2853 | 2889 | 2882 | 2904 |
| B Main Steam | | 3033 | 3050 | 3050 | 3000 | 3000 | 3000 | 3000 | 3050 |
| C Superheat Spray L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C Superheat Spray R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C Reheat Spray | | 0 | 0 | 0 | 0 | 17.3 | 0 | 0 | 7.9 |
| C Ext. Stm. to Stm. AH 2-1 | | 58.8 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C Ext. Stm. to Stm. AH 2-2 | | 58.8 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C Aux. Stm. to Stm. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C Aux. Stm. to Stm. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C Aux. Stm. to SJAE | | 3.0 | 3.1 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| B Air Flow to Boiler | | 3770 | 3710 | 3730 | 3130 | 3250 | 3140 | 3200 | 3190 |
| **PRESSURES STEAM & WATER** | PSIG | | | | | | | | |
| C Feedwater to Econ. | | 2810 | 2818 | 2818 | 2813 | 2814 | 2807 | 2812 | 2808 |
| C Boiler Drum | | 2703 | 2716 | 2719 | 2719 | 2718 | 2705 | 2713 | 2713 |
| C Turbine Throttle | | 2423 | 2417 | 2420 | 2415 | 2420 | 2411 | 2417 | 2415 |
| C Turbine 1st Stage | | 1812 | 1827 | 1828 | 1829 | 1829 | 1806 | 1823 | 1824 |
| C RH Inlet Left | | 567 | 569 | 570 | 573 | 576 | 565 | 572 | 573 |
| C RH Inlet Right | | 571 | 573 | 573 | 577 | 579 | 569 | 575 | 577 |
| C RH Inlet Avg. | | 569 | 571 | 572 | 575 | 578 | 567 | 574 | 575 |
| C RH Outlet | | 531 | 530 | 531 | 533 | 536 | 528 | 533 | 534 |
| C HP Htr. 2-7 Stm. In | | 366 | 362 | 359 | 360 | 359 | 362 | 361 | 360 |
| **PRESSURES AIR & GAS** | "$H_2O$ | | | | | | | | |
| B FD Fan Discharge R | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| B FD Fan Discharge L | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| B FD Fan Discharge Avg. | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| C AH 2-1 Air Diff. Press. R | | 4.42 | 4.41 | 4.40 | 3.37 | 3.56 | 3.33 | 3.42 | 3.44 |
| C AH 2-2 Air Diff. Press. L | | 5.02 | 4.84 | 4.84 | 3.81 | 3.98 | 3.73 | 3.90 | 3.90 |
| C AH Air Diff. Press. Avg. | | 4.72 | 4.62 | 4.62 | 3.59 | 3.77 | 3.53 | 3.66 | 3.67 |
| B Windbox Press. R | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B Windbox Press. L | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B Windbox Press. Avg. | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B Furnace Draft | | -1.0 | -1.0 | -1.0 | -1.0 | -1.2 | -1.0 | -1.0 | -1.0 |
| C SH Draft Diff. | | 2.54 | 2.26 | 2.36 | 1.82 | 1.95 | 1.73 | 1.84 | 1.82 |
| C Econ. Draft Diff. | | 3.16 | 3.08 | 3.11 | 2.44 | 2.51 | 2.31 | 2.41 | 2.39 |
| B AH 2-1 Gas Out. Press. R | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.5 | -13.6 | -13.5 |
| B AH 2-2 Gas Out. Press. L | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.4 | -13.6 | -13.4 |
| B AH Gas Out. Press. Avg. | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.4 | -13.6 | -13.4 |
| B ID Fan 2-1 Inlet Press. R | | -21.5 | -19.1 | -19.0 | -15.8 | -16.9 | -15.6 | -16.0 | -16.0 |
| B ID Fan 2-2 Inlet Press. L | | -17.5 | -19.1 | -19.0 | -14.8 | -15.4 | -14.5 | -14.8 | -14.5 |
| B ID Fan Inlet Press. Avg. | | -19.5 | -19.1 | -19.0 | -15.3 | -16.2 | -15.0 | -15.4 | -15.2 |

B = Board Data
C = Computer Data

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 10/3 | 10/3 | 10/6 | 10/8 | 10/10 | 10/9 | 10/12 | 10/5 |
| TIME | | 22:30 | 20:30 | 19:00 | 10:30 | 01:45 | 01:15 | 08:15 | 18:45 |
| C LOAD | MW | 423 | 430 | 417 | 426 | 356 | 358 | 253 | 266 |
| FLOWS | $10^3$LB/HR | | | | | | | | |
| C FEEDWATER | | 2926 | 2885 | 2900 | 2908 | 2333 | 2307 | 1665 | 1657 |
| B MAIN STEAM | | 3100 | 3038 | 3050 | 3050 | 2400 | 2400 | 1650 | 1650 |
| C SUPERHEAT SPRAY L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C SUPERHEAT SPRAY R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C REHEAT SPRAY | | 22.9 | 18.7 | 0 | 0 | 0 | 4.5 | 0 | 0 |
| C EXT. STM. TO STM. AH 2-1 | | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 28.2 | 58.8 |
| C EXT. STM. TO STM. AH 2-2 | | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 28.5 | 58.8 |
| C AUX. STM. TO STM. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C AUX. STM. TO STM. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C AUX. STM. TO SJAE | | 3.0 | 3.0 | 3.0 | 3.2 | 3.0 | 3.1 | 3.0 | 3.0 |
| B AIR FLOW TO BOILER | | 3180 | 3240 | 3100 | 3110 | 2460 | 2640 | 1800 | 1810 |
| PRESSURES STEAM & WATER | PSIG | | | | | | | | |
| C FEEDWATER TO ECON. | | 2813 | 2806 | 2813 | 2816 | 2705 | 2701 | 2592 | 2593 |
| C BOILER DRUM | | 2715 | 2711 | 2715 | 2720 | 2628 | 2631 | 2537 | 2532 |
| C TURBINE THROTTLE | | 2418 | 2413 | 2415 | 2419 | 2416 | 2420 | 2416 | 2414 |
| C TURBINE 1ST STAGE | | 1826 | 1824 | 1824 | 1829 | 1442 | 1438 | NA | 1008 |
| C RH INLET LEFT | | 574 | 574 | 572 | 571 | 464 | 465 | NA | 334 |
| C RH INLET RIGHT | | 578 | 579 | 576 | 575 | 468 | 469 | NA | 336 |
| C RH INLET AVG. | | 576 | 576 | 574 | 573 | 460 | 467 | NA | 335 |
| C RH OUTLET | | 535 | 535 | 524 | 532 | 428 | 429 | 293 | 301 |
| C HP HTR. 2-7 STM. IN | | 357 | 360 | 359 | 363 | 380 | 384 | 404 | 408 |
| PRESSURES AIR & GAS | "$H_2O$ | | | | | | | | |
| B FD FAN DISCHARGE R | | 9.0 | 9.4 | 8.8 | 8.5 | 4.8 | 6.8 | 2.5 | 2.5 |
| B FD FAN DISCHARGE L | | 8.9 | 9.4 | 8.8 | 8.5 | 4.6 | 6.6 | 2.5 | 2.5 |
| B FD FAN DISCHARGE AVG. | | 9.0 | 9.4 | 8.8 | 8.5 | 4.7 | 6.7 | 2.5 | 2.5 |
| C AH 2-1 AIR DIFF. PRESS. R | | 3.35 | 3.44 | 3.23 | 3.30 | 2.21 | 2.50 | 1.36 | 1.38 |
| C AH 2-2 AIR DIFF. PRESS. L | | 3.79 | 3.88 | 3.64 | 3.72 | 2.58 | 2.87 | 1.52 | 1.57 |
| C AH AIR DIFF. PRESS. AVG. | | 3.57 | 3.66 | 3.44 | 3.51 | 2.40 | 2.68 | 1.44 | 1.48 |
| B WINDBOX PRESS. R | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B WINDBOX PRESS. L | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B WINDBOX PRESS. AVG. | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B FURNACE DRAFT | | -1.2 | -1.2 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| C SH DRAFT DIFF. | | 1.93 | 2.00 | 1.85 | 1.77 | 1.13 | 1.33 | 0.53 | 0.60 |
| C ECON. DRAFT DIFF. | | 2.45 | 2.61 | 2.43 | 2.45 | 1.71 | 1.80 | 0.98 | 0.88 |
| B AH 2-1 GAS OUT. PRESS. R | | -13.5 | -13.8 | -13.3 | -13.8 | -10.6 | -10.0 | -6.8 | -6.8 |
| B AH 2-2 GAS OUT. PRESS. L | | -13.5 | -13.8 | -12.8 | -13.2 | -9.8 | -10.0 | -6.0 | -6.6 |
| B AH GAS OUT. PRESS. AVG. | | -13.5 | -13.8 | -13.0 | -13.5 | -10.2 | -10.0 | -6.4 | -6.7 |
| B ID FAN 2-1 INLET PRESS. R | | -15.8 | -16.0 | -15.5 | -15.5 | -11.6 | -11.8 | -7.5 | -8.0 |
| B ID FAN 2-2 INLET PRESS. L | | -14.8 | -15.0 | -14.0 | -14.0 | -10.6 | -10.5 | -6.8 | -7.6 |
| B ID FAN INLET PRESS. AVG. | | -15.3 | -15.5 | -14.8 | -14.8 | -11.1 | -11.2 | -7.2 | -7.8 |

B = BOARD DATA
C = COMPUTER DATA

# OVERFIRE AIR OPERATION STUDY

## BOARD AND COMPUTER DATA

| TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 9/27 | 9/27 | 9/27 | 10/5 | 10/4 | 10/5 | 10/4 | 10/3 |
| TIME | | 13:30 | 12:00 | 14:00 | 13:45 | 16:00 | 12:00 | 14:15 | 18:30 |
| C LOAD | MW | 428 | 429 | 429 | 427 | 434 | 422 | 429 | 427 |
| **FLOWS** | $10^3$LB/HR | | | | | | | | |
| C FEEDWATER | | 2885 | 2881 | 2891 | 2909 | 2853 | 2889 | 2882 | 2904 |
| B MAIN STEAM | | 3033 | 3050 | 3050 | 3000 | 3000 | 3000 | 3000 | 3050 |
| C SUPERHEAT SPRAY L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C SUPERHEAT SPRAY R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C REHEAT SPRAY | | 0 | 0 | 0 | 0 | 17.3 | 0 | 0 | 7.9 |
| C EXT. STM. TO STM. AH 2-1 | | 58.8 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C EXT. STM. TO STM. AH 2-2 | | 58.8 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C AUX. STM. TO STM. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C AUX. STM. TO STM. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C AUX. STM. TO SJAE | | 3.0 | 3.1 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| B AIR FLOW TO BOILER | | 3770 | 3710 | 3730 | 3130 | 3250 | 3140 | 3200 | 3190 |
| **PRESSURES STEAM & WATER** | PSIG | | | | | | | | |
| C FEEDWATER TO ECON. | | 2810 | 2818 | 2818 | 2813 | 2814 | 2807 | 2812 | 2808 |
| C BOILER DRUM | | 2703 | 2716 | 2719 | 2719 | 2718 | 2705 | 2713 | 2713 |
| C TURBINE THROTTLE | | 2423 | 2417 | 2420 | 2415 | 2420 | 2411 | 2417 | 2415 |
| C TURBINE 1ST STAGE | | 1812 | 1827 | 1828 | 1829 | 1829 | 1806 | 1823 | 1824 |
| C RH INLET LEFT | | 567 | 569 | 570 | 573 | 576 | 565 | 572 | 573 |
| C RH INLET RIGHT | | 571 | 573 | 573 | 577 | 579 | 569 | 575 | 577 |
| C RH INLET AVG. | | 569 | 571 | 572 | 575 | 578 | 567 | 574 | 575 |
| C RH OUTLET | | 531 | 530 | 531 | 533 | 536 | 528 | 533 | 534 |
| C HP HTR. 2-7 STM. IN | | 366 | 362 | 359 | 360 | 359 | 362 | 361 | 360 |
| **PRESSURES AIR & GAS** | "$H_2O$ | | | | | | | | |
| B FD FAN DISCHARGE R | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| B FD FAN DISCHARGE L | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| B FD FAN DISCHARGE AVG. | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| C AH 2-1 AIR DIFF. PRESS. R | | 4.42 | 4.41 | 4.40 | 3.37 | 3.56 | 3.33 | 3.42 | 3.44 |
| C AH 2-2 AIR DIFF. PRESS. L | | 5.02 | 4.84 | 4.84 | 3.81 | 3.98 | 3.73 | 3.90 | 3.90 |
| C AH AIR DIFF. PRESS. AVG. | | 4.72 | 4.62 | 4.62 | 3.59 | 3.77 | 3.53 | 3.66 | 3.67 |
| B WINDBOX PRESS. R | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B WINDBOX PRESS. L | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B WINDBOX PRESS. AVG. | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B FURNACE DRAFT | | -1.0 | -1.0 | -1.0 | -1.0 | -1.2 | -1.0 | -1.0 | -1.0 |
| C SH DRAFT DIFF. | | 2.54 | 2.26 | 2.36 | 1.82 | 1.95 | 1.73 | 1.84 | 1.82 |
| C ECON. DRAFT DIFF. | | 3.16 | 3.08 | 3.11 | 2.44 | 2.51 | 2.31 | 2.41 | 2.39 |
| B AH 2-1 GAS OUT. PRESS. R | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.5 | -13.6 | -13.5 |
| B AH 2-2 GAS OUT. PRESS. L | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.4 | -13.6 | -13.4 |
| B AH GAS OUT. PRESS. AVG. | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.4 | -13.6 | -13.4 |
| B ID FAN 2-1 INLET PRESS. R | | -21.5 | -19.1 | -19.0 | -15.8 | -16.9 | -15.6 | -16.0 | -16.0 |
| B ID FAN 2-2 INLET PRESS. L | | -17.5 | -19.1 | -19.0 | -14.8 | -15.4 | -14.5 | -14.8 | -14.5 |
| B ID FAN INLET PRESS. AVG. | | -19.5 | -19.1 | -19.0 | -15.3 | -16.2 | -15.0 | -15.4 | -15.2 |

B = BOARD DATA
C = COMPUTER DATA

# OVERFIRE AIR OPERATION STUDY

## BOARD AND COMPUTER DATA

| | TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1975 | 10/3 | 10/3 | 10/6 | 10/8 | 10/10 | 10/9 | 10/12 | 10/5 |
| | Time | | 22:30 | 20:30 | 19:00 | 10:30 | 01:45 | 01:15 | 08:15 | 18:45 |
| C | Load | MW | 423 | 430 | 417 | 426 | 356 | 358 | 253 | 266 |
| | FLOWS | $10^3$LB/HR | | | | | | | | |
| C | Feedwater | | 2926 | 2885 | 2900 | 2908 | 2333 | 2307 | 1665 | 1657 |
| B | Main Steam | | 3100 | 3038 | 3050 | 3050 | 2400 | 2400 | 1650 | 1650 |
| C | Superheat Spray L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | Superheat Spray R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | Reheat Spray | | 22.9 | 18.7 | 0 | 0 | 0 | 4.5 | 0 | 0 |
| C | Ext. Stm. to Stm. AH 2-1 | | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 28.2 | 58.8 |
| C | Ext. Stm. to Stm. AH 2-2 | | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 28.5 | 58.8 |
| C | Aux. Stm. to Stm. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | Aux. Stm. to Stm. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | Aux. Stm. to SJAE | | 3.0 | 3.0 | 3.0 | 3.2 | 3.0 | 3.1 | 3.0 | 3.0 |
| B | Air Flow to Boiler | | 3180 | 3240 | 3100 | 3110 | 2460 | 2640 | 1800 | 1810 |
| | PRESSURES STEAM & WATER | PSIG | | | | | | | | |
| C | Feedwater to Econ. | | 2813 | 2806 | 2813 | 2816 | 2705 | 2701 | 2592 | 2593 |
| C | Boiler Drum | | 2715 | 2711 | 2715 | 2720 | 2628 | 2631 | 2537 | 2532 |
| C | Turbine Throttle | | 2418 | 2413 | 2415 | 2419 | 2416 | 2420 | 2416 | 2414 |
| C | Turbine 1st Stage | | 1826 | 1824 | 1824 | 1829 | 1442 | 1438 | NA | 1008 |
| C | RH Inlet Left | | 574 | 574 | 572 | 571 | 464 | 465 | NA | 334 |
| C | RH Inlet Right | | 578 | 579 | 576 | 575 | 468 | 469 | NA | 336 |
| C | RH Inlet Avg. | | 576 | 576 | 574 | 573 | 460 | 467 | NA | 335 |
| C | RH Outlet | | 535 | 535 | 524 | 532 | 428 | 429 | 293 | 301 |
| C | HP Htr. 2-7 Stm. In | | 357 | 360 | 359 | 363 | 380 | 384 | 404 | 408 |
| | PRESSURES AIR & GAS | "$H_2O$ | | | | | | | | |
| B | FD Fan Discharge R | | 9.0 | 9.4 | 8.8 | 8.5 | 4.8 | 6.8 | 2.5 | 2.5 |
| B | FD Fan Discharge L | | 8.9 | 9.4 | 8.8 | 8.5 | 4.6 | 6.6 | 2.5 | 2.5 |
| B | FD Fan Discharge Avg. | | 9.0 | 9.4 | 8.8 | 8.5 | 4.7 | 6.7 | 2.5 | 2.5 |
| C | AH 2-1 Air Diff. Press. R | | 3.35 | 3.44 | 3.23 | 3.30 | 2.21 | 2.50 | 1.36 | 1.38 |
| C | AH 2-2 Air Diff. Press. L | | 3.79 | 3.88 | 3.64 | 3.72 | 2.58 | 2.87 | 1.52 | 1.57 |
| C | AH Air Diff. Press. Avg. | | 3.57 | 3.66 | 3.44 | 3.51 | 2.40 | 2.68 | 1.44 | 1.48 |
| B | Windbox Press. R | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | Windbox Press. L | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | Windbox Press. Avg. | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | Furnace Draft | | -1.2 | -1.2 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| C | SH Draft Diff. | | 1.93 | 2.00 | 1.85 | 1.77 | 1.13 | 1.33 | 0.53 | 0.60 |
| C | Econ. Draft Diff. | | 2.45 | 2.61 | 2.43 | 2.45 | 1.71 | 1.80 | 0.98 | 0.88 |
| B | AH 2-1 Gas Out. Press. R | | -13.5 | -13.8 | -13.3 | -13.8 | -10.6 | -10.0 | -6.8 | -6.8 |
| B | AH 2-2 Gas Out. Press. L | | -13.5 | -13.8 | -12.8 | -13.2 | -9.8 | -10.0 | -6.0 | -6.6 |
| B | AH Gas Out. Press. Avg. | | -13.5 | -13.8 | -13.0 | -13.5 | -10.2 | -10.0 | -6.4 | -6.7 |
| B | ID Fan 2-1 Inlet Press. R | | -15.8 | -16.0 | -15.5 | -15.5 | -11.6 | -11.8 | -7.5 | -8.0 |
| B | ID Fan 2-2 Inlet Press. L | | -14.8 | -15.0 | -14.0 | -14.0 | -10.6 | -10.5 | -6.8 | -7.6 |
| B | ID Fan Inlet Press. Avg. | | -15.3 | -15.5 | -14.8 | -14.8 | -11.1 | -11.2 | -7.2 | -7.8 |

B = Board Data
C = Computer Data

# OVERFIRE AIR OPERATION STUDY

## BOARD AND COMPUTER DATA

| TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 9/27 | 9/27 | 9/27 | 10/5 | 10/4 | 10/5 | 10/4 | 10/3 |
| TIME | : | 13:30 | 12:00 | 14:00 | 13:45 | 16:00 | 12:00 | 14:15 | 18:30 |
| C LOAD | MW | 428 | 429 | 429 | 427 | 434 | 422 | 429 | 427 |
| **FLOWS** | $10^3$LB/HR | | | | | | | | |
| C FEEDWATER | | 2885 | 2881 | 2891 | 2909 | 2853 | 2889 | 2882 | 2904 |
| B MAIN STEAM | | 3033 | 3050 | 3050 | 3000 | 3000 | 3000 | 3000 | 3050 |
| C SUPERHEAT SPRAY L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C SUPERHEAT SPRAY R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C REHEAT SPRAY | | 0 | 0 | 0 | 0 | 17.3 | 0 | 0 | 7.9 |
| C EXT. STM. TO STM. AH 2-1 | | 58.8 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C EXT. STM. TO STM. AH 2-2 | | 58.8 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C AUX. STM. TO STM. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C AUX. STM. TO STM. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C AUX. STM. TO SJAE | | 3.0 | 3.1 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| B AIR FLOW TO BOILER | | 3770 | 3710 | 3730 | 3130 | 3250 | 3140 | 3200 | 3190 |
| **PRESSURES STEAM & WATER** | PSIG | | | | | | | | |
| C FEEDWATER TO ECON. | | 2810 | 2818 | 2816 | 2813 | 2814 | 2807 | 2812 | 2808 |
| C BOILER DRUM | | 2703 | 2716 | 2719 | 2719 | 2718 | 2705 | 2713 | 2713 |
| C TURBINE THROTTLE | | 2423 | 2417 | 2420 | 2415 | 2420 | 2411 | 2417 | 2415 |
| C TURBINE 1ST STAGE | | 1812 | 1827 | 1828 | 1829 | 1829 | 1806 | 1823 | 1824 |
| C RH INLET LEFT | | 567 | 569 | 570 | 573 | 576 | 565 | 572 | 573 |
| C RH INLET RIGHT | | 571 | 573 | 573 | 577 | 579 | 569 | 575 | 577 |
| C RH INLET AVG. | | 569 | 571 | 572 | 575 | 578 | 567 | 574 | 575 |
| C RH OUTLET | | 531 | 530 | 531 | 533 | 536 | 528 | 533 | 534 |
| C HP HTR. 2-7 STM. IN | | 366 | 362 | 359 | 360 | 359 | 362 | 361 | 360 |
| **PRESSURES AIR & GAS.** | "$H_2O$ | | | | | | | | |
| B FD FAN DISCHARGE R | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| B FD FAN DISCHARGE L | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| B FD FAN DISCHARGE AVG. | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| C AH 2-1 AIR DIFF. PRESS. R | | 4.42 | 4.41 | 4.40 | 3.37 | 3.56 | 3.33 | 3.42 | 3.44 |
| C AH 2-2 AIR DIFF. PRESS. L | | 5.02 | 4.84 | 4.84 | 3.81 | 3.98 | 3.73 | 3.90 | 3.90 |
| C AH AIR DIFF. PRESS. AVG. | | 4.72 | 4.62 | 4.62 | 3.59 | 3.77 | 3.53 | 3.66 | 3.67 |
| B WINDBOX PRESS. R | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B WINDBOX PRESS. L | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B WINDBOX PRESS. AVG. | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B FURNACE DRAFT | | -1.0 | -1.0 | -1.0 | -1.0 | -1.2 | -1.0 | -1.0 | -1.0 |
| C SH DRAFT DIFF. | | 2.54 | 2.26 | 2.36 | 1.82 | 1.95 | 1.73 | 1.84 | 1.82 |
| C ECON. DRAFT DIFF. | | 3.16 | 3.08 | 3.11 | 2.44 | 2.51 | 2.31 | 2.41 | 2.39 |
| B AH 2-1 GAS OUT. PRESS. R | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.5 | -13.6 | -13.5 |
| B AH 2-2 GAS OUT. PRESS. L | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.4 | -13.6 | -13.4 |
| B AH GAS OUT. PRESS. AVG. | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.4 | -13.6 | -13.4 |
| B ID FAN 2-1 INLET PRESS. R | | -21.5 | -19.1 | -19.0 | -15.8 | -16.9 | -15.6 | -16.0 | -16.0 |
| B ID FAN 2-2 INLET PRESS. L | | -17.5 | -19.1 | -19.0 | -14.8 | -15.4 | -14.5 | -14.8 | -14.5 |
| B ID FAN INLET PRESS. AVG. | | -19.5 | -19.1 | -19.0 | -15.3 | -16.2 | -15.0 | -15.4 | -15.2 |

B = BOARD DATA
C = COMPUTER DATA

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| | TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 10/3 | 10/3 | 10/6 | 10/8 | 10/10 | 10/9 | 10/12 | 10/5 |
| | TIME | | 22:30 | 20:30 | 19:00 | 10:30 | 01:45 | 01:15 | 08:15 | 18:45 |
| C | LOAD | MW | 423 | 430 | 417 | 426 | 356 | 358 | 253 | 266 |
| | FLOWS | $10^3$LB/HR | | | | | | | | |
| C | FEEDWATER | | 2926 | 2885 | 2900 | 2908 | 2333 | 2307 | 1665 | 1657 |
| B | MAIN STEAM | | 3100 | 3038 | 3050 | 3050 | 2400 | 2400 | 1650 | 1650 |
| C | SUPERHEAT SPRAY L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | SUPERHEAT SPRAY R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | REHEAT SPRAY | | 22.9 | 18.7 | 0 | 0 | 0 | 4.5 | 0 | 0 |
| C | EXT. STM. TO STM. AH 2-1 | | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 28.2 | 58.8 |
| C | EXT. STM. TO STM. AH 2-2 | | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 28.5 | 58.8 |
| C | AUX. STM. TO STM. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | AUX. STM. TO STM. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | AUX. STM. TO SJAE | | 3.0 | 3.0 | 3.0 | 3.2 | 3.0 | 3.1 | 3.0 | 3.0 |
| B | AIR FLOW TO BOILER | | 3180 | 3240 | 3100 | 3110 | 2460 | 2640 | 1800 | 1810 |
| | PRESSURES STEAM & WATER | PSIG | | | | | | | | |
| C | FEEDWATER TO ECON. | | 2813 | 2806 | 2813 | 2816 | 2705 | 2701 | 2592 | 2593 |
| C | BOILER DRUM | | 2715 | 2711 | 2715 | 2720 | 2628 | 2631 | 2537 | 2532 |
| C | TURBINE THROTTLE | | 2418 | 2413 | 2415 | 2419 | 2416 | 2420 | 2416 | 2414 |
| C | TURBINE 1ST STAGE | | 1826 | 1824 | 1824 | 1829 | 1442 | 1438 | NA | 1008 |
| C | RH INLET LEFT | | 574 | 574 | 572 | 571 | 464 | 465 | NA | 334 |
| C | RH INLET RIGHT | | 578 | 579 | 576 | 575 | 468 | 469 | NA | 336 |
| C | RH INLET AVG. | | 576 | 576 | 574 | 573 | 460 | 467 | NA | 335 |
| C | RH OUTLET | | 535 | 535 | 524 | 532 | 428 | 429 | 293 | 301 |
| C | HP HTR. 2-7 STM. IN | | 357 | 360 | 359 | 363 | 380 | 384 | 404 | 408 |
| | PRESSURES AIR & GAS | "$H_2O$ | | | | | | | | |
| B | FD FAN DISCHARGE R | | 9.0 | 9.4 | 8.8 | 8.5 | 4.8 | 6.8 | 2.5 | 2.5 |
| B | FD FAN DISCHARGE L | | 8.9 | 9.4 | 8.8 | 8.5 | 4.6 | 6.6 | 2.5 | 2.5 |
| B | FD FAN DISCHARGE AVG. | | 9.0 | 9.4 | 8.8 | 8.5 | 4.7 | 6.7 | 2.5 | 2.5 |
| C | AH 2-1 AIR DIFF. PRESS. R | | 3.35 | 3.44 | 3.23 | 3.30 | 2.21 | 2.50 | 1.36 | 1.38 |
| C | AH 2-2 AIR DIFF. PRESS. L | | 3.79 | 3.88 | 3.64 | 3.72 | 2.58 | 2.87 | 1.52 | 1.57 |
| C | AH AIR DIFF. PRESS. AVG. | | 3.57 | 3.66 | 3.44 | 3.51 | 2.40 | 2.68 | 1.44 | 1.48 |
| B | WINDBOX PRESS. R | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | WINDBOX PRESS. L | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | WINDBOX PRESS. AVG. | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | FURNACE DRAFT | | -1.2 | -1.2 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| C | SH DRAFT DIFF. | | 1.93 | 2.00 | 1.85 | 1.77 | 1.13 | 1.33 | 0.53 | 0.60 |
| C | ECON. DRAFT DIFF. | | 2.45 | 2.61 | 2.43 | 2.45 | 1.71 | 1.80 | 0.98 | 0.88 |
| B | AH 2-1 GAS OUT. PRESS. R | | -13.5 | -13.8 | -13.3 | -13.8 | -10.6 | -10.0 | -6.8 | -6.8 |
| B | AH 2-2 GAS OUT. PRESS. L | | -13.5 | -13.8 | -12.8 | -13.2 | -9.8 | -10.0 | -6.0 | -6.6 |
| B | AH GAS OUT. PRESS. AVG. | | -13.5 | -13.8 | -13.0 | -13.5 | -10.2 | -10.0 | -6.4 | -6.7 |
| B | ID FAN 2-1 INLET PRESS. R | | -15.8 | -16.0 | -15.5 | -15.5 | -11.6 | -11.8 | -7.5 | -8.0 |
| B | ID FAN 2-2 INLET PRESS. L | | -14.8 | -15.0 | -14.0 | -14.0 | -10.6 | -10.5 | -6.8 | -7.6 |
| B | ID FAN INLET PRESS. AVG. | | -15.3 | -15.5 | -14.8 | -14.8 | -11.1 | -11.2 | -7.2 | -7.8 |

B = BOARD DATA
C = COMPUTER DATA

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 9/27 | 9/27 | 9/27 | 10/5 | 10/4 | 10/5 | 10/4 | 10/3 |
| TIME | | 13:30 | 12:00 | 14:00 | 13:45 | 16:00 | 12:00 | 14:15 | 18:30 |
| C LOAD | MW | 428 | 429 | 429 | 427 | 434 | 422 | 429 | 427 |
| **FLOWS** | $10^3$LB/HR | | | | | | | | |
| C FEEDWATER | | 2885 | 2881 | 2891 | 2909 | 2853 | 2889 | 2882 | 2904 |
| B MAIN STEAM | | 3033 | 3050 | 3050 | 3000 | 3000 | 3000 | 3000 | 3050 |
| C SUPERHEAT SPRAY L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C SUPERHEAT SPRAY R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C REHEAT SPRAY | | 0 | 0 | 0 | 0 | 17.3 | 0 | 0 | 7.9 |
| C EXT. STM. TO STM. AH 2-1 | | 58.8 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C EXT. STM. TO STM. AH 2-2 | | 58,8 | 58.9 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| C AUX. STM. TO STM. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C AUX. STM. TO STM. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C AUX. STM. TO SJAE | | 3.0 | 3.1 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| B AIR FLOW TO BOILER | | 3770 | 3710 | 3730 | 3130 | 3250 | 3140 | 3200 | 3190 |
| **PRESSURES STEAM & WATER** | PSIG | | | | | | | | |
| C FEEDWATER TO ECON. | | 2810 | 2818 | 2818 | 2813 | 2814 | 2807 | 2812 | 2808 |
| C BOILER DRUM | | 2703 | 2716 | 2719 | 2719 | 2718 | 2705 | 2713 | 2713 |
| C TURBINE THROTTLE | | 2423 | 2417 | 2420 | 2415 | 2420 | 2411 | 2417 | 2415 |
| C TURBINE 1ST STAGE | | 1812 | 1827 | 1828 | 1829 | 1829 | 1806 | 1823 | 1824 |
| C RH INLET LEFT | | 567 | 569 | 570 | 573 | 576 | 565 | 572 | 573 |
| C RH INLET RIGHT | | 571 | 573 | 573 | 577 | 579 | 569 | 575 | 577 |
| C RH INLET AVG. | | 569 | 571 | 572 | 575 | 578 | 567. | 574 | 575 |
| C RH OUTLET | | 531 | 530 | 531 | 533 | 536 | 528 | 533 | 534 |
| C HP HTR. 2-7 STM. IN | | 366 | 362 | 359 | 360 | 359 | 362 | 361 | 360 |
| **PRESSURES AIR & GAS.** | "$H_2O$ | | | | | | | | |
| B FD FAN DISCHARGE R | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| B FD FAN DISCHARGE L | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| B FD FAN DISCHARGE AVG. | | 11.0 | 11.8 | 11.8 | 9.3 | 9.8 | 9.2 | 9.1 | 9.5 |
| C AH 2-1 AIR DIFF. PRESS. R | | 4.42 | 4.41 | 4.40 | 3.37 | 3.56 | 3.33 | 3.42 | 3.44 |
| C AH 2-2 AIR DIFF. PRESS. L | | 5.02 | 4.84 | 4.84 | 3.81 | 3.98 | 3.73 | 3.90 | 3.90 |
| C AH AIR DIFF. PRESS. AVG. | | 4.72 | 4.62 | 4.62 | 3.59 | 3.77 | 3.53 | 3.66 | 3.67 |
| B WINDBOX PRESS. R | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B WINDBOX PRESS. L | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B WINDBOX PRESS. AVG. | | 3.5 | 4.3 | 4.5 | 3.5 | 3.8 | 3.4 | 3.5 | 3.5 |
| B FURNACE DRAFT | | -1.0 | -1.0 | -1.0 | -1.0 | -1.2 | -1.0 | -1.0 | -1.0 |
| C SH DRAFT DIFF. | | 2.54 | 2.26 | 2.36 | 1.82 | 1.95 | 1.73 | 1.84 | 1.82 |
| C ECON. DRAFT DIFF. | | 3.16 | 3.08 | 3.11 | 2.44 | 2.51 | 2.31 | 2.41 | 2.39 |
| B AH 2-1 GAS OUT. PRESS. R | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.5 | -13.6 | -13.5 |
| B AH 2-2 GAS OUT. PRESS. L | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.4 | -13.6 | -13.4 |
| B AH GAS OUT. PRESS. AVG. | | -15.0 | -15.0 | -15.0 | -13.5 | -14.3 | -13.4 | -13.6 | -13.4 |
| B ID FAN 2-1 INLET PRESS. R | | -21.5 | -19.1 | -19.0 | -15.8 | -16.9 | -15.6 | -16.0 | -16.0 |
| B ID FAN 2-2 INLET PRESS. L | | -17.5 | -19.1 | -19.0 | -14.8 | -15.4 | -14.5 | -14.8 | -14.5 |
| B ID FAN INLET PRESS. AVG. | | -19.5 | -19.1 | -19.0 | -15.3 | -16.2 | -15.0 | -15.4 | -15.2 |

B = BOARD DATA
C = COMPUTER DATA

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| | TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| | DATE | 1975 | 10/3 | 10/3 | 10/6 | 10/8 | 10/10 | 10/9 | 10/12 | 10/5 |
| | TIME | | 22:30 | 20:30 | 19:00 | 10:30 | 01:45 | 01:15 | 08:15 | 18:45 |
| C | LOAD | MW | 423 | 430 | 417 | 426 | 356 | 358 | 253 | 266 |
| | FLOWS | $10^3$LB/HR | | | | | | | | |
| C | FEEDWATER | | 2926 | 2885 | 2900 | 2908 | 2333 | 2307 | 1665 | 1657 |
| B | MAIN STEAM | | 3100 | 3038 | 3050 | 3050 | 2400 | 2400 | 1650 | 1650 |
| C | SUPERHEAT SPRAY L | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | SUPERHEAT SPRAY R | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | REHEAT SPRAY | | 22.9 | 18.7 | 0 | 0 | 0 | 4.5 | 0 | 0 |
| C | EXT. STM. TO STM. AH 2-1 | | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 28.2 | 58.8 |
| C | EXT. STM. TO STM. AH 2-2 | | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 28.5 | 58.8 |
| C | AUX. STM. TO STM. AH 2-1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | AUX. STM. TO STM. AH 2-2 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | AUX. STM. TO SJAE | | 3.0 | 3.0 | 3.0 | 3.2 | 3.0 | 3.1 | 3.0 | 3.0 |
| B | AIR FLOW TO BOILER | | 3180 | 3240 | 3100 | 3110 | 2460 | 2640 | 1800 | 1810 |
| | PRESSURES STEAM & WATER | PSIG | | | | | | | | |
| C | FEEDWATER TO ECON. | | 2813 | 2806 | 2813 | 2816 | 2705 | 2701 | 2592 | 2593 |
| C | BOILER DRUM | | 2715 | 2711 | 2715 | 2720 | 2628 | 2631 | 2537 | 2532 |
| C | TURBINE THROTTLE | | 2418 | 2413 | 2415 | 2419 | 2416 | 2420 | 2416 | 2414 |
| C | TURBINE 1ST STAGE | | 1826 | 1824 | 1824 | 1829 | 1442 | 1438 | NA | 1008 |
| C | RH INLET LEFT | | 574 | 574 | 572 | 571 | 464 | 465 | NA | 334 |
| C | RH INLET RIGHT | | 578 | 579 | 576 | 575 | 468 | 469 | NA | 336 |
| C | RH INLET AVG. | | 576 | 576 | 574 | 573 | 460 | 467 | NA | 335 |
| C | RH OUTLET | | 535 | 535 | 524 | 532 | 428 | 429 | 293 | 301 |
| C | HP HTR. 2-7 STM. IN | | 357 | 360 | 359 | 363 | 380 | 384 | 404 | 408 |
| | PRESSURES AIR & GAS | "$H_2O$ | | | | | | | | |
| B | FD FAN DISCHARGE R | | 9.0 | 9.4 | 8.8 | 8.5 | 4.8 | 6.8 | 2.5 | 2.5 |
| B | FD FAN DISCHARGE L | | 8.9 | 9.4 | 8.8 | 8.5 | 4.6 | 6.6 | 2.5 | 2.5 |
| B | FD FAN DISCHARGE AVG. | | 9.0 | 9.4 | 8.8 | 8.5 | 4.7 | 6.7 | 2.5 | 2.5 |
| C | AH 2-1 AIR DIFF. PRESS. R | | 3.35 | 3.44 | 3.23 | 3.30 | 2.21 | 2.50 | 1.36 | 1.38 |
| C | AH 2-2 AIR DIFF. PRESS. L | | 3.79 | 3.88 | 3.64 | 3.72 | 2.58 | 2.87 | 1.52 | 1.57 |
| C | AH AIR DIFF. PRESS. AVG. | | 3.57 | 3.66 | 3.44 | 3.51 | 2.40 | 2.68 | 1.44 | 1.48 |
| B | WINDBOX PRESS. R | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | WINDBOX PRESS. L | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | WINDBOX PRESS. AVG. | | 3.1 | 3.5 | 3.3 | 3.0 | 1.0 | 2.5 | 0 | 0 |
| B | FURNACE DRAFT | | -1.2 | -1.2 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 | -1.0 |
| C | SH DRAFT DIFF. | | 1.93 | 2.00 | 1.85 | 1.77 | 1.13 | 1.33 | 0.53 | 0.60 |
| C | ECON. DRAFT DIFF. | | 2.45 | 2.61 | 2.43 | 2.45 | 1.71 | 1.80 | 0.98 | 0.88 |
| B | AH 2-1 GAS OUT. PRESS. R | | -13.5 | -13.8 | -13.3 | -13.8 | -10.6 | -10.0 | -6.8 | -6.8 |
| B | AH 2-2 GAS OUT. PRESS. L | | -13.5 | -13.8 | -12.8 | -13.2 | -9.8 | -10.0 | -6.0 | -6.6 |
| B | AH GAS OUT. PRESS. AVG. | | -13.5 | -13.8 | -13.0 | -13.5 | -10.2 | -10.0 | -6.4 | -6.7 |
| B | ID FAN 2-1 INLET PRESS. R | | -15.8 | -16.0 | -15.5 | -15.5 | -11.6 | -11.8 | -7.5 | -8.0 |
| B | ID FAN 2-2 INLET PRESS. L | | -14.8 | -15.0 | -14.0 | -14.0 | -10.6 | -10.5 | -6.8 | -7.6 |
| B | ID FAN INLET PRESS. AVG. | | -15.3 | -15.5 | -14.8 | -14.8 | -11.1 | -11.2 | -7.2 | -7.8 |

B = BOARD DATA
C = COMPUTER DATA

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 9/17 | 9/26 | 9/26 | 9/26 | 9/26 | 10/1 | 10/1 | 10/1 |
| TIME | | 10:20 | 09:40 | 11:30 | 15:30 | 17:15 | 18:00 | 19:30 | 21:00 |
| C LOAD | MW | 428 | 430 | 430 | 430 | 431 | 430 | 428 | 428 |
| TEMPERATURES AIR & GAS | °F | | | | | | | | |
| C AH 2-1 AIR IN TEMP. | | 103 | 108 | 108 | 109 | 109 | 96 | 96 | 95 |
| C AH 2-2 AIR IN TEMP. | | 98 | 94 | 94 | 91 | 91 | 110 | 109 | 109 |
| C AH AIR IN TEMP. AVG. | | 100 | 101 | 101 | 100 | 100 | 103 | 102 | 102 |
| C AH 2-1 AIR OUT TEMP. | | 521 | 513 | 513 | 511 | 512 | 534 | 532 | 533 |
| C AH 2-2 AIR OUT TEMP. | | 544 | 546 | 548 | 545 | 547 | 534 | 535 | 536 |
| C AH AIR OUT TEMP. AVG. | | 532 | 530 | 530 | 528 | 530 | 534 | 534 | 534 |
| C AH 2-1 GAS IN TEMP. | | 722 | 714 | 715 | 710 | 711 | 716 | 714 | 713 |
| C AH 2-2 GAS IN TEMP. | | 722 | 701 | 703 | 703 | 708 | 707 | 707 | 709 |
| C AH GAS IN TEMP. AVG. | | 722 | 708 | 709 | 706 | 710 | 712 | 710 | 711 |
| C AH 2-1 GAS OUT TEMP. | | 268 | 261 | 261 | 261 | 261 | 282 | 280 | 279 |
| C AH 2-2 GAS OUT TEMP.* | | 279 | 286 | 287 | 286 | 288 | 264 | 265 | 265 |
| C AH GAS OUT TEMP. AVG. | | 274 | 274 | 274 | 274 | 274 | 273 | 272 | 272 |
| TEMPERATURES STEAM & WATER | °F | | | | | | | | |
| C FW IN TEMP. TO ECON. | | 484 | 485 | 485 | 486 | 486 | 485 | 484 | 485 |
| C ECON. OUT. AVG. | | 576 | 577 | 577 | 574 | 575 | 570 | 570 | 571 |
| C BOILER DOWNCOMER | | 678 | 678 | 678 | 678 | 679 | 678 | 678 | 678 |
| C SH DESH INLET L | | 752 | 749 | 751 | 749 | 750 | 745 | 747 | 749 |
| C SH DESH INLET R | | 759 | 763 | 759 | 757 | 756 | 755 | 756 | 760 |
| C SH DESH INLET AVG. | | 756 | 756 | 755 | 753 | 753 | 750 | 752 | 754 |
| C SH DESH OUTLET L | | 758 | 754 | 756 | 755 | 757 | 751 | 753 | 755 |
| C SH DESH OUTLET R | | 764 | 764 | 763 | 759 | 759 | 760 | 758 | 761 |
| C SH DESH OUTLET AVG. | | 761 | 759 | 760 | 757 | 758 | 756 | 756 | 758 |
| C SH OUTLET | | 987 | 983 | 983 | 989 | 987 | 991 | 980 | 982 |
| C THROTTLE STEAM | | 976 | 971 | 973 | 979 | 974 | 980 | 971 | 974 |
| C RH TURBINE L | | 616 | 613 | 613 | 619 | 616 | 619 | 612 | 615 |
| C RH TURBINE R | | 617 | 613 | 614 | 620 | 616 | 619 | 613 | 615 |
| C RH TURBINE AVG. | | 616 | 613 | 614 | 619 | 616 | 619 | 612 | 615 |
| C RH BOILER L | | 601 | 598 | 600 | 576 | 581 | 615 | 608 | 611 |
| C RH BOILER R | | 595 | 592 | 595 | 562 | 569 | 614 | 608 | 610 |
| C RH BOILER AVG. | | 598 | 595 | 598 | 569 | 575 | 614 | 608 | 610 |
| C RH OUTLET | | 995 | 1004 | 1002 | 994 | 1002 | 1020 | 1011 | 1014 |
| C HP HTR. 2-7 STM. IN | | 615 | 611 | 612 | 619 | 614 | 618 | 612 | 613 |
| C HP HTR. 2-7 FW IN | | 415 | 415 | 415 | 416 | 416 | 415 | 415 | 416 |
| C HP HTR. 2-7 DRAIN | | 423 | 423 | 423 | 424 | 424 | 424 | 424 | 424 |
| C AUX. STEAM TEMP. | | 528 | 528 | 529 | 530 | 530 | 531 | 530 | 531 |
| FAN DAMPER POSITION | % OPEN | | | | | | | | |
| B FD FANS | | 75 | 73 | 74 | 74 | 74 | 70 | 70 | 70 |
| B ID FANS | | 67 | 66 | 65 | 66 | 66 | 60 | 63 | 62 |
| SPRAY VALVE POSITION | % OPEN | | | | | | | | |
| B SH SPRAY | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B RH SPRAY | | 15 | 14 | 13 | 28 | 25 | 0 | 0 | 0 |

B = BOARD DATA
C = COMPUTER DATA
* TC READING OPEN

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| | TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1975 | 9/27 | 9/27 | 9/27 | 10/5 | 10/4 | 10/5 | 10/4 | 10/3 |
| | Time | | 13:30 | 12:00 | 14:00 | 13:45 | 16:00 | 12:00 | 14:15 | 18:30 |
| C | Load | MW | 428 | 429 | 429 | 427 | 434 | 422 | 429 | 427 |
| | TEMPERATURES AIR & GAS | °F | | | | | | | | |
| C | AH 2-1 Air In Temp. | | 106 | 96 | 96 | 101 | 100 | 101 | 100 | 99 |
| C | AH 2-2 Air In Temp. | | 98 | 104 | 105 | 103 | 103 | 104 | 104 | 104 |
| C | AH Air In Temp. Avg. | | 102 | 100 | 100 | 102 | 102 | 102 | 102 | 102 |
| C | AH 2-1 Air Out Temp. | | 512 | 530 | 531 | 527 | 531 | 524 | 526 | 526 |
| C | AH 2-2 Air Out Temp. | | 543 | 545 | 545 | 540 | 541 | 536 | 538 | 535 |
| C | AH Air Out Temp. Avg. | | 528 | 538 | 538 | 534 | 536 | 530 | 532 | 530 |
| C | AH 2-1 Gas In Temp. | | 724 | 728 | 729 | 715 | 724 | 710 | 714 | 711 |
| C | AH 2-2 Gas In Temp. | | 713 | 733 | 731 | 714 | 716 | 709 | 709 | 714 |
| C | AH Gas In Temp. Avg. | | 718 | 730 | 730 | 714 | 720 | 710 | 712 | 712 |
| C | AH 2-1 Gas Out Temp. | | 266 | 281 | 282 | 276 | 277 | 274 | 275 | 275 |
| C | AH 2-2 Gas Out Temp.* | | 282 | 270 | 271 | 274 | 273 | 273 | 272 | 270 |
| C | AH Gas Out Temp. Avg. | | 274 | 276 | 276 | 275 | 275 | 274 | 274 | 272 |
| | TEMPERATURES STEAM & WATER | °F | | | | | | | | |
| C | FW In Temp. to Econ. | | 485 | 484 | 484 | 484 | 486 | 484 | 485 | 485 |
| C | Econ. Out. Avg. | | 584 | 586 | 587 | 571 | 574 | 568 | 571 | 570 |
| C | Boiler Downcomer | | 678 | 678 | 678 | 678 | 678 | 677 | 678 | 678 |
| C | SH DESH Inlet L | | 751 | 758 | 759 | 748 | 748 | 742 | 744 | 740 |
| C | SH DESH Inlet R | | 758 | 762 | 762 | 748 | 761 | 742 | 751 | 751 |
| C | SH DESH Inlet Avg. | | 754 | 760 | 760 | 748 | 754 | 742 | 748 | 746 |
| C | SH DESH Outlet L | | 757 | 765 | 766 | 753 | 754 | 748 | 750 | 747 |
| C | SH DESH Outlet R | | 761 | 769 | 770 | 753 | 765 | 749 | 756 | 757 |
| C | SH DESH Outlet Avg. | | 759 | 767 | 768 | 753 | 760 | 748 | 753 | 752 |
| C | SH Outlet | | 983 | 994 | 993 | 977 | 1006 | 969 | 988 | 978 |
| C | Throttle Steam | | 973 | 980 | 982 | 967 | 997 | 960 | 977 | 968 |
| C | RH Turbine L | | 613 | 620 | 621 | 609 | 634 | 602 | 617 | 611 |
| C | RH Turbine R | | 614 | 620 | 621 | 609 | 635 | 603 | 618 | 611 |
| C | RH Turbine Avg. | | 614 | 620 | 621 | 609 | 634 | 602 | 618 | 611 |
| C | RH Boiler L | | 609 | 616 | 618 | 605 | 612 | 600 | 611 | 596 |
| C | RH Boiler R | | 609 | 616 | 616 | 604 | 603 | 599 | 610 | 588 |
| C | RH Boiler Avg. | | 609 | 616 | 617 | 604 | 608 | 600 | 610 | 592 |
| C | RH Outlet | | 1012 | 1012 | 1011 | 1006 | 1026 | 991 | 1017 | 995 |
| C | HP Htr. 2-7 Stm. In | | 613 | 621 | 620 | 608 | 635 | 602 | 616 | 609 |
| C | HP Htr. 2-7 FW In | | 413 | 415 | 415 | 415 | 416 | 414 | 415 | 415 |
| C | HP Htr. 2-7 Drain | | 423 | 423 | 423 | 424 | 424 | 423 | 424 | 423 |
| C | Aux. Steam Temp. | | 525 | 542 | 545 | 525 | 577 | 518 | 530 | 526 |
| | FAN DAMPER POSITION | % Open | | | | | | | | |
| B | FD Fans | | 80 | 79 | 80 | 72 | 73 | 71 | 72 | 72 |
| B | ID Fans | | 74 | 71 | 71 | 63 | 65 | 62 | 64 | 64 |
| | SPRAY VALVE POSITION | % Open | | | | | | | | |
| B | SH Spray | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B | RH Spray | | 0 | 0 | 0 | 0 | 23 | 0 | 3 | 15 |

B = Board Data
C = Computer Data
* TC Reading Open

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|
| Date | 1975 | 10/3 | 10/3 | 10/6 | 10/8 | 10/10 | 10/9 | 10/12 | 10/5 |
| Time | | 22:30 | 20:30 | 19:00 | 10:30 | 01:45 | 01:15 | 08:15 | 18:45 |
| C Load | MW | 423 | 430 | 417 | 426 | 356 | 358 | 253 | 266 |
| **TEMPERATURES AIR & GAS** | °F | | | | | | | | |
| C AH 2-1 Air In Temp. | | 98 | 97 | 102 | 97 | 109 | 110 | 116 | 115 |
| C AH 2-2 Air In Temp. | | 104 | 103 | 104 | 103 | 108 | 112 | 118 | 117 |
| C AH Air In Temp. Avg. | | 101 | 100 | 103 | 100 | 108 | 111 | 117 | 116 |
| C AH 2-1 Air Out Temp. | | 524 | 527 | 524 | 522 | 504 | 505 | 468 | 476 |
| C AH 2-2 Air Out Temp. | | 534 | 538 | 534 | 532 | 511 | 510 | 470 | 476 |
| C AH Air Out Temp. Avg. | | 529 | 532 | 529 | 527 | 508 | 508 | 469 | 476 |
| C AH 2-1 Gas In Temp. | | 708 | 715 | 710 | 710 | 659 | 672 | 592 | 608 |
| C AH 2-2 Gas In Temp. | | 708 | 721 | 702 | 702 | 655 | 673 | 591 | 607 |
| C AH Gas In Temp. Avg. | | 708 | 718 | 706 | 706 | 657 | 672 | 592 | 608 |
| C AH 2-1 Gas Out Temp. | | 274 | 275 | 273 | 272 | 262 | 262 | 248 | 252 |
| C AH 2-2 Gas Out Temp.* | | 271 | 272 | 272 | 271 | 266 | 259 | 250 | 254 |
| C AH Gas Out Temp. Avg. | | 272 | 274 | 272 | 272 | 264 | 260 | 249 | 253 |
| **TEMPERATURES STEAM & WATER** | °F | | | | | | | | |
| C FW In Temp. to Econ. | | 484 | 486 | 484 | 484 | 464 | 464 | 430 | 434 |
| C Econ. Out. Avg. | | 569 | 573 | 567 | 568 | 539 | 545 | 498 | 504 |
| C Boiler Downcomer | | 678 | 678 | 678 | 678 | 672 | 673 | 668 | 668 |
| C SH DESH Inlet L | | 739 | 747 | 744 | 739 | 738 | 751 | 730 | 740 |
| C SH DESH Inlet R | | 752 | 759 | 742 | 743 | 742 | 757 | 733 | 741 |
| C SH DESH Inlet Avg. | | 746 | 753 | 743 | 741 | 740 | 754 | 732 | 740 |
| C SH DESH Outlet L | | 746 | 753 | 744 | 744 | 743 | 758 | 734 | 741 |
| C SH DESH Outlet R | | 750 | 758 | 747 | 748 | 744 | 756 | 737 | 746 |
| C SH DESH Outlet Avg. | | 748 | 756 | 746 | 746 | 744 | 757 | 736 | 744 |
| C SH Outlet • | | 961 | 989 | 961 | 972 | 983 | 995 | 973 | 1005 |
| C Throttle Steam | | 951 | 981 | 958 | 960 | 976 | 989 | 963 | 996 |
| C RH Turbine L | | 597 | 622 | 602 | 603 | 579 | 591 | NA | 550 |
| C RH Turbine R | | 597 | 623 | 603 | 603 | 585 | 596 | NA | 562 |
| C RH Turbine Avg. | | 597 | 622 | 602 | 603 | 582 | 594 | NA | 556 |
| C RH Boiler L | | 555 | 595 | 599 | 601 | 577 | 576 | 519 | 547 |
| C RH Boiler R | | 544 | 581 | 599 | 599 | 579 | 573 | 529 | 557 |
| C RH Boiler Avg. | | 550 | 588 | 599 | 600 | 578 | 574 | 524 | 552 |
| C RH Outlet | | 965 | 1007 | 987 | 991 | 983 | 1002 | 954 | 988 |
| C HP Htr. 2-7 Stm. In | | 594 | 620 | 603 | 602 | 580 | 591 | 529 | 556 |
| C HP Htr. 2-7 FW In | | 415 | 416 | 415 | 415 | 399 | 400 | 371 | 374 |
| C HP Htr. 2-7 Drain | | 423 | 424 | 424 | 423 | 405 | 405 | 375 | 377 |
| C Aux. Steam Temp. | | 511 | 533 | 518 | 513 | 530 | 552 | 519 | 535 |
| **FAN DAMPER POSITION** | % Open | | | | | | | | |
| B FD Fans | | 70 | 70 | 70 | 68 | 57 | 61 | 46 | 46 |
| B ID Fans | | 63 | 62 | 60 | 60 | 53 | 55 | 41 | 41 |
| **SPRAY VALVE POSITION** | % Open | | | | | | | | |
| B SH Spray | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| B RH Spray | | 25 | 22 | 0 | 0 | 0 | 12 | 0 | 0 |

B = Board Data
C = Computer Data
* TC Reading Open

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 9/17 | 9/26 | 9/26 | 9/26 | 9/26 | 10/1 | 10/1 | 10/1 |
| TIME | | 10:20 | 09:40 | 11:30 | 15:30 | 17:15 | 18:00 | 19:30 | 21:00 |
| C LOAD | MW | 428 | 430 | 430 | 430 | 431 | 430 | 428 | 428 |
| **MILL DATA** | | | | | | | | | |
| C MILL 2-1 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C MILL 2-2 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C MILL 2-3 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C MILL 2-4 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C MILL 2-5 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C COAL AIR TEMP. MILL 2-1 | °F | 148 | 149 | 148 | 149 | 149 | 150 | 150 | 149 |
| C COAL AIR TEMP. MILL 2-2 | °F | 148 | 150 | 150 | 150 | 150 | 150 | 150 | 149 |
| C COAL AIR TEMP. MILL 2-3 | °F | 147 | 148 | 147 | 147 | 147 | 149 | 149 | 147 |
| C COAL AIR TEMP. MILL 2-4 | °F | 146 | 148 | 148 | 148 | 148 | 146 | 146 | 146 |
| C COAL AIR TEMP. MILL 2-5 | °F | 148 | 149 | 149 | 149 | 149 | 148 | 148 | 149 |
| B MILL 2-1 EXH. DISCH. | "$H_2O$ | 7.0 | 6.0 | 6.2 | 6.0 | 6.0 | 7.4 | 7.1 | 7.3 |
| B MILL 2-2 EXH. DISCH. | "$H_2O$ | 7.0 | 6.4 | 6.5 | 6.5 | 6.5 | 6.8 | 7.1 | 6.7 |
| B MILL 2-3 EXH. DISCH. | "$H_2O$ | 8.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| B MILL 2-4 EXH. DISCH. | "$H_2O$ | 9.0 | 8.7 | 8.8 | 8.8 | 8.5 | 7.0 | 7.0 | 7.0 |
| B MILL 2-5 EXH. DISCH. | "$H_2O$ | 8.0 | 7.2 | 7.3 | 7.9 | 7.5 | 7.4 | 7.0 | 7.4 |
| B MILL 2-1 SUCTION | "$H_2O$ | -1.8 | -1.7 | -1.8 | -1.8 | -1.8 | -2.0 | -2.0 | -2.0 |
| B MILL 2-2 SUCTION | "$H_2O$ | -2.0 | -1.9 | -1.9 | -2.0 | -2.0 | -2.0 | -2.0 | -1.9 |
| B MILL 2-3 SUCTION | "$H_2O$ | -1.8 | -1.8 | -1.9 | -1.9 | -1.9 | -1.8 | -1.9 | -1.9 |
| B MILL 2-4 SUCTION | "$H_2O$ | -1.7 | -1.7 | -1.7 | -1.8 | -1.7 | -2.0 | -2.1 | -2.1 |
| B MILL 2-5 SUCTION | "$H_2O$ | -2.0 | -2.0 | -2.1 | -2.0 | -2.0 | -1.8 | -1.9 | -2.0 |
| B MILL 2-1 COAL FLOW | $10^3$LB/HR | 66 | 67 | 68 | 69 | 68 | 69 | 67 | 69 |
| B MILL 2-2 COAL FLOW | $10^3$LB/HR | 64 | 65 | 66 | 66 | 66 | 66 | 64 | 66 |
| B MILL 2-3 COAL FLOW | $10^3$LB/HR | 63 | 63 | 63 | 64 | 64 | 65 | 63 | 65 |
| B MILL 2-4 COAL FLOW | $10^3$LB/HR | 63 | 64 | 63 | 64 | 64 | 64 | 63 | 64 |
| B MILL 2-5 COAL FLOW | $10^3$LB/HR | 63 | 65 | 64 | 64 | 65 | 66 | 64 | 66 |
| B MILL 2-1 FEEDER SPEED * | % | 75 | 76 | 78 | 79 | 78 | 79 | 77 | 79 |
| B MILL 2-2 FEEDER SPEED | % | 76 | 76 | 77 | 78 | 77 | 79 | 76 | 79 |
| B MILL 2-3 FEEDER SPEED | % | 75 | 75 | 75 | 76 | 76 | 78 | 76 | 77 |
| B MILL 2-4 FEEDER SPEED | % | 75 | 77 | 77 | 77 | 78 | 78 | 76 | 78 |
| B MILL 2-5 FEEDER SPEED | % | 75 | 77 | 76 | 77 | 77 | 78 | 77 | 78 |
| **BURNER TILT** | ± DEGREES | | | | | | | | |
| B POSITION LF | | +6 | -11 | -11 | -14 | -14 | +9 | +9 | +10 |
| B POSITION LR | | +7 | -9 | -9 | -12 | -10 | +10 | +10 | +10 |
| B POSITION RF | | +5 | -10 | -12 | -14 | -15 | +7 | +8 | +8 |
| B POSITION RR | | +6 | -10 | -10 | -14 | -13 | +9 | +10 | +11 |
| **MISCELLANEOUS** | | | | | | | | | |
| B DRUM LEVEL " ± NORM. $H_2O$ LEVEL | | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C FD FAN 2-1 | AMPS | 216 | 215 | 214 | 214 | 214 | 208 | 208 | 207 |
| C FD FAN 2-2 | AMPS | 240 | 235 | 235 | 235 | 235 | 229 | 228 | 226 |
| C ID FAN 2-1 | AMPS | 397 | 389 | 385 | 385 | 385 | 400 | 404 | 400 |
| C ID FAN 2-2 | AMPS | 405 | 424 | 419 | 419 | 416 | 373 | 376 | 374 |
| B FLUE GAS $SO_2$ IN STACK | PPM | NA | NA | NA | NA | NA | 60 | 60 | 70 |
| B FLUE GAS $NO_x$ IN STACK | PPM | NA | 627 | NA | 515 | 580 | 400 | 408 | 400 |
| C FLUE GAS COMBUSTIBLES L | % | 0.11 | 0.11 | 0.10 | 0.06 | 0.06 | 0.06 | 0.08 | 0.08 |
| C FLUE GAS COMBUSTIBLES R | % | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| C FLUE GAS $O_2$ L | % | 4.13 | 4.52 | 4.16 | 4.05 | 3.71 | 2.96 | 2.31 | 2.24 |
| C FLUE GAS $O_2$ R | % | 4.06 | 3.62 | 3.86 | 3.77 | 4.19 | 2.54 | 2.49 | 3.64 |
| C FLUE GAS $O_2$ AVG. | % | 4.10 | 4.07 | 4.01 | 3.91 | 3.95 | 2.75 | 2.40 | 2.94 |
| B AMBIENT TEMP. | °F | 73 | 67 | 74 | 74 | 70 | 64 | 57 | 54 |
| B AMBIENT REL. HUMIDITY | % | 43 | 29 | 25 | 20 | 24 | 28 | 33 | 35 |
| B BAROMETRIC PRESS. | "HG | 23.86 | 23.97 | 23.96 | 23.93 | 23.92 | 24.05 | 24.05 | 24.07 |

B = BOARD DATA
C = COMPUTER DATA
* FEEDER SPEED IN % OF CONTROL SIGNAL

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| TEST NO. | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| DATE | 1975 | 9/27 | 9/27 | 9/27 | 10/5 | 10/4 | 10/5 | 10/4 | 10/3 |
| TIME | | 13:30 | 12:00 | 14:00 | 13:45 | 16:00 | 12:00 | 14:15 | 18:30 |
| C LOAD | MW | 428 | 429 | 429 | 427 | 434 | 422 | 429 | 427 |
| **MILL DATA** | | | | | | | | | |
| C MILL 2-1 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C MILL 2-2 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C MILL 2-3 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C MILL 2-4 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C MILL 2-5 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C COAL AIR TEMP. MILL 2-1 | °F | 148 | 149 | 149 | 148 | 150 | 148 | 150 | 148 |
| C COAL AIR TEMP. MILL 2-2 | °F | 149 | 149 | 150 | 148 | 149 | 148 | 150 | 150 |
| C COAL AIR TEMP. MILL 2-3 | °F | 147 | 147 | 148 | 147 | 146 | 147 | 146 | 147 |
| C COAL AIR TEMP. MILL 2-4 | °F | 141 | 146 | 146 | 145 | 145 | 145 | 145 | 145 |
| C COAL AIR TEMP. MILL 2-5 | °F | 148 | 148 | 149 | 149 | 149 | 148 | 149 | 149 |
| B MILL 2-1 EXH. DISCH. | "$H_2O$ | 5.8 | 7.2 | 7.2 | 8.0 | 6.6 | 8.0 | 6.9 | 7.5 |
| B MILL 2-2 EXH. DISCH. | "$H_2O$ | 7.0 | 6.9 | 6.8 | 6.7 | 6.8 | 7.0 | 7.0 | 6.9 |
| B MILL 2-3 EXH. DISCH. | "$H_2O$ | 7.0 | 7.0 | 7.0 | 7.3 | 7.3 | 7.0 | 7.1 | 7.4 |
| B MILL 2-4 EXH. DISCH. | "$H_2O$ | 8.5 | 6.9 | 7.0 | 7.3 | 7.0 | 7.1 | 7.0 | 7.0 |
| B MILL 2-5 EXH. DISCH. | "$H_2O$ | 7.5 | 7.2 | 7.5 | 7.0 | 7.1 | 7.3 | 7.4 | 7.1 |
| B MILL 2-1 SUCTION | "$H_2O$ | -1.9 | -1.9 | -1.9 | -1.9 | -2.1 | -2.0 | -2.1 | -2.0 |
| B MILL 2-2 SUCTION | "$H_2O$ | -2.0 | -1.8 | -1.8 | -2.0 | -1.9 | -2.0 | -2.0 | -1.9 |
| B MILL 2-3 SUCTION | "$H_2O$ | -1.8 | -1.7 | -1.8 | -1.9 | -1.8 | -2.1 | -1.9 | -1.8 |
| B MILL 2-4 SUCTION | "$H_2O$ | -1.7 | -2.0 | -2.0 | -2.2 | -2.0 | -2.2 | -2.1 | -2.1 |
| B MILL 2-5 SUCTION | "$H_2O$ | -2.0 | -1.9 | -1.9 | -2.0 | -2.0 | -2.1 | -2.0 | -2.0 |
| B MILL 2-1 COAL FLOW | $10^3$ LB/HR | 60 | 69 | 68 | 72 | 60 | 71 | 60 | 67 |
| B MILL 2-2 COAL FLOW | $10^3$ LB/HR | 66 | 67 | 66 | 65 | 67 | 65 | 67 | 64 |
| B MILL 2-3 COAL FLOW | $10^3$ LB/HR | 64 | 65 | 64 | 60 | 66 | 60 | 66 | 63 |
| B MILL 2-4 COAL FLOW | $10^3$ LB/HR | 64 | 64 | 63 | 60 | 65 | 60 | 65 | 62 |
| B MILL 2-5 COAL FLOW | $10^3$ LB/HR | 66 | 66 | 65 | 61 | 67 | 61 | 67 | 64 |
| B MILL 2-1 FEEDER SPEED * | % | 69 | 79 | 78 | 83 | 69 | 83 | 69 | 77 |
| B MILL 2-2 FEEDER SPEED | % | 79 | 79 | 78 | 78 | 79 | 77 | 80 | 76 |
| B MILL 2-3 FEEDER SPEED | % | 77 | 77 | 76 | 73 | 79 | 72 | 78 | 75 |
| B MILL 2-4 FEEDER SPEED | % | 78 | 77 | 78 | 74 | 79 | 71 | 78 | 77 |
| B MILL 2-5 FEEDER SPEED | % | 78 | 78 | 78 | 75 | 79 | 73 | 79 | 77 |
| **BURNER TILT** | ± DEGREES | | | | | | | | |
| B POSITION LF | | +10 | +16 | +12 | -20 | -1 | -23 | -1 | +21 |
| B POSITION LR | | +10 | +17 | +12 | -19 | +1 | -19 | +1 | +24 |
| B POSITION RF | | +9 | +15 | +11 | -23 | 0 | -23 | 0 | +20 |
| B POSITION RR | | +11 | +18 | +13 | -19 | 0 | -20 | 0 | +23 |
| **MISCELLANEOUS** | | | | | | | | | |
| B DRUM LEVEL " ± NORM. $H_2O$ LEVEL | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C FD FAN 2-1 | AMPS | 230 | 231 | 230 | 207 | 210 | 207 | 208 | 210 |
| C FD FAN 2-2 | AMPS | 255 | 258 | 256 | 228 | 233 | 228 | 230 | 232 |
| C ID FAN 2-1 | AMPS | 435 | 475 | 477 | 392 | 400 | 390 | 396 | 398 |
| C ID FAN 2-2 | AMPS | 461 | 419 | 419 | 385 | 390 | 383 | 387 | 388 |
| B FLUE GAS $SO_2$ IN STACK | PPM | 107 | 50 | 50 | 30 | 40 | 10 | 40 | 63 |
| B FLUE GAS $NO_x$ IN STACK | PPM | 400 | 408 | 400 | 370 | 360 | 360 | 358 | 373 |
| C FLUE GAS COMBUSTIBLES L | % | 0.07 | 0.11 | 0.06 | 0.06 | 0.07 | 0.11 | 0.09 | 0.08 |
| C FLUE GAS COMBUSTIBLES R | % | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| C FLUE GAS $O_2$ L | % | 5.12 | 5.51 | 5.20 | 2.67 | 3.27 | 2.72 | 3.45 | 3.41 |
| C FLUE GAS $O_2$ R | % | 5.35 | 5.75 | 6.06 | 4.14 | 3.50 | 4.10 | 3.41 | 3.53 |
| C FLUE GAS $O_2$ AVG. | % | 5.24 | 5.63 | 5.63 | 3.40 | 3.38 | 3.41 | 3.43 | 3.47 |
| B AMBIENT TEMP. | °F | 77 | 64 | 70 | 75 | 73 | 72 | 75 | 62 |
| B AMBIENT REL. HUMIDITY | % | 20 | 38 | 30 | 28 | 24 | 31 | 26 | 22 |
| B BAROMETRIC PRESS. | "HG | 23.97 | 24.20 | 24.18 | 24.03 | 24.00 | 24.05 | 24.03 | 24.03 |

B = BOARD DATA
C = COMPUTER DATA
* FEEDER SPEED IN % OF CONTROL SIGNAL

# OVERFIRE AIR OPERATION STUDY

BOARD AND COMPUTER DATA

| | TEST NO. | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date | 1975 | 10/3 | 10/3 | 10/6 | 10/8 | 10/10 | 10/9 | 10/12 | 10/5 |
| | Time | | 22:30 | 20:30 | 19:00 | 10:30 | 01:45 | 01:15 | 08:15 | 18:45 |
| C | Load | MW | 423 | 430 | 417 | 426 | 356 | 358 | 253 | 266 |
| | MILL DATA | | | | | | | | | |
| C | Mill 2-1 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C | Mill 2-2 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C | Mill 2-3 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C | Mill 2-4 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C | Mill 2-5 | AMPS | NA | NA | NA | NA | NA | NA | NA | NA |
| C | Coal Air Temp. Mill 2-1 | °F | 148 | 149 | 148 | 148 | 148 | 149 | 78 | 148 |
| C | Coal Air Temp. Mill 2-2 | °F | 150 | 150 | 148 | 148 | 147 | 148 | 146 | 146 |
| C | Coal Air Temp. Mill 2-3 | °F | 146 | 147 | 147 | 147 | 147 | 147 | 146 | 94 |
| C | Coal Air Temp. Mill 2-4 | °F | 145 | 145 | 146 | 146 | 145 | 91 | 145 | 145 |
| C | Coal Air Temp. Mill 2-5 | °F | 149 | 149 | 149 | 148 | 145 | 149 | 149 | 149 |
| B | Mill 2-1 Exh. Disch. | "$H_2O$ | 7.3 | 7.5 | 7.5 | 7.4 | 6.5 | 7.5 | NA | 6.6 |
| B | Mill 2-2 Exh. Disch. | "$H_2O$ | 7.1 | 6.9 | 6.5 | 6.5 | 6.0 | 6.4 | 6.1 | NA |
| B | Mill 2-3 Exh. Disch. | "$H_2O$ | 7.0 | 7.1 | 7.3 | 7.0 | 6.5 | 7.3 | 6.3 | 6.5 |
| B | Mill 2-4 Exh. Disch. | "$H_2O$ | 7.0 | 7.0 | 7.5 | 7.0 | 7.0 | NA | 6.5 | 6.5 |
| B | Mill 2-5 Exh. Disch. | "$H_2O$ | 7.0 | 7.3 | 7.0 | 7.0 | 6.6 | 7.0 | 6.1 | 6.3 |
| B | Mill 2-1 Suction | "$H_2O$ | -2.1 | -2.0 | -2.0 | -2.0 | -2.2 | -2.0 | NA | -2.4 |
| B | Mill 2-2 Suction | "$H_2O$ | -2.0 | -2.0 | -2.0 | -2.0 | -2.3 | -1.9 | -2.4 | NA |
| B | Mill 2-3 Suction | "$H_2O$ | -1.9 | -1.8 | -1.9 | -2.0 | -2.1 | -1.8 | -2.4 | -2.3 |
| B | Mill 2-4 Suction | "$H_2O$ | -2.1 | -2.1 | -2.1 | -2.1 | -2.3 | NA | -2.5 | -2.4 |
| B | Mill 2-5 Suction | "$H_2O$ | -2.0 | -1.9 | -2.1 | -2.0 | -2.3 | -1.9 | -2.4 | -2.3 |
| B | Mill 2-1 Coal Flow | $10^3$LB/HR | 67 | 69 | 70 | 66 | 55 | 65 | NA | 55 |
| B | Mill 2-2 Coal Flow | $10^3$LB/HR | 65 | 67 | 67 | 66 | 45 | 69 | 52 | NA |
| B | Mill 2-3 Coal Flow | $10^3$LB/HR | 64 | 65 | 66 | 64 | 56 | 68 | 50 | 49 |
| B | Mill 2-4 Coal Flow | $10^3$LB/HR | 63 | 65 | 66 | 64 | 56 | NA | 49 | 49 |
| B | Mill 2-5 Coal Flow | $10^3$LB/HR | 65 | 66 | 66 | 64 | 58 | 69 | 50 | 50 |
| B | Mill 2-1 Feeder Speed * | % | 77 | 79 | 80 | 77 | 63 | 74 | NA | 64 |
| B | Mill 2-2 Feeder Speed | % | 76 | 79 | 80 | 76 | 54 | 82 | 61 | NA |
| B | Mill 2-3 Feeder Speed | % | 75 | 78 | 79 | 76 | 67 | 81 | 59 | 58 |
| B | Mill 2-4 Feeder Speed | % | 76 | 78 | 79 | 75 | 68 | NA | 59 | 59 |
| B | Mill 2-5 Feeder Speed | % | 77 | 78 | 79 | 75 | 68 | 81 | 60 | 60 |
| | BURNER TILT | ± Degrees | | | | | | | | |
| B | Position LF | | 0 | +21 | 0 | 0 | 0 | 0 | +1 | 0 |
| B | Position LR | | +1 | +24 | +1 | +2 | +1 | +1 | +1 | 0 |
| B | Position RF | | -2 | +20 | 0 | 0 | -2 | 0 | 0 | 0 |
| B | Position RR | | 0 | +23 | 0 | 0 | 0 | 0 | 0 | 0 |
| | MISCELLANEOUS | | | | | | | | | |
| B | Drum Level In. ± Norm. $H_2O$ Level | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | FD Fan 2-1 | AMPS | 207 | 210 | 204 | 208 | 186 | 195 | NA | 168 |
| C | FD Fan 2-2 | AMPS | 228 | 232 | 226 | 229 | 199 | 211 | NA | 177 |
| C | ID Fan 2-1 | AMPS | 392 | 395 | 391 | 391 | 348 | 354 | 313 | 322 |
| C | ID Fan 2-2 | AMPS | 385 | 387 | 385 | 387 | 350 | 352 | 313 | 316 |
| B | Flue Gas $SO_2$ in Stack | PPM | 73 | 80 | 40 | 80 | NA | 183 | NA | 40 |
| B | Flue Gas $NO_x$ in Stack | PPM | 365 | 373 | 373 | 400 | 400 | 400 | 400 | 368 |
| C | Flue Gas Combustibles L | % | 0.09 | 0.08 | 0.09 | 0.10 | 0.10 | 0.10 | 0.10 | 0.08 |
| C | Flue Gas Combustibles R | % | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| C | Flue Gas $O_2$ L | % | 3.75 | 2.96 | 2.70 | 3.50 | 3.11 | 2.79 | 3.07 | 3.63 |
| C | Flue Gas $O_2$ R | % | 3.29 | 3.51 | 3.63 | 3.21 | 3.14 | 3.73 | 3.50 | 4.07 |
| C | Flue Gas $O_2$ Avg. | % | 3.52 | 3.24 | 3.16 | 3.36 | 3.12 | 3.26 | 3.28 | 3.85 |
| B | Ambient Temp. | °F | 52 | 56 | 64 | 44 | 40 | 34 | 49 | 64 |
| B | Ambient Rel. Humidity | % | 33 | 28 | 28 | 48 | 55 | 67 | 54 | 27 |
| B | Barometric Press. | "Hg | 24.06 | 24.03 | 23.77 | 23.90 | 23.96 | 23.98 | 23.66 | 23.96 |

B = Board Data
C = Computer Data
* Feeder Speed in % of Control Signal

# WATERWALL CORROSION COUPON DATA SUMMARY

WEIGHT LOSS EVALUATION

BASELINE TEST

| Probe Loc. | Probe No. | Coupon No. | Initial Wt. g | Final Wt. g | Wt. Loss g | Wt. Loss/ Coupon mg/cm² | Avg. Wt. Loss/ Probe mg/cm² |
|---|---|---|---|---|---|---|---|
| 1 | 3 | 1 | 192.6190 | 192.2669 | .3521 | 6.9809 | |
| | | 2 | 193.4064 | 193.0755 | .3309 | 6.5605 | 4.7132 |
| | | 3 | 192.9291 | 192.7393 | .1898 | 3.7630 | |
| | | 4 | 193.5940 | 193.5159 | .0781 | 1.5484 | |
| 2 | I | 1 | 198.8883 | 198.6551 | .2332 | 4.6235 | |
| | | 2 | 201.0329 | 200.8816 | .1513 | 2.9997 | 2.6810 |
| | | 3 | 198.0410 | 197.9497 | .0913 | 1.8101 | |
| | | 4 | 195.5068 | 195.4417 | .0651 | 1.2907 | |
| 3 | 4 | 1 | 192.7191 | 192.5353 | .1838 | 3.6441 | |
| | | 2 | 194.8814 | 194.6926 | .1888 | 3.7432 | 2.8689 |
| | | 3 | 193.0414 | 192.9217 | .1197 | 2.3732 | |
| | | 4 | 191.3704 | 191.2839 | .0865 | 1.7150 | |
| 4 | X | 1 | 191.5552 | 191.3449 | .2103 | 4.1695 | |
| | | 2 | 192.4223 | 192.2041 | .2182 | 4.3261 | 3.4444 |
| | | 3 | 193.2662 | 193.1064 | .1598 | 3.1683 | |
| | | 4 | 193.4873 | 193.3807 | .1066 | 2.1135 | |
| 5 | Z | 1 | 193.6625 | 193.3771 | .2854 | 5.6584 | |
| | | 2 | 191.0583 | 190.8201 | .2382 | 4.7226 | 3.4062 |
| | | 3 | 192.9096 | 192.7892 | .1204 | 2.3871 | |
| | | 4 | 192.5761 | 192.5329 | .0432 | .8565 | |

Avg. Wt. Loss/Test 3.4266 mg/cm$^2$

# WATERWALL CORROSION COUPON DATA SUMMARY

## WEIGHT LOSS EVALUATION

## OVERFIRE AIR TEST

| Probe Loc. | Probe No. | Coupon No. | Initial Wt. g | Final Wt. g | Wt. Loss g | Wt. Loss/ Coupon $mg/cm^2$ | Avg. Wt. Loss/ Probe $mg/cm^2$ |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 191.9684 | 191.8866 | .0818 | 1.6218 | |
| | | 2 | 192.4812 | 192.3816 | .0996 | 1.9747 | 1.6709 |
| | | 3 | 192.9861 | 192.9142 | .0719 | 1.4255 | |
| | | 4 | 191.5205 | 191.4367 | .0838 | 1.6614 | |
| 2 | 5 | 1 | 193.4934 | 193.3406 | .1528 | 3.0294 | |
| | | 2 | 193.3895 | 193.1540 | .2355 | 4.6691 | 3.3858 |
| | | 3 | 193.2459 | 193.0711 | .1748 | 3.4656 | |
| | | 4 | 192.2109 | 192.0909 | .1200 | 2.3791 | |
| 3 | V | 1 | 193.8941 | 193.7867 | .1074 | 2.1293 | |
| | | 2 | 192.2687 | 192.1525 | .1162 | 2.3038 | 2.0268 |
| | | 3 | 193.1048 | 193.0082 | .0966 | 1.9152 | |
| | | 4 | 194.6248 | 194.5362 | .0886 | 1.7589 | |
| 4 | U | 1 | 192.0607 | 191.9105 | .1502 | 2.9818 | |
| | | 2 | 191.8937 | 191.7479 | .1458 | 2.8945 | 3.0340 |
| | | 3 | 191.6559 | 191.5016 | .1542 | 3.0613 | |
| | | 4 | 192.3558 | 192.1947 | .1611 | 3.1982 | |
| 5 | L | 1 | 202.3430 | 202.1440 | .1990 | 3.9506 | |
| | | 2 | 200.5759 | 200.4172 | .1587 | 3.1506 | 3.0608 |
| | | 3 | 202.4755 | 202.3190 | .1565 | 3.1069 | |
| | | 4 | 197.4743 | 197.3718 | .1025 | 2.0349 | |

Avg. Wt. Loss/Test 2.6357 $mg/cm^2$

# APPENDIX C

# TEST DATA & RESULTS
# FOR
# ALABAMA POWER COMPANY
# BARRY STATION
# UNIT #2

ALABAMA POWER COMPANY
BARRY #2

C-E POWER SYSTEMS
FIELD TESTING AND
PERFORMANCE RESULTS

# $NO_x$ TEST DATA SUMMARY

## BASELINE STUDY BEFORE MODIFICATION

PURPOSE OF TEST:
- Tests 1–14: EXCESS AIR VARIATION
- Tests 1–7: CLEAN FURNACE (Tests 1–3: 1/2 LOAD; Test 4: 3/4; Tests 5–10: FULL LOAD)
- Tests 8–10: MOD. DIRTY FURN.
- Tests 11–14: DIRTY FURNACE (Tests 11–12: 1/2 LOAD; Tests 13–14: FULL LOAD)


| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 1973 | 11/30 | 11/30 | 11/30 | 1/18/74 | 11/14 | 11/28 | 11/28 | 11/15 | 11/19 | 11/19 | 12/5 | 12/4 | 11/16 | 11/16 |
| LOAD | MW | 66 | 65 | 67 | 93 | 124 | 123 | 123 | 126 | 122 | 124 | 66 | 74 | 125 | 125 |
| MAIN STEAM FLOW | KG/S | 61 | 62 | 59 | 88 | 112 | 113 | 112 | 114 | 112 | 112 | 59 | 57 | 114 | 113 |
| EXCESS AIR ECON. OUTLET | % | 35.5 | 17.5 | 58.9 | 12.6 | 22.7 | 11.7 | 30.8 | 21.5 | 13.0 | 26.0 | 32.7 | 51.2 | 20.7 | 24.3 |
| THEO. AIR TO FUEL FIRING ZONE | % | 130.6 | 117.1 | 151.3 | 109.2 | 117.9 | 107.2 | 125.3 | 116.9 | 108.5 | 120.8 | 128.0 | 144.1 | 115.7 | 119.2 |
| FUEL ELEVATIONS IN SERVICE | | ABC | ABC | ABC | ABC | ALL | ALL | ALL | ALL | ALL | ALL | ABC | ABC | ALL | ALL |
| FUEL NOZZLE TILT | DEG | +3 | +7 | +3 | +8 | +3 | 0 | 0 | +8 | -22 | -22 | 0 | 0 | -22 | -22 |
| NOZZLE COMPARTMENT DAMPER POSITION % OPEN: AUX | | 20 | 0 | 50 | 30 | 60 | 100 | 100 | 60 | 100 | 100 | 20 | 50 | 100 | 100 |
| FUEL | | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| AUX | | 20 | 0 | 50 | 60 | 100 | 100 | 100 | 100 | 100 | 100 | 20 | 50 | 100 | 100 |
| FUEL | | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| AUX/AUX | | 20/20 | 20/10 | 50/50 | 80/80 | 100/100 | 100/100 | 100/100 | 100/100 | 100/100 | 100/100 | 20/20 | 50/50 | 100/100 | 100/100 |
| FUEL | | 30 | 30 | 30 | 20 | 20 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| AUX | | 20 | 10 | 50 | 50 | 100 | 100 | 100 | 100 | 100 | 100 | 20 | 50 | 100 | 100 |
| FUEL | | 0 | 0 | 0 | 0 | 20 | 30 | 30 | 30 | 30 | 30 | 0 | 0 | 30 | 30 |
| AUX | | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 100 | 100 |
| SHO TEMPERATURE | °C | 529 | 498 | 548 | 500 | 539 | 539 | 538 | 548 | 533 | 544 | 518 | 548 | 539 | 543 |
| RHO TEMPERATURE | °C | 488 | 446 | 517 | 499 | 514 | 524 | 524 | 533 | 510 | 531 | 476 | 508 | 522 | 529 |
| UNIT EFFICIENCY | % | 88.3 | 88.2 | 87.6 | 89.3 | 89.0 | 89.1 | 89.5 | 89.6 | 89.6 | 89.6 | 88.3 | 87.9 | 89.2 | 89.3 |
| GAS WT. ENT. A.H. | KG/S | 97.8 | 100.0 | 114.4 | 107.2 | 153.9 | 160.6 | 164.4 | 157.5 | 139.4 | 156.9 | 89.7 | 102.5 | 154.4 | 157.5 |
| $NO_x$ | PPM-0% $O_2$ | 631 | 489 | 718 | 429 | 494 | 357 | 664 | 421 | 361 | 581 | 536 | 658 | 499 | 586 |
| $NO_x$ | NG/J | 319.3 | 246.0 | 362.8 | 214.0 | 248.6 | 181.8 | 335.1 | 213.5 | 178.6 | 286.1 | 267.0 | 327.2 | 247.7 | 292.6 |
| $SO_2$ | PPM-0% $O_2$ | 2298 | 2318 | 1644 | 1635 | 1641 | 1434 | 1455 | 1171 | 2052 | 2179 | 2348 | 2164 | 1917 | 1370 |
| $SO_2$ | NG/J | 1617.0 | 1622.7 | 1156.3 | 1139.1 | 1150.0 | 1016.1 | 1021.8 | 825.9 | 1414.4 | 1493.0 | 1629.2 | 1496.8 | 1322.7 | 951.8 |
| CO | PPM-0% $O_2$ | 24 | 142 | 8 | 39 | 31 | 153 | 33 | 46 | 432 | 5 | 298 | 220 | 41 | 34 |
| CO | NG/J | 7.5 | 43.5 | 24.8 | 11.9 | 9.6 | 47.3 | 10.1 | 14.1 | 130.2 | 1.6 | 90.3 | 66.9 | 12.4 | 10.3 |
| HC | PPM-0% $O_2$ | 0.144 | 0.160 | 0.0 | 0.0 | 0.509 | 0.0 | 0.0 | 0.61 | 0.128 | 1.54 | 0.0 | 0.0 | 0.513 | 0.397 |
| $O_2$ | % AH IN | 5.6 | 3.2 | 7.9 | 2.4 | 4.0 | 2.3 | 5.0 | 3.8 | 2.5 | 4.4 | 5.3 | 7.2 | 3.7 | 4.2 |
| $O_2$ | % AH OUT | 7.3 | 5.6 | 9.1 | 5.1 | 6.2 | 4.6 | 6.9 | 5.3 | 4.6 | 6.6 | 7.0 | 8.6 | 6.0 | 6.4 |
| CARBON LOSS IN FLYASH | % | 0.29 | 0.97 | 0.17 | 0.96 | 0.48 | 0.57 | 0.20 | 0.16 | 0.27 | 0.05 | 0.58 | 0.20 | 0.17 | 0.10 |

# $NO_x$ TEST DATA SUMMARY

## BIASED FIRING STUDY


| TEST NO. | | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | ← BIASED FIRING - 1 FUEL ELEV. OUT OF SERVICE - AIR DAMPERS OPEN → | | | | | | | | | |
| | | 1/2 | 3/4 | ← MAX. LOAD → | | | | 3/4 | ← 1/2 LOAD → | | |
| DATE | | 1/19/74 | 1/18/74 | 12/3/73 | 12/4/73 | 12/5/73 | 12/6/73 | 1/18/74 | 1/19/74 | 1/19/74 | 1/19/74 |
| LOAD | MW | 66 | 96 | 100 | 103 | 99 | 102 | 94 | 64 | 64 | 66 |
| MAIN STEAM FLOW | KG/S | 55 | 82 | 87 | 89 | 89 | 87 | 86 | 58 | 59 | 56 |
| EXCESS AIR ECON. OUT | % | 50.1 | 26.7 | 21.1 | 22.2 | 21.8 | 24.2 | 29.0 | 48.0 | 47.0 | 47.0 |
| THEO. AIR TO FUEL FIRING ZONE | % | 105.8 | 121.7 | 116.5 | 117.5 | 117.2 | 94.7 | 97.3 | 112.5 | 141.4 | 141.3 |
| FUEL ELEVATIONS IN SERVICE | | ABC | ABC | ABC | ABD | ACD | BCD | BCD | BCD | ACD | ABD |
| FUEL NOZZLE TILT | DEG | -9 | 0 | -15 | -15 | -10 | -5 | +10 | 0 | 0 | -15 |
| NOZZLE COMPARTMENT DAMPER POSITION % OPEN — AUX | | 50 | 50 | 50 | 50 | 50 | 100 | 100 | 100 | 50 | 50 |
| "A" FUEL | | 20 | 20 | 30 | 30 | 30 | 100 | 100 | 100 | 20 | 20 |
| AUX | | 50 | 50 | 50 | 50 | 100 | 50 | 50 | 50 | 100 | 50 |
| "B" FUEL | | 20 | 20 | 30 | 30 | 100 | 30 | 20 | 20 | 100 | 20 |
| AUX/AUX | | 50/50 | 50/50 | 50/50 | 50/100 | 50/50 | 50/50 | 50/50 | 50/50 | 50/50 | 50/100 |
| "C" FUEL | | 20 | 20 | 30 | 100 | 30 | 30 | 20 | 20 | 20 | 100 |
| AUX | | 50 | 50 | 50 | 50 | 50 | 50 | ·50 | 50 | 50 | 50 |
| "D" FUEL | | 100 | 100 | 100 | 30 | 30 | 30 | 20 | 20 | 20 | 20 |
| AUX | | 100 | 100 | 100 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| SHO TEMPERATURE | °C | 546 | 539 | 529 | 543 | 523 | 544 | 512 | 501 | 507 | 544 |
| RHO TEMPERATURE | °C | 496 | 506 | 501 | 520 | 486 | 515 | 469 | 448 | 454 | 513 |
| UNIT EFFICIENCY | % | 87.9 | 89.3 | 89.1 | 89.3 | 88.9 | 88.8 | 89.6 | 87.8 | 87.9 | 87.7 |
| GAS WT. ENTERING AH | KG/S | 94.7 | 119.4 | 121.9 | 126.4 | 118.9 | 125.3 | 120.8 | 100.0 | 100.3 | 98.9 |
| $NO_x$ | PPM-0% $O_2$ | 594 | 543 | 397 | 373 | 387 | 285 | 331 | 520 | 485 | 609 |
| $NO_2$ | NG/J | 288.0 | 272.8 | 200.6 | 189.2 | 189.9 | 143.1 | 166.2 | 268.5 | 249.1 | 306.2 |
| $SO_2$ | PPM-0% $O_2$ | 1721 | 1682 | 2422 | 2553 | 2292 | 2277 | 1566 | 1861 | 2245 | 1807 |
| $SO_2$ | UG/J | 1161.0 | 1175.6 | 1704.6 | 1799.9 | 1562.8 | 1591.0 | 1093.4 | 1335.9 | 1602.7 | 1263.0 |
| CO | PPM-0% $O_2$ | 33 | 29 | 46 | 38 | 35 | 27 | 31 | 29 | 22 | 28 |
| CO | NG/J | 9.8 | 8.9 | 14.0 | 11.9 | 10.6 | 8.1 | 9.5 | 9.1 | 7.0 | 8.4 |
| HC | PPM-0% $O_2$ | 0.0 | 0.0 | 0.0 | 0.012 | 0.012 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $O_2$ | % AH IN | 7.1 | 4.5 | 3.7 | 3.9 | 3.8 | 4.2 | 4.8 | 6.9 | 6.8 | 6.8 |
| $O_2$ | % AH OUT | 8.5 | 7.2 | 6.1 | 5.8 | 6.3 | 7.3 | 8.4 | 8.4 | 8.6 | 6.9 |
| CARBON LOSS IN FLYASH | % | 0.32 | 0.34 | 0.46 | 0.37 | 0.42 | 0.25 | 0.30 | 0.20 | 0.11 | 0.21 |

ALABAMA POWER COMPANY
BARRY #2

# $NO_x$ TEST DATA SUMMARY

C-E POWER SYSTEMS
FIELD TESTING AND
PERFORMANCE RESULTS

## BASELINE STUDY AFTER MODIFICATION

| TEST NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | ← EXCESS AIR VARIATION - CLEAN FURN. → | | | | | | | ← EA VAR. - MOD. DIRTY → | | | ← EA VAR. - DIRTY FURN. → | | | |
| | | ← 1/2 LOAD → | | | 3/4 | ← MAXIMUM LOAD → | | | | | | ← 1/2 LOAD → | | ← MAX LOAD → | |
| DATE | | 6/25/74 | 6/25/74 | 6/25/74 | 6/27/74 | 6/19/74 | 6/27/74 | 6/27/74 | 6/20/74 | 6/20/74 | 6/28/74 | 6/26/74 | 6/26/74 | 6/28/74 | 6/28/74 |
| LOAD | MW | 62 | 62 | 64 | 92 | 131 | 127 | 125 | 130 | 129 | 125 | 65 | 68 | 126 | 125 |
| MAIN STEAM FLOW | KG/SEC | 61 | 59 | 60 | 87 | 125 | 122 | 117 | 122 | 124 | 119 | 68 | 61 | 120 | 118 |
| EXCESS AIR ECON. OUTLET | % | 33.5 | 16.0 | 64.7 | 15.5 | 21.0 | 12.4 | 25.4 | 17.8 | 12.1 | 26.6 | 30.9 | 63.1 | 22.0 | 25.9 |
| THEO. AIR TO FUEL FIRING ZONE | % | 127.1 | 113.4 | 155.4 | 111.0 | 115.3 | 107.1 | 119.5 | 112.3 | 106.9 | 120.5 | 124.6 | 154.0 | 116.2 | 119.9 |
| FUEL ELEV. IN SERVICE | | ABC | ABC | ABC | ABC | ALL | ALL | ALL | ALL | ALL | ALL | ABC | ABC | ALL | ALL |
| OFA NOZZLE TILT | DEG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FUEL NOZZLE TILT | DEG | 3 | 6 | -14 | 2 | -13 | -3 | -22 | -21 | -17 | -16 | -16 | -16 | -6 | -6 |
| NOZZLE COMP. DAMPER POSITION % OPEN: OFA | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OFA | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AUX | | 20 | 0 | 50 | 30 | 80 | 100 | 100 | 80 | 80 | 100 | 20 | 50 | 100 | 100 |
| "A" FUEL | | 30 | 30 | 30 | 20 | 30 | 30 | 35 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| AUX | | 20 | 0 | 50 | 60 | 100 | 100 | 100 | 100 | 100 | 100 | 20 | 50 | 100 | 100 |
| "B" FUEL | | 30 | 30 | 30 | 20 | 30 | 30 | 35 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| AUX/AUX | | 20/20 | 10/10 | 50/50 | 80/80 | 100/100 | 100/100 | 100/100 | 100/100 | 100/100 | 100/100 | 20/20 | 50/50 | 100/100 | 100/100 |
| "C" FUEL | | 30 | 30 | 30 | 20 | 30 | 30 | 35 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| AUX | | 20 | 10 | 50 | 50 | 100 | 100 | 100 | 100 | 100 | 100 | 20 | 50 | 100 | 100 |
| "D" FUEL | | 0 | 0 | 0 | 0 | 30 | 30 | 35 | 30 | 30 | 30 | 0 | 0 | 30 | 30 |
| AUX | | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 0 | 0 | 100 | 100 |
| SHO TEMPERATURE | °C | 492 | 468 | 536 | 504 | 528 | 524 | 518 | 526 | 528 | 524 | 507 | 531 | 524 | 529 |
| RHO TEMPERATURE | °C | 435 | 402 | 499 | 466 | 488 | 487 | 480 | 486 | 483 | 480 | 457 | 498 | 496 | 499 |
| UNIT EFFICIENCY | % | 88.4 | 88.8 | 87.4 | 89.8 | 88.4 | 89.2 | 89.5 | 89.0 | 88.9 | 89.5 | 89.3 | 88.0 | 89.0 | 89.4 |
| GAS WT. ENT. AIR HTR. | KG/SEC | 93 | 75 | 115 | 111 | 165 | 152 | 155 | 157 | 151 | 162 | 101 | 116 | 160 | 162 |
| $NO_x$ | PPM-0% $O_2$ | 444 | 335 | 640 | 327 | 404 | 330 | 477 | 470 | 334 | 431 | 373 | 626 | 391 | 431 |
| $NO_2$ | NG/J | 221.9 | 167.4 | 319.8 | 163.4 | 202.1 | 165.3 | 238.8 | 235.3 | 167.0 | 215.4 | 186.8 | 312.9 | 195.6 | 215.4 |
| $SO_2$ | PPM-0% $O_2$ | 3678 | 3621 | 2611 | 2634 | 2251 | 2677 | 2707 | 1941 | 2482 | 2500 | 2558 | 2461 | 2564 | 2629 |
| $SO_2$ | UG/J | 256.0 | 252.0 | 181.7 | 183.3 | 156.7 | 186.3 | 188.4 | 135.1 | 172.7 | 174.0 | 178.0 | 171.3 | 178.4 | 183.0 |
| CO | PPM-0% $O_2$ | 28 | 376 | 35 | 110 | 26 | 127 | 22 | 24 | 97 | 24 | 26 | 24 | 23 | 23 |
| CO | NG/J | 8.4 | 114.4 | 10.6 | 33.4 | 8.0 | 38.7 | 6.6 | 7.4 | 29.6 | 7.2 | 8.0 | 7.3 | 7.1 | 7.0 |
| HC | PPM-0% $O_2$ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $O_2$ | % AH IN | 5.4 | 3.0 | 8.4 | 2.9 | 3.7 | 2.4 | 4.3 | 3.2 | 2.3 | 4.5 | 5.0 | 8.2 | 3.9 | 4.4 |
| $O_2$ | % AH OUT | 7.4 | 5.5 | 9.7 | 5.5 | 7.4 | 5.8 | 7.0 | 6.8 | 6.2 | 7.5 | 7.6 | 10.8 | 7.3 | 7.2 |
| CARBON LOSS IN FLY ASH | % | 0.29 | 0.23 | 1.06 | 0.11 | 0.75 | 0.51 | 0.74 | 0.22 | 0.42 | 0.61 | 0.17 | 0.05 | 0.36 | 0.25 |

# $NO_x$ TEST DATA SUMMARY

## OFA LOCATION, RATE AND VELOCITY VARIATION


| TEST NO. | | 15 | 16 | 17 | 18A | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE OF TEST | | OFA DAMPER POSITION VARIATION; 3/4 LOAD | | | | | | | | |
| DATE | | 7/10/74 | 7/10/74 | 7/10/74 | 7/12/74 | 7/11/74 | 7/11/74 | 7/12/74 | 7/12/74 | 7/12/74 |
| LOAD | MW | 97 | 98 | 100 | 100 | 100 | 100 | 102 | 102 | 102 |
| MAIN STEAM FLOW | KG/SEC | 93 | 94 | 94 | 96 | 94 | 96 | 95 | 95 | 96 |
| EXCESS AIR ECON. OUT | % | 28.5 | 27.1 | 25.6 | 26.6 | 24.8 | 25.4 | 25.4 | 27.9 | 28.1 |
| THEO. AIR TO FUEL FIRING ZONE | % | 114.5 | 96.7 | 95.8 | 84.8 | 89.3 | 100.5 | 117.4 | 90.4 | 96.9 |
| FUEL ELEVATIONS IN SERVICE | | BCD | BCD | BCD | BCD | BCD | BCD | ABC | ABC | ABC |
| OFA NOZZLE TILT | DEG | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| FUEL NOZZLE TILT | DEG | -5 | -5 | -5 | -4 | -4 | -4 | -4 | -4 | -4 |
| OFA | | 0 | 100 | 0 | 100 | 50 | 0 | 0 | 100 | 50 |
| OFA | | 0 | 0 | 100 | 100 | 50 | 0 | 0 | 100 | 50 |
| AUX | | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 100 | 50 |
| FUEL | | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 50 |
| AUX | | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| FUEL | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| AUX/AUX | | 50/50 | 50/50 | 50/50 | 50/50 | 50/50 | 50/50 | 50/50 | 50/50 | 50/50 |
| FUEL | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| AUX | | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| FUEL | | 30 | 30 | 30 | 30 | 30 | 30 | 0 | 0 | 0 |
| AUX | | 50 | 50 | 50 | 50 | 50 | 50 | 0 | 0 | 0 |
| SHO TEMPERATURE | °C | 518 | 510 | 514 | 524 | 521 | 524 | 532 | 524 | 521 |
| RHO TEMPERATURE | °C | 457 | 452 | 457 | 476 | 486 | 479 | 498 | 491 | 485 |
| UNIT EFFICIENCY | % | 90.0 | 89.8 | 89.7 | 89.6 | 89.3 | 90.2 | 90.1 | 89.0 | 89.1 |
| GAS WT. ENT. AH | KG/SEC | 127 | 124 | 123 | 129 | 130 | 130 | 132 | 137 | 137 |
| $NO_x$ | PPM-0% $O_2$ | 345 | 254 | 254 | 229 | 232 | 323 | 483 | 329 | 336 |
| $NO_2$ | NG/J | 178.7 | 127.3 | 127.3 | 114.4 | 116.1 | 161.7 | 241.7 | 164.6 | 168.1 |
| $SO_2$ | PPM-0% $O_2$ | 1892 | 1973 | 2092 | 2391 | 2684 | 1821 | 1814 | 2259 | 2417 |
| $SO_2$ | UG/J | 131.6 | 137.3 | 145.6 | 166.8 | 186.8 | 126.8 | 126.2 | 157.2 | 168.2 |
| CO | PPM-0% $O_2$ | 28 | 30 | 32 | 48 | 39 | 29 | 25 | 26 | 25 |
| CO | NG/J | 8.6 | 9.1 | 9.9 | 14.6 | 11.9 | 8.8 | 7.7 | 7.8 | 7.7 |
| HC | PPM-0% $O_2$ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $O_2$ | % AH IN | 4.7 | 4.6 | 4.4 | 4.5 | 4.3 | 4.3 | 4.3 | 4.7 | 4.7 |
| $O_2$ | % AH OUT | 6.5 | 6.5 | 6.1 | 6.3 | 6.1 | 6.1 | 6.1 | 6.5 | 6.7 |
| CARBON LOSS IN FLY ASH | % | 0.51 | 0.59 | 0.63 | 0.54 | 0.32 | 0.49 | 0.46 | 0.54 | 0.60 |

ALABAMA POWER COMPANY
BARRY #2

C-E POWER SYSTEMS
FIELD TESTING AND
PERFORMANCE RESULTS

# $NO_x$ TEST DATA SUMMARY

## OFA TILT AND LOAD VARIATION


| TEST NO. | | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Purpose of Test | | ← OFA & FUEL NOZZLE TILT VARIATION — FULL LOAD → | | | | | | ← LOAD VARIATION AT OPTIMUM COND. → MAX | 3/4 | 1/2 | MAX | 3/4 | 1/2 |
| Date | | 7/29/74 | 7/29/74 | 7/29/74 | 7/29/74 | 7/29/74 | 7/29/74 | 7/30/74 | 7/31/74 | 7/31/74 | 7/31/74 | 7/31/74 | 8/1/74 |
| Load | MW | 124 | 124 | 124 | 125 | 125 | 124 | 125 | 97 | 65 | 122 | 95 | 64 |
| Main Steam Flow | kg/s | 113 | 116 | 114 | 113 | 115 | 116 | 116 | 87 | 57 | 114 | 86 | 57 |
| Excess Air Econ. Out | % | 25.9 | 23.7 | 25.1 | 22.3 | 20.2 | 23.7 | 21.6 | 25.2 | 46.9 | 27.4 | 27.4 | 45.9 |
| Theo. Air to Fuel Firing Zone | % | 94.2 | 92.4 | 93.2 | 94.5 | 89.6 | 92.6 | 90.7 | 89.4 | 88.5 | 94.6 | 90.6 | 88.5 |
| Fuel Elevations in Service | | ALL | ALL | ALL | ALL | ALL | ALL | ALL | ABC | AB | ALL | ABC | AB |
| OFA Nozzle Tilt | DEG | 0 | 0 | 0 | -30 | -30 | +30 | 0 | -12 | 0 | -22 | -22 | -10 |
| Fuel Nozzle Tilt | DEG | -5 | -23 | +19 | -5 | +22 | -21 | -4 | -16 | -5 | -22 | -22 | -15 |
| Nozzle Compartment Damper Position % Open — OFA | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| OFA | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| FUEL ("A") | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| AUX | | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| FUEL ("B") | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| AUX/AUX | | 50/50 | 50/50 | 50/50 | 50/50 | 50/50 | 50/50 | 50/50 | 50/50 | 50/0 | 50/50 | 50/50 | 50/50 |
| FUEL ("C") | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 0 | 30 | 30 | 0 |
| AUX | | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 0 | 50 | 50 | 0 |
| FUEL ("D") | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 0 | 0 | 30 | 0 | 0 |
| AUX | | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 0 | 0 | 50 | 0 | 0 |
| SHO Temperature | °C | 538 | 521 | 524 | 527 | 524 | 521 | 538 | 525 | 535 | 521 | 506 | 512 |
| RHO Temperature | °C | 532 | 508 | 527 | 533 | 535 | 505 | 536 | 514 | 514 | 521 | 493 | 493 |
| Unit Efficiency | % | 89.6 | 89.3 | 88.9 | 89.3 | 88.6 | 89.4 | 89.0 | 89.1 | 89.2 | 89.0 | 88.2 | 89.0 |
| Gas Wt. Entering AH | kg/s | 152 | 157 | 163 | 155 | 163 | 151 | 159 | 127 | 95 | 162 | 131 | 91 |
| $NO_x$ | PPM-0% $O_2$ | 339 | 290 | 368 | 344 | 404 | 285 | 339 | 338 | 396 | 333 | 291 | 313 |
| $NO_x$ | ng/J | 169.6 | 145.5 | 183.9 | 172.2 | 202.1 | 142.4 | 169.6 | 169.1 | 197.8 | 166.5 | 145.2 | 156.4 |
| $SO_2$ | PPM-0% $O_2$ | 2450 | 2920 | 3310 | 3160 | 3370 | 3240 | 1680 | 1730 | 1740 | 2430 | 2490 | 2420 |
| $SO_2$ | ug/J | 170.5 | 203.3 | 230.4 | 219.9 | 234.5 | 225.5 | 116.9 | 120.5 | 121.1 | 169.2 | 173.3 | 166.2 |
| CO | PPM-0% $O_2$ | 25 | 27 | 32 | 22 | 28 | 49 | 26 | 26 | 24 | 25 | 26 | 25 |
| CO | ng/J | 7.7 | 8.3 | 9.7 | 6.7 | 8.6 | 15.0 | 8.0 | 8.0 | 7.4 | 7.5 | 8.0 | 7.6 |
| HC | PPM-0% $O_2$ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $O_2$ | % AH In | 4.4 | 4.1 | 4.3 | 3.9 | 3.6 | 4.1 | 3.8 | 4.3 | 6.8 | 4.6 | 4.6 | 6.7 |
| $O_2$ | % AH Out | 5.9 | 6.0 | 6.2 | 6.0 | 5.8 | 6.4 | 5.3 | 5.7 | 8.2 | 6.3 | 6.8 | 8.4 |
| Carbon Loss in Fly Ash | % | 0.37 | 0.37 | 0.40 | 0.29 | 0.29 | 0.49 | 0.61 | 0.39 | 0.32 | 0.24 | 0.33 | 0.15 |

# WATERWALL ABSORPTION RATES, KG-CAL/HR-CM$^2$

## RIGHT WALL CENTERLINE TUBE RATES

| TC # / ELEVATION | 1<br>118'-6" | 3<br>107'-6" | 5<br>96'-6" | 7<br>85'-6" | 9<br>74'-6" | 19<br>69'-6" | 22<br>64'-7" | 44<br>59'-7" | 47<br>54'-9" | 57<br>49'-11" | 60<br>45'-7" | 62<br>35'-7" | 64<br>25'-7" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEST 1 | 2.02 | 3.56 | 7.49 | 8.81 | 10.93 | 9.07 | 1.28 | --- | --- | 8.54 | 4.08 | 3.30 | --- |
| 2 | 2.36 | 3.64 | 8.63 | 12.07 | 13.13 | 9.95 | .86 | --- | --- | 6.51 | 5.99 | 3.12 | --- |
| 3 | 1.33 | 2.85 | 5.18 | 7.02 | 8.08 | 7.55 | .83 | --- | --- | 9.66 | 9.93 | 4.13 | --- |
| 4 | 3.01 | 5.36 | 12.23 | 1.25 | 2.76 | 14.88 | 5.10 | --- | --- | 13.29 | 7.73 | 4.31 | --- |
| 5 | 3.78 | 7.19 | 10.90 | 10.90 | 22.55 | 7.46 | 6.93 | --- | --- | 18.85 | 20.96 | 12.49 | --- |
| 6 | 4.41 | 7.30 | 13.66 | 1.83 | 3.37 | 16.04 | 7.83 | --- | --- | 20.81 | 14.45 | 10.21 | --- |
| 7 | 3.73 | 5.04 | 10.06 | 1.19 | 2.18 | 7.67 | 8.73 | 12.18 | --- | 27.78 | 11.38 | 14.56 | --- |
| 8 | 4.59 | 8.28 | 11.45 | 8.54 | 21.78 | 5.11 | 4.06 | --- | --- | 10.13 | 13.04 | 15.70 | --- |
| 9 | 6.26 | 9.96 | 14.99 | 15.52 | 23.46 | 15.52 | 6.26 | --- | --- | 8.63 | 12.34 | 15.26 | --- |
| 10 | 5.14 | 5.66 | 12.27 | 7.51 | 6.45 | 10.15 | 9.36 | --- | --- | 24.18 | 6.98 | 12.80 | --- |
| 11 | 4.16 | 4.95 | 6.26 | 6.79 | 6.53 | 4.43 | 6.00 | --- | --- | 11.56 | 6.53 | 6.53 | --- |
| 12 | 4.15 | 5.46 | 6.51 | 6.51 | 5.98 | 5.72 | 5.72 | --- | --- | 11.53 | 7.56 | 7.83 | --- |
| 13 | 4.95 | 6.53 | 13.14 | 9.96 | 13.94 | 17.38 | 15.00 | --- | --- | 25.05 | 10.76 | 12.61 | --- |
| 14 | 4.44 | 4.96 | 11.30 | 9.97 | 17.66 | 14.74 | 15.01 | --- | --- | 24.00 | 15.28 | 12.62 | --- |
| 15 | 4.12 | 5.17 | 9.66 | .37 | 3.34 | 7.80 | 13.36 | --- | --- | 3.34 | 10.71 | 10.98 | --- |
| 16 | 5.25 | 5.77 | 8.15 | 2.38 | 7.62 | 10.26 | 12.38 | --- | --- | 3.42 | 8.68 | 9.47 | --- |
| 17 | 6.47 | 7.26 | 9.90 | 3.33 | 6.99 | 10.96 | 13.61 | --- | --- | 3.84 | 10.70 | 12.55 | --- |
| 18 | 3.61 | 4.91 | 9.92 | .16 | 13.37 | 13.37 | 10.45 | --- | --- | 18.67 | 17.34 | 8.07 | --- |
| 19 | 4.39 | 5.44 | 10.19 | 2.32 | 4.65 | 9.40 | 5.17 | --- | --- | 14.43 | 9.92 | 10.45 | --- |
| 20 | 3.14 | 5.23 | 10.24 | .64 | 4.18 | 2.63 | 12.1 | --- | --- | 20.58 | 18.20 | 9.72 | --- |
| 21 | 4.00 | 5.31 | 12.45 | .49 | 2.71 | 2.20 | 12.98 | --- | --- | 15.10 | 10.33 | 4.53 | --- |
| 22 | 3.49 | 5.32 | 11.40 | 1.46 | 2.46 | 1.96 | 11.93 | --- | --- | 15.11 | 9.81 | 3.24 | --- |
| 23 | 2.67 | 5.00 | 11.87 | .91 | 2.67 | 1.90 | 11.87 | --- | --- | 15.32 | 10.02 | 3.70 | --- |
| 24 | 4.76 | 5.28 | 12.68 | 9.24 | 7.92 | 3.98 | 8.18 | --- | --- | 23.80 | 12.68 | 7.92 | --- |
| 25 | 3.00 | 5.08 | 10.63 | 6.66 | 6.13 | 2.48 | 11.95 | --- | --- | 32.55 | 20.43 | 13.01 | --- |
| 26 | 4.61 | 6.71 | 14.66 | 13.07 | 19.69 | 2.80 | 12.80 | --- | --- | 15.45 | 10.15 | 4.35 | --- |
| 27 | 4.22 | 6.32 | 8.43 | 10.02 | 15.85 | 10.81 | 11.34 | --- | --- | 18.76 | 15.05 | 12.40 | --- |
| 28 | 7.16 | 8.22 | 11.93 | 14.04 | 17.22 | 11.66 | 12.72 | --- | --- | 13.25 | 11.93 | 7.43 | --- |
| 29 | 5.42 | 7.80 | 8.32 | 9.91 | 11.24 | 9.91 | 12.03 | --- | --- | 27.63 | 17.33 | 17.86 | --- |
| 30 | 7.55 | 9.14 | 9.93 | 8.08 | 3.87 | 6.23 | 9.14 | --- | --- | 4.65 | 7.02 | 8.34 | --- |
| 31 | 7.07 | 7.60 | 8.65 | 6.80 | 7.07 | 11.56 | 7.07 | --- | --- | 18.98 | 16.07 | 9.98 | --- |
| 32 | 5.21 | 6.00 | 7.05 | 6.00 | 5.47 | 8.90 | 4.42 | --- | --- | 14.73 | 12.87 | 7.05 | --- |
| 33 | 7.27 | 7.53 | 7.80 | 7.80 | 7.27 | 11.24 | 14.15 | --- | --- | 24.47 | 14.95 | 16.54 | --- |
| 34 | 7.52 | 7.52 | 8.84 | 8.05 | 8.05 | 9.37 | 11.22 | --- | --- | 15.47 | 13.35 | 14.14 | --- |
| 35 | 6.60 | 5.81 | 6.60 | 6.33 | 6.33 | 8.18 | 7.92 | --- | --- | 10.56 | 17.45 | 7.92 | --- |

# WATERWALL ABSORPTION RATES, KG-CAL/HR-CM$^2$

## FRONT WALL CENTERLINE TUBE RATES

| TC # | 2 | 4 | 6 | 8 | 13 | 38 | 51 | 61 | 63 |
|---|---|---|---|---|---|---|---|---|---|
| ELEVATION | 107'-6" | 96'-6" | 85'-6" | 74'-6" | 69'-6" | 59'-7" | 49'-11" | 35'-7" | 25'-7" |
| TEST 1 | 6.44 | 7.49 | 11.99 | 18.08 | 10.93 | ---- | 10.13 | 3.04 | 2.52 |
| 2 | 6.78 | 8.89 | 14.72 | 16.31 | 11.01 | --- | 8.89 | 2.88 | 2.36 |
| 3 | 5.18 | 4.92 | 7.55 | 8.08 | 8.61 | --- | 13.11 | 4.66 | 1.33 |
| 4 | 10.11 | 11.96 | 7.46 | 24.67 | 9.84 | --- | 14.62 | 4.05 | 3.01 |
| 5 | 11.16 | 9.57 | 10.37 | 24.92 | 10.10 | --- | 19.11 | 12.75 | 7.46 |
| 6 | 12.33 | 12.60 | 18.69 | 27.14 | 12.86 | --- | 20.28 | 13.39 | 4.67 |
| 7 | 9.26 | 8.47 | 12.44 | 10.85 | 6.35 | --- | 23.56 | 18.55 | 9.53 |
| 8 | 10.92 | 7.48 | 10.66 | 22.31 | 16.76 | --- | 7.22 | 15.70 | 9.60 |
| 9 | 13.67 | 9.96 | 10.48 | 25.83 | 14.20 | --- | 7.05 | 17.38 | 7.84 |
| 10 | 11.48 | 4.61 | 15.98 | 14.92 | 7.24 | --- | 5.40 | 15.72 | 5.66 |
| 11 | 5.21 | 4.95 | 6.79 | 6.53 | 4.95 | --- | 7.85 | 6.26 | 6.26 |
| 12 | 5.46 | 5.72 | 6.77 | 6.25 | 5.46 | --- | 8.88 | 8.09 | 7.56 |
| 13 | 12.88 | 6.26 | 7.84 | 11.56 | 6.79 | --- | 7.58 | 14.47 | 5.21 |
| 14 | 10.77 | 4.96 | 8.39 | 11.56 | 5.48 | --- | 12.36 | 14.74 | 5.22 |
| 15 | 8.07 | 5.17 | 14.16 | 11.77 | 2.57 | --- | 2.32 | 18.13 | 6.22 |
| 16 | 7.62 | 5.77 | 10.79 | 15.83 | 4.46 | --- | 2.92 | 15.83 | 7.62 |
| 17 | 8.05 | 6.99 | 12.29 | 14.41 | 5.68 | --- | 4.63 | 16.26 | 9.37 |
| 18 | 8.07 | 5.17 | 14.16 | 11.25 | 7.28 | --- | 10.19 | 9.92 | 6.49 |
| 19 | 9.13 | 4.91 | 12.84 | 6.22 | 8.86 | --- | 9.66 | 10.98 | 5.44 |
| 20 | 8.66 | 9.98 | 11.30 | 22.69 | 9.98 | --- | 9.19 | 16.07 | 4.97 |
| 21 | 10.33 | 11.39 | 17.22 | 21.98 | 8.48 | --- | 3.23 | 5.58 | 3.48 |
| 22 | 10.34 | 10.07 | 18.29 | 15.90 | 4.80 | --- | 2.21 | 4.80 | 2.45 |
| 23 | 10.02 | 7.64 | 16.91 | 19.02 | 13.46 | --- | 2.40 | 5.00 | 2.67 |
| 24 | 10.56 | 8.18 | 9.51 | 15.07 | 6.34 | --- | 16.40 | 12.95 | 5.02 |
| 25 | 10.10 | 8.24 | 6.66 | 15.66 | 10.10 | --- | 19.64 | 20.43 | 9.57 |
| 26 | 12.27 | 10.68 | 19.96 | 19.96 | 7.51 | --- | 12.80 | 5.40 | 4.35 |
| 27 | 9.22 | 7.64 | 14.26 | 8.16 | 7.11 | --- | 8.69 | 14.26 | 3.44 |
| 28 | 9.54 | 9.81 | 12.99 | 12.19 | 9.54 | --- | 6.11 | 8.75 | 6.90 |
| 29 | 9.91 | 8.06 | 11.24 | 10.18 | 10.44 | --- | 18.92 | 20.77 | 9.38 |
| 30 | 9.66 | 9.66 | 13.38 | 25.81 | 13.90 | --- | 8.61 | 8.87 | 7.55 |
| 31 | 7.86 | 8.12 | 11.56 | 8.12 | 7.60 | --- | 7.33 | 11.56 | 8.12 |
| 32 | 6.00 | 5.21 | 8.10 | 6.26 | 5.21 | --- | 5.21 | 7.84 | 5.73 |
| 33 | 8.85 | 7.00 | 7.00 | 18.66 | 6.48 | --- | 21.57 | 19.98 | 12.56 |
| 34 | 8.31 | 6.99 | 6.99 | 10.96 | 5.68 | --- | 22.08 | 14.94 | 10.43 |
| 35 | 7.12 | 5.81 | 5.54 | 7.39 | 3.20 | --- | 7.92 | 8.18 | 7.65 |

# WATERWALL ABSORPTION RATES, KG-CAL/HR-CM$^2$

| | Right Wall Horizontal Average Tube Rates | | | Rear Wall Horizontal Average Tube Rates | Left Wall Horizontal Average Tube Rates | Front Wall Horizontal Average Tube Rates | | |
|---|---|---|---|---|---|---|---|---|
| TC # | 17-21 | 42-46 | 55-59 | 23-29 | 30-34 | 10-16 | 35-41 | 48-54 |
| Elevation | 69'-8" | 59'-7" | 49'-11" | 59'-7" | 59'-7" | 69'-6" | 59'-7" | 49'-11" |
| TEST 1 | 8.65 | 9.54 | 8.28 | 5.78 | 11.67 | 11.94 | 10.31 | 8.24 |
| 2 | 9.53 | 9.16 | 5.82 | 4.97 | 12.23 | 12.34 | 11.11 | 6.92 |
| 3 | 7.97 | 9.27 | 9.58 | 4.79 | 10.72 | 8.56 | 8.85 | 11.87 |
| 4 | 13.51 | 11.84 | 7.90 | 6.01 | 10.20 | 13.20 | 15.68 | 9.39 |
| 5 | 5.67 | 9.98 | 10.64 | 12.22 | 17.10 | 16.33 | 17.34 | 18.73 |
| 6 | 14.40 | 15.11 | 16.75 | 8.07 | 14.53 | 17.01 | 17.41 | 12.26 |
| 7 | 7.84 | 11.96 | 18.26 | 8.21 | 9.04 | 10.90 | 16.12 | 17.13 |
| 8 | 3.66 | 7.63 | 7.10 | 9.22 | 14.12 | 13.80 | 20.10 | 20.73 |
| 9 | 7.38 | 10.05 | 6.53 | 14.01 | 14.83 | 16.45 | 18.43 | 17.94 |
| 10 | 8.20 | 16.31 | 15.28 | 12.13 | 19.48 | 14.92 | 18.98 | 13.86 |
| 11 | 4.84 | 5.09 | 9.18 | 9.10 | 4.79 | 6.35 | 7.59 | 7.76 |
| 12 | 5.62 | 5.46 | 9.16 | 8.74 | 6.19 | 5.72 | 6.38 | 8.75 |
| 13 | 10.18 | 14.34 | 15.70 | 13.94 | 16.06 | 12.93 | 17.64 | 13.27 |
| 14 | 8.34 | 15.34 | 17.92 | 14.06 | 16.81 | 13.91 | 18.09 | 13.66 |
| 15 | 9.70 | 11.38 | 9.41 | 10.62 | 18.29 | 10.77 | 15.70 | 8.54 |
| 16 | 11.70 | 10.93 | 12.13 | 10.46 | 18.37 | 12.74 | 16.45 | 9.09 |
| 17 | 13.77 | 10.44 | 11.95 | 10.44 | 16.47 | 13.17 | 16.88 | 10.35 |
| 18 | 7.31 | 12.77 | 16.73 | 6.07 | 14.48 | 10.81 | 17.16 | 16.12 |
| 19 | 6.96 | 4.61 | 8.72 | 7.52 | 7.50 | 9.70 | 14.43 | 9.54 |
| 20 | 2.89 | 9.52 | 13.62 | 6.42 | 7.77 | 10.92 | 16.25 | 9.16 |
| 21 | 2.76 | 10.14 | 13.51 | 5.51 | 13.72 | 15.85 | 18.76 | 8.42 |
| 22 | 2.52 | 9.36 | 13.43 | 6.28 | 14.85 | 13.48 | 17.66 | 7.74 |
| 23 | 3.19 | 10.16 | 13.64 | 6.04 | 15.54 | 19.17 | 17.12 | 12.28 |
| 24 | 12.22 | 12.22 | 8.55 | 9.74 | 15.86 | 11.89 | 16.08 | 9.18 |
| 25 | 9.63 | 14.00 | 22.35 | 9.61 | 14.18 | 12.04 | 16.76 | 13.81 |
| 26 | 10.54 | 12.21 | 10.25 | 7.53 | 14.45 | 14.22 | 13.95 | 10.17 |
| 27 | 10.81 | 12.40 | 14.70 | 8.14 | 13.52 | 9.88 | 10.03 | 8.88 |
| 28 | 12.94 | 14.44 | 12.81 | 9.21 | 17.60 | 13.52 | 14.80 | 7.26 |
| 29 | 11.34 | 16.07 | 20.06 | 12.18 | 12.72 | 12.30 | 16.76 | 17.63 |
| 30 | 9.52 | 10.66 | 4.48 | 12.01 | 11.47 | 14.00 | 16.51 | 10.51 |
| 31 | 7.71 | 10.38 | 17.84 | 10.85 | 8.85 | 7.33 | 16.78 | 9.14 |
| 32 | 6.32 | 7.98 | 14.02 | 8.53 | 9.02 | 5.21 | 14.51 | 8.11 |
| 33 | 10.08 | 17.06 | 18.21 | 10.44 | 10.66 | 8.33 | 16.05 | 16.05 |
| 34 | 8.21 | 14.67 | 13.35 | 9.11 | 9.27 | 8.10 | 13.79 | 16.57 |
| 35 | 7.65 | 10.76 | 10.12 | 9.05 | 9.50 | 7.75 | 9.20 | 9.42 |

# WATERWALL CORROSION COUPON
# DATA SUMMARY

## WEIGHT LOSS EVALUATION

## BASELINE TEST

| Probe Loc. | Probe No. | Coupon No. | Initial Wt. GR. | Final Wt. GR. | Wt. Loss GR. | Wt. Loss/ Coupon $MG/CM^2$ | Avg. Wt. Loss/ Probe $MG/CM^2$ |
|---|---|---|---|---|---|---|---|
| 1 | I | 1 | 199.2937 | 199.1341 | .1596 | 3.1643 | |
| | | 2 | 201.3871 | 201.2135 | .1736 | 3.4418 | 2.9392 |
| | | 3 | 198.3883 | 198.2384 | .1499 | 2.9719 | |
| | | 4 | 195.8045 | 195.6946 | .1099 | 2.1789 | |
| 2 | J | 1 | 199.1977 | 199.0534 | .1443 | 2.8609 | |
| | | 2 | 199.6807 | 199.5009 | .1798 | 3.5647 | 2.8088 |
| | | 3 | 202.8649 | 202.7226 | .1423 | 2.8213 | |
| | | 4 | 202.3445 | 202.2442 | .1003 | 1.9885 | |
| 3 | E | 1 | 199.0122 | 198.8632 | .1490 | 2.9541 | |
| | | 2 | 202.2508 | 202.1171 | .1337 | 2.6507 | 2.13475 |
| | | 3 | 201.9826 | 201.8976 | .0850 | 1.6852 | |
| | | 4 | 199.6584 | 199.5954 | .0630 | 1.249 | |
| 4 | L | 1 | 202.5778 | 202.5080 | .0698 | 1.3838 | |
| | | 2 | 200.8579 | 200.7484 | .1095 | 2.1769 | 1.91965 |
| | | 3 | 202.7075 | 202.5924 | .1151 | 2.282 | |
| | | 4 | 197.7676 | 197.6750 | .0926 | 1.8359 | |
| 5 | K | 1 | 199.5913 | --- | --- | --- | |
| | | 2 | 197.4684 | 197.2730 | .1954 | 3.874 | 3.38826 |
| | | 3 | 194.9513 | 194.7783 | .1730 | 3.4299 | |
| | | 4 | 202.0694 | 201.9251 | .1443 | 2.8609 | |

Avg. Wt. Loss/Test 2.6381 $MG/CM^2$

# WATERWALL CORROSION COUPON DATA SUMMARY

## WEIGHT LOSS EVALUATION

## BIASED FIRING TEST

| Probe Loc. | Probe No. | Coupon No. | Initial Wt. GR. | Final Wt. GR. | Wt. Loss GR. | Wt. Loss/ Coupon MG/CM$^2$ | Avg. Wt. Loss/ Probe MG/CM$^2$ |
|---|---|---|---|---|---|---|---|
| 1 | B | 1 | 197.9531 | 197.6484 | .3047 | 6.0411 | |
| | | 2 | 202.1660 | 201.8659 | .3001 | 5.9499 | 5.8795 |
| | | 3 | 198.3393 | 198.0383 | .3010 | 5.9678 | |
| | | 4 | 200.5603 | 200.2799 | .2804 | 5.5593 | |
| 2 | Q | 1 | 199.3158 | 199.1437 | .1721 | 3.4121 | |
| | | 2 | 196.2751 | 196.0480 | .2271 | 4.5026 | 4.3777 |
| | | 3 | 202.8709 | 202.5541 | .3168 | 6.2810 | |
| | | 4 | 200.2327 | 200.0655 | .1672 | 3.3150 | |
| 3 | R | 1 | 198.8940 | 198.7626 | .1314 | 2.6051 | |
| | | 2 | 199.8790 | 199.6842 | .1948 | 3.8622 | 3.4081 |
| | | 3 | 196.0683 | 195.8721 | .1962 | 3.8899 | |
| | | 4 | 199.3342 | 199.1690 | .1652 | 3.2753 | |
| 4 | M | 1 | 199.5078 | 199.3628 | .1450 | 2.8748 | |
| | | 2 | 198.7039 | 198.4853 | .2186 | 4.3341 | 3.8201 |
| | | 3 | 198.3125 | 198.1121 | .2004 | 3.9732 | |
| | | 4 | 200.8838 | 200.6771 | .2067 | 4.0981 | |
| 5 | D | 1 | 197.9655 | 197.7001 | .2654 | 5.2619 | |
| | | 2 | 202.9412 | 202.5809 | .3603 | 7.1435 | 5.7289 |
| | | 3 | 199.1306 | 198.7976 | .3330 | 6.6022 | |
| | | 4 | 198.2205 | 198.0234 | .1971 | 3.9078 | |

Avg. Wt. Loss/Test 4.6429 MG/CM$^2$

# WATERWALL CORROSION COUPON

# DATA SUMMARY

## WEIGHT LOSS EVALUATION

## OVERFIRE AIR TEST

| Probe Loc. | Probe No. | Coupon No. | Initial Wt. GR. | Final Wt. GR. | Wt. Loss GR. | Wt. Loss/ Coupon MG/CM$^2$ | Avg. Wt. Loss/ Probe MG/CM$^2$ |
|---|---|---|---|---|---|---|---|
| 1 | S | 1 | 200.7678 | 200.5465 | .2213 | 4.3876 | |
| | | 2 | 196.0684 | 195.8121 | .2563 | 5.0815 | 4.5244 |
| | | 3 | 199.6433 | 199.3849 | .2584 | 5.1235 | |
| | | 4 | 197.8187 | 197.6419 | .1768 | 3.5053 | |
| 2 | T | 1 | 200.7026 | 199.1437 | .2802 | 5.5554 | |
| | | 2 | --- | --- | --- | 3.3540 | 3.9044 |
| | | 3 | 593.7075 | 593.2000 | .5075 | 3.3540 | |
| | | 4 | --- | --- | --- | 3.3540 | |
| 3 | F | 1 | 199.1897 | 198.9156 | .2741 | 5.4344 | |
| | | 2 | 199.4476 | 199.1351 | .3125 | 6.1958 | 6.0401 |
| | | 3 | 199.3119 | 198.9858 | .3261 | 6.4654 | |
| | | 4 | 199.0463 | 198.7404 | .3059 | 6.0649 | |
| 4 | N | 1 | 202.8354 | 202.6125 | .2234 | 4.4292 | |
| | | 2 | 201.2249 | 200.9784 | .2465 | 4.8872 | 3.7656 |
| | | 3 | --- | --- | --- | 2.8729 | |
| | | 4 | 397.4898 | 397.2000 | .2898 | 2.8729 | |
| 5 | 2 | 1 | --- | --- | --- | --- | |
| | | 2 | 191.8528 | 191.6484 | .2044 | 4.0525 | 3.9752 |
| | | 3 | 192.7875 | 192.5909 | .1966 | 3.8979 | |
| | | 4 | --- | --- | --- | --- | |

Avg. Wt. Loss/Test 4.4419 MG/CM$^2$

# APPENDIX D

# COMPFLOW
# WINDBOX COMPARTMENT AIR FLOW
# DISTRIBUTION COMPUTER PROGRAM

APPENDIX D

COMPFLOW - WINDBOX

COMPARTMENT AIR FLOW DISTRIBUTION COMPUTER PROGRAM

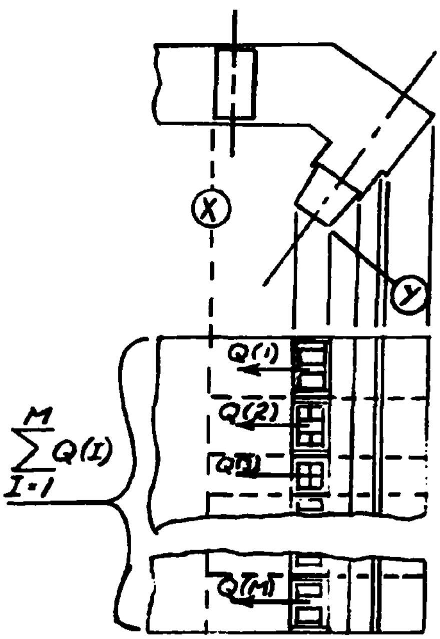
## INTRODUCTION

A description of COMPAIR, a computer program which calculates the windbox assembly air flow distribution, was presented in Reference 1. The program has been subsequently found to be deficient; the approach taken in the calculation of the compartment loss coefficient resulted in operational difficulties in certain cases. The program was revised to eliminate this problem.

The revised program, COMPFLOW, is described herein. The basic assumptions and limitations of the calculation method are outlined and discussed. Program runs for two tests conducted at Barry #2 are included.

## ANALYSIS

Consideration will be initially focused on those cases where the air flow to each compartment is supplied solely by the windbox.




Assumptions:

1. Constant total pressure at compartment inlet plane, i.e., $P_{T_X}$ = const.

2. Constant density, i.e., R(I) = R = const.

3. Constant static pressure at nozzle exit plane, i.e., $P_{s_y}$ = const.

4. Fully turbulent flow, i.e., Head Loss $\approx$ (Velocity)$^2$.

Utilizing these assumptions, it follows that

$$2 * \left[\frac{P_{T_X} - P_{s_y}}{R}\right] = K(I) * \left[\frac{Q(I)}{A(I)}\right]^2 = \text{const.} \quad \text{- - - - - - - - - - - -(1)}$$

Where K(I) = loss coef. for Compartment "I"
Q(I) = volume rate of flow for Compartment "I"
A(I) = nozzle exit area of Compartment "I"

Equation (1) yields

$$\frac{Q(I) \Big/ \sum_{I=1}^{M} Q(I)}{} = \frac{A(I)/\sqrt{K(I)}}{\sum_{I=1}^{M} A(I)/\sqrt{K(I)}} \quad \text{------------------------------------(2)}$$

By definition

$$P_{T_y}(I) = P_{s_y} + \frac{R}{2} * \left[\frac{Q(I)}{A(I)}\right]^2 \quad \text{-----------------------------------(3)}$$

Using Equations (1) and (3), we have

$$2 * \left[\frac{P_{T_X} - P_{T_y}(I)}{R}\right] = 2 * \left[\frac{P_{T_X} - P_{s_y}}{R}\right] - \left[\frac{Q(I)}{A(I)}\right]^2 = [K(I) - 1] *$$

$$\left[\frac{Q(I)}{A(I)}\right]^2 \quad \text{-------------------------------------------------(4)}$$

In order to arrive at a relation for K(I), the windbox compartment total pressure loss will be set equal to the sum of its component losses, i.e.,

$$2 * \left[\frac{P_{T_X} - P_{T_y}(I)}{R}\right] = [K_D(I) + K_\beta(I) + K_{90}(I) + K_f(I)] * \left[\frac{Q(I)}{B(I)}\right]^2 +$$

$$K_N(I) * \left[\frac{Q(I)}{A(I)}\right]^2 \quad \text{-----------------------------------------(5)}$$

. Where B(I) = inlet flow area of Compartment "I"

Assumption (5): The values listed below, which allow for no interaction, adequately represent the compartment total pressure loss.

| LOSS | VALUE | COMMENT | REFERENCE |
|---|---|---|---|
| Miter bend, $K_\beta(I)$ | 0.3 | Typical, $\beta = 45°$ | 2 |
| 90° bend, $K_{90}(I)$ | 1.2 | ----- | 2 |
| Friction, $K_f(I)$ | 0.1 | $f \approx 0.02$, $\frac{L}{D} \leq 5$; $K_f = f\frac{L}{D}$ | 2 |
| Nozzle, $K_N(I)$ | 0 | $K_N = \frac{1}{C_V} - 1$; Assume $C_v = 1$ | 3 |
| Damper, $K_D(I)$ | Figure 1 | Assumed to include inlet loss | 4 |

Using the above values, Equations (4) and (5) yield

$$K(I) = 1 + [1.6 + K_D(I)] * \left[\frac{A(I)}{B(I)}\right]^2 \quad \text{--------------------------(6)}$$

For coal fired units the mill air must be taken into account. Using Equation (2) for the secondary air flow, it follows that

$$\frac{W(I)}{W1 + W2} = \frac{\left[\frac{A(I)/\sqrt{K(I)}}{\sum_{I=1}^{M} A(I)/\sqrt{K(I)}}\right] * W1 + X(I) * W2}{W1 + W2} \qquad (7)$$

where W(I) = mass rate of flow to Compartment "I"
W1 = total windbox air to corner
W2 = total mill air to corner
X(I) = fraction of mill air to Compartment "I"

Figure 1 and Equations (6) and (7) constitute the basis of COMPFLOW.

Note that if some other source of air were available to the windbox assembly, Equation (7) would yield the flow distribution with adjustments in the definitions of W2 and X(I).

Note also that if there is no corner to corner biasing of compartment dampers, Equation (7) may, to a very good approximation, be regarded on a furnace/elevation basis.

## PROGRAM DESCRIPTION

A description of the program input is as follows:

### Input

#### Fuel and Air Compartment Geometry

Number of Compartments
Width of Compartments
Height of Individual Compartments
Number of Dampers per Compartment
Nozzle Exit Area per Compartment

#### Test Data

Percent Excess Air
Total Air Flow
Compartment Damper Positions
Fuel Elevations in Service

Typical program outputs for Alabama Power Co., Barry #2, tests 5 and 20, are shown on Figure 2. These runs represent both normal and overfire air operation. A definition of the output is shown on Figure 3.

## DISCUSSION

### A. Development of the Method

The method presented herein, of calculating the windbox assembly flow distribution, is the result of what is obviously a greatly simplified treatment; numerous assumptions were made in the development of the method. The validity of each of these assumptions will now be examined.

Assumption (1): Constant total pressure at the compartment inlet plane.

Air issuing from a duct branches to each of the windbox assemblies; the fluid is moving at a low velocity relative to that at the nozzle exit. It would be reasonable to assume that the total pressure loss between the supply duct exit and the compartment inlet plane is a negligible fraction of the velocity head at the nozzle exit. It is all the more realistic to assume, as is the case herein, that the total pressure distribution in the supply duct and the consequent losses along individual streamlines, are such that the total pressure is uniform at the compartment inlet plane.

Assumption (2): Constant density fluid within the windbox assembly.

The reasoning for this assumption is analagous to that set forth in (1); note that while isothermal flow is not implied between the supply duct and the compartment inlet, it is assumed within the windbox assembly.

Assumption (3): Constant static pressure at the nozzle exit plane.

The static pressure of the jets issuing from the windbox nozzles is equal to the local furnace pressure. The variation in furnace pressure throughout this region should be negligibly small.

Assumption (4): Fully turbulent flow.

This is a valid assumption for the vast majority of cases; unit Reynolds numbers(based on nozzle exit velocity) greater than $10^5$ per foot are typical even for small opening of compartment dampers.

Assumption (5): The compartment loss coefficient for existing configurations are adequately represented by the formulations presented herein (i.e. Figure 1 and Equation (6)).

Curves of K versus damper position, as calculated from Figure 1 and Equation (6), are shown in Figure 4 for compartment outlet/inlet area ratios (i.e. A(I)/B(I) of 0.534, 0.322 and 0.136; these values cover the range of our existing compartments. Results obtained from the cold-flow model tests of Reference 5, at area ratios of 0.322 and 0.136, are also shown in this figure; the test results are seen to be in excellent agreement with the predicted values. These test results indicate that nozzle tilt, flow rate, firing angle, the presence of turning vanes and probably compartment inlet interaction, are secondary influences on compartment pressure loss and consequently on compartment flow rate. These results justify the omission of these factors in the development of the method presented herein.

## B. Previous Calculations

In the previous method of calculating the windbox assembly flow distribution (Reference 1), the compartment loss coefficient was determined from the equation

$$K(I) = KO + K_D(I) * \left[\frac{A(I)}{B(I)}\right]^2$$

where $K_D(I)$ was specified as herein KO evaluated from test values of the total secondary air flow and windbox/furnace $\Delta P$. Highly closed damper positions result in a very large value of $K_D$, as is seen in Figure 1, and a small error in this parameter will result in a large variation in KO. Program runs with all compartment dampers at or near the full open position yielded values of KO consistent with the value presented herein, i.e.,

@ 100% open, $K_D \approx 0.1$, K = K/100%

from Equation (6), $K/100\% \approx 1 + 1.7 * \left[\frac{A}{B}\right]^2$

for existing geometries, $0 < \left[\frac{A}{B}\right]^2 < 0.29$

therefore, with $KO \approx K/100\%$, $1 < KO < 1.5$

Program runs with one or more compartment dampers highly closed would sometimes yield values of KO outside this range; in rare cases this would result in operational difficulties.

## REFERENCES


1. N. D. Brown, "COMPAIR, Burner-Compartment Air-Flow Distribution Computer Program," Project No. 121029, September, 1971.

2. "Flow of Fluids Through Valves, Fittings, and Pipe," Crane Co., Technical Paper No. 409, May, 1942.

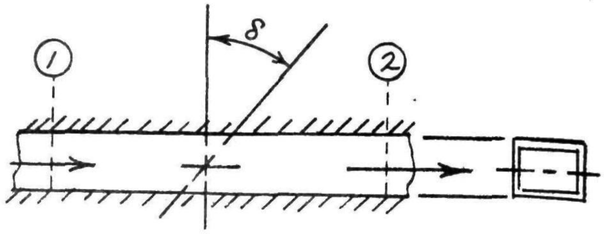
3. R. V. Giles, "Fluid Mechanics and Hydraulics," Schaum Publishing Co., 1962.

4. P. S. Dickey & H. L. Coplan, "A Study of Damper Characteristics," Trans. of the ASME, February, 1942.

5. N. D. Brown, "Windbox Compartment Flow Tests," Test Report 72-6, Project No. 412003, March 2, 1972.

# DAMPER LOSS COEFFICIENT
# VS.
# POSITION

% Open = $(\delta/90) \times 100$




$$K_D = \frac{2(P_{T_1} - P_{T_2})/R}{(Q/A)^2}$$

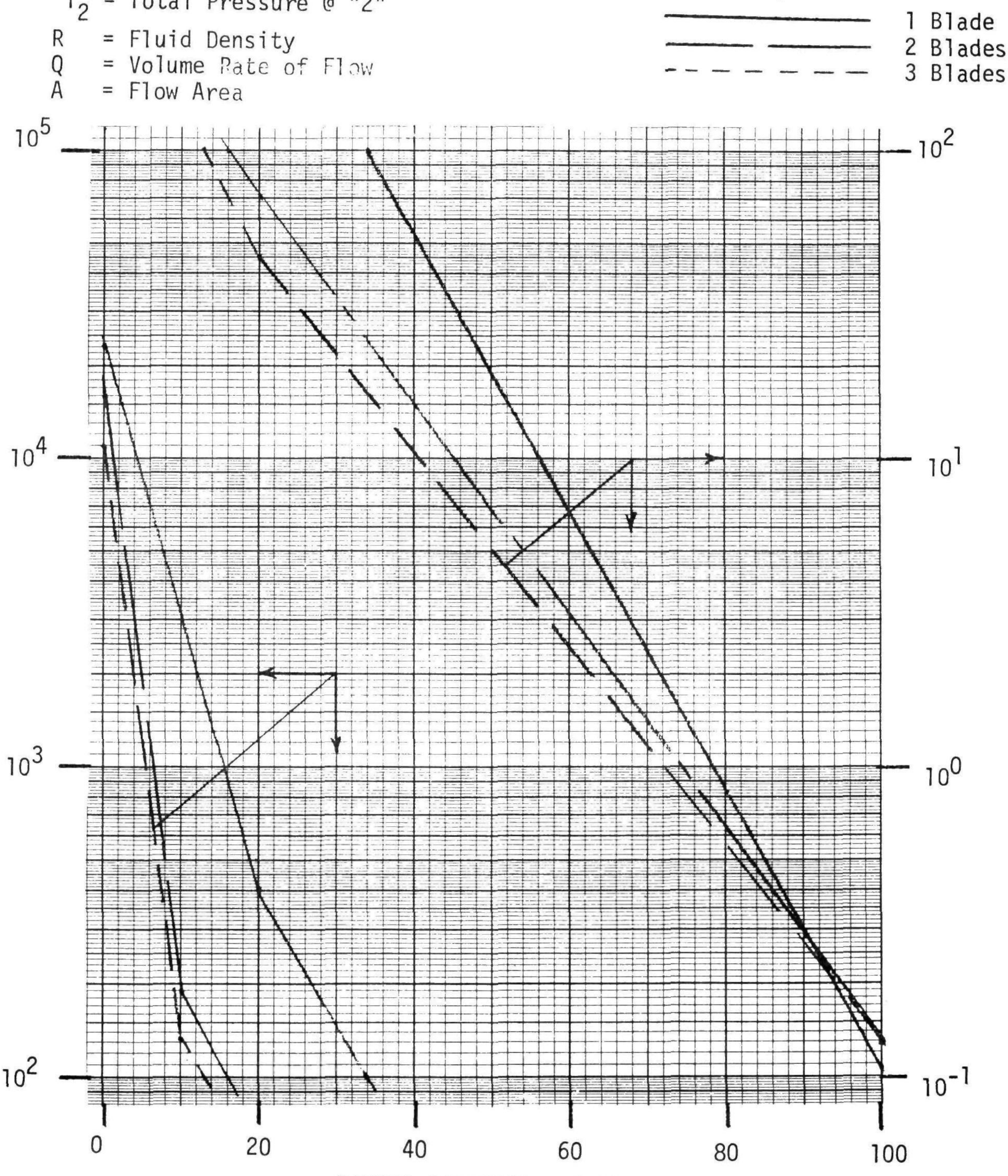
$P_{T_1}$ = Total Pressure @ "1"

$P_{T_2}$ = Total Pressure @ "2"

R = Fluid Density

Q = Volume Rate of Flow

A = Flow Area



AIR FLOW DISTRIBUTION TO WINDBOX COMPARTMENTS
ALABAMA POWER AND LIGHT CO., BARRY #2
EPA '73 - '74 TESTS

FLOW DISTRIBUTION FOR TEST NO. 5

PER CENT EXCESS AIR 22.7

| COMPART-MENT (NO.) | FIRING | AREA WT. FLOW (% OF TOTAL) | DAMPERS (% OPEN) | ACTUAL FLOW (% OF TOTAL) |
|---|---|---|---|---|
| 1 | | 9.44 | 60 | 7.8 |
| 2 | Yes | 6.55 | 20 | 8.39 |
| 3 | | 18.03 | 100 | 16.37 |
| 4 | Yes | 6.55 | 20 | 8.39 |
| 5 | | 9.44 | 100 | 8.64 |
| 6 | | 9.44 | 100 | 8.64 |
| 7 | Yes | 6.55 | 20 | 8.39 |
| 8 | | 18.03 | 100 | 16.37 |
| 9 | Yes | 6.55 | 20 | 8.39 |
| 10 | | 9.44 | 100 | 3.64 |

Firing Fuel Compartment Total Air Flow (%) = 33.55
Air Flow Above Burner Zone (%) = 3.9
Air Flow to Burner Zone (% of Theor. Air) = 117.91

FLOW DISTRIBUTION FOR TEST NO. 20

PERCENT EXCESS AIR 24.2

| COMPART-MENT (NO.) | FIRING | AREA WT. FLOW (% OF TOTAL) | DAMPERS (% OPEN) | ACTUAL FLOW (% OF TOTAL) |
|---|---|---|---|---|
| 1 | | 9.44 | 100 | 9.42 |
| 2 | | 6.55 | 100 | 6.85 |
| 3 | | 18.03 | 50 | 14.93 |
| 4 | Yes | 6.55 | 30 | 10.27 |
| 5 | | 9.44 | 50 | 7.68 |
| 6 | | 9.44 | 50 | 7.68 |
| 7 | Yes | 6.55 | 30 | 10.27 |
| 8 | | 18.03 | 50 | 14.93 |
| 9 | Yes | 6.55 | 30 | 10.27 |
| 10 | | 9.44 | 50 | 7.68 |

Firing Fuel Compartment Total Air Flow (%) = 30.82
Air Flow Above Burner Zone (%) = 23.73
Air Flow to Burner Zone (% of Theor. Air) = 94.72

## COMPFLOW

### Definition of Output

1. The "AREA WT. FLOW" is the ratio of the compartment free area to the total free area of the corner; as such it is a realistic approximation of the actual compartment (secondary) flow only when all compartment dampers are full open.

2. The comparment "ACTUAL FLOW" is the ratio of the compartment mass flow rate (including mill air if applicable) to the total mass flow to the corner (see ANALYSIS, equation (7)).

3. The "FIRING FUEL COMPARTMENT TOTAL AIR FLOW" is the ratio of the total mass flow rate to firing fuel compartments (including mill air if applicable) to the total mass flow to the corner.

4. The "AIR FLOW ABOVE BURNER ZONE" is defined as the percentage of the total mass flow rate supplied above the uppermost firing fuel compartment, less 50% of the flow to the compartment immediately above it.

5. $\%$ Theoretical Air $= \left(1 - \frac{\%\text{ Air Above Burner Zone}}{100}\right)(100 + \%\text{ Excess Air})$ to Burner Zone.

## COMPARTMENT LOSS COEFFICIENT
## VS.
## DAMPER POSITION

$$K = \frac{2(P_{T_x} - P_{s_y})/R}{(Q/A)^2}$$

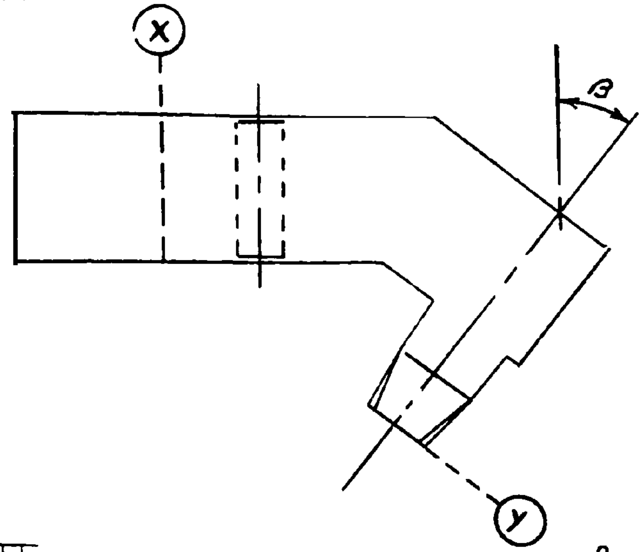
$P_{T_x}$ = Total Pressure @ "x"

$P_{s_y}$ = Static Pressure @ "y"

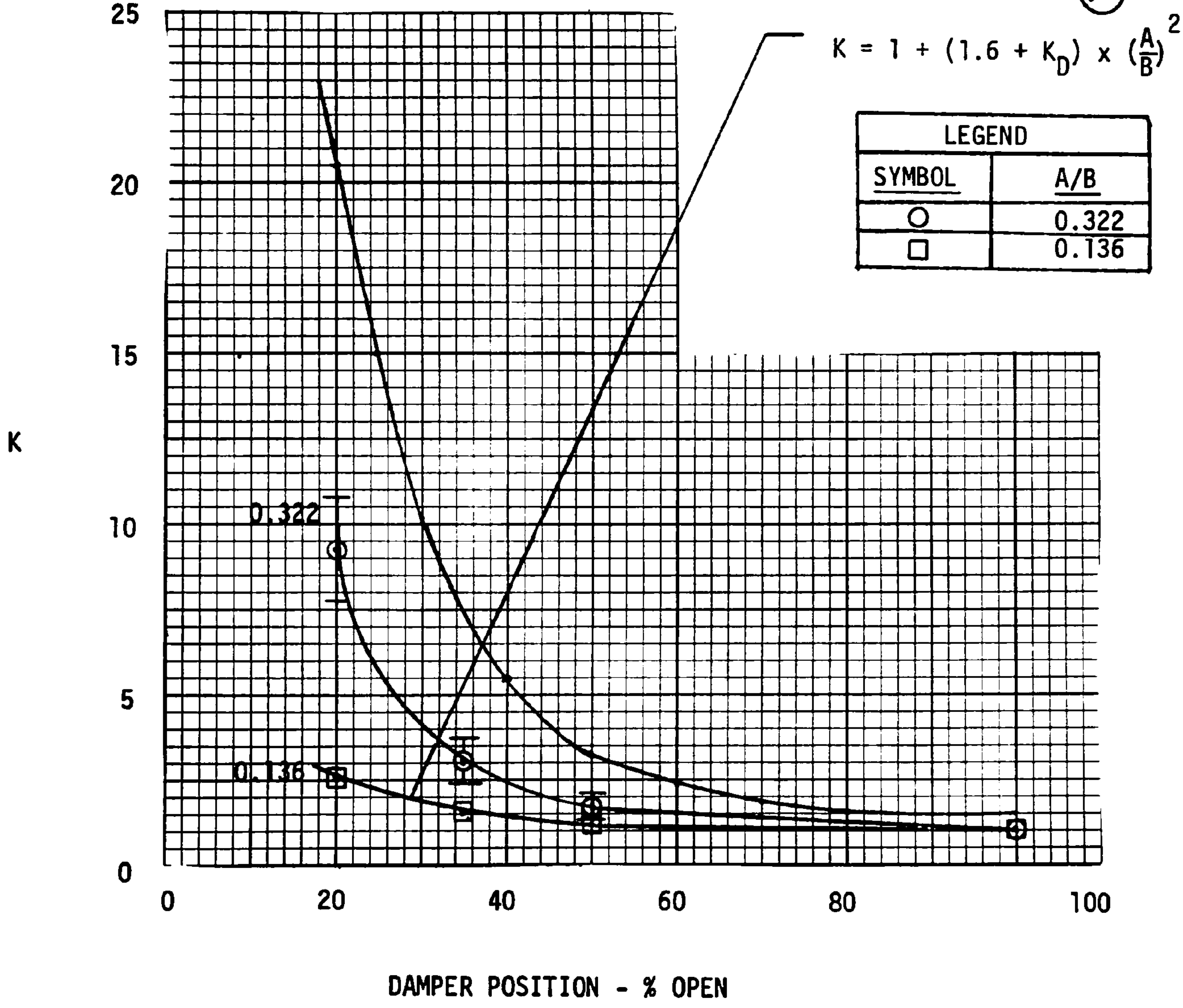
R = Fluid Density

Q = Volume Rate of Flow

A = Nozzle Exit Area




$\frac{A}{B} = 0.534 = \frac{\text{Nozzle Exit Area}}{\text{Compart. Inlet Area}}$



## TECHNICAL REPORT DATA
*(Please read Instructions on the reverse before completing)*

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| 7. AUTHOR(S) Richard L. Burrington, John D. Cavers, and Ambrose P. Selker | | 8. PERFORMING ORGANIZATION REPORT NO. |
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16. ABSTRACT The report gives results of an investigation and evaluation of the effectiveness of overfire air in reducing NOx emissions from tangentially fired boilers burning Western U.S. coal. Results are compared with those obtained during phase II, 'Program for Reduction of NOx from Tangentially Coal Fired Boilers,' EPA contract 68-02-1367. Both programs investigated the effect that variations in excess air, unit slagging, load, and overfire air had on unit performance and emissions. The effect of biasing combustion air through various out-of-service fuel nozzle elevations was also investigated. The effect of overfire air operation on waterwall corrosion potential was evaluated during 30-day baseline and overfire air corrosion coupon tests. Overfire air operation for low NOx optimization did not significantly increase corrosion coupon degradation. Overfire air operation and reductions in excess air levels were effective in reducing NOx emissions. NOx reductions of 20-30% were obtained when operating with 15-20% overfire air. These reductions occurred with the boilers operating at a total unit excess air of about 15-25%, measured at the economizer outlet. Unit loading exhibited a minimal effect on NOx emissions. Waterwall slag conditions had wide and inconsistent effects on NOx emission levels.

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
| Air Pollution | Air Pollution Control | 13B |
| Nitrogen Oxides | Stationary Sources | 07B |
| Combustion Control | NOx Reduction | 21B |
| Coal | Tangential Firing | 21D |
| Boilers | Combustion Modification | 13A |
| Utilities | Overfire Air | |

| | | |
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