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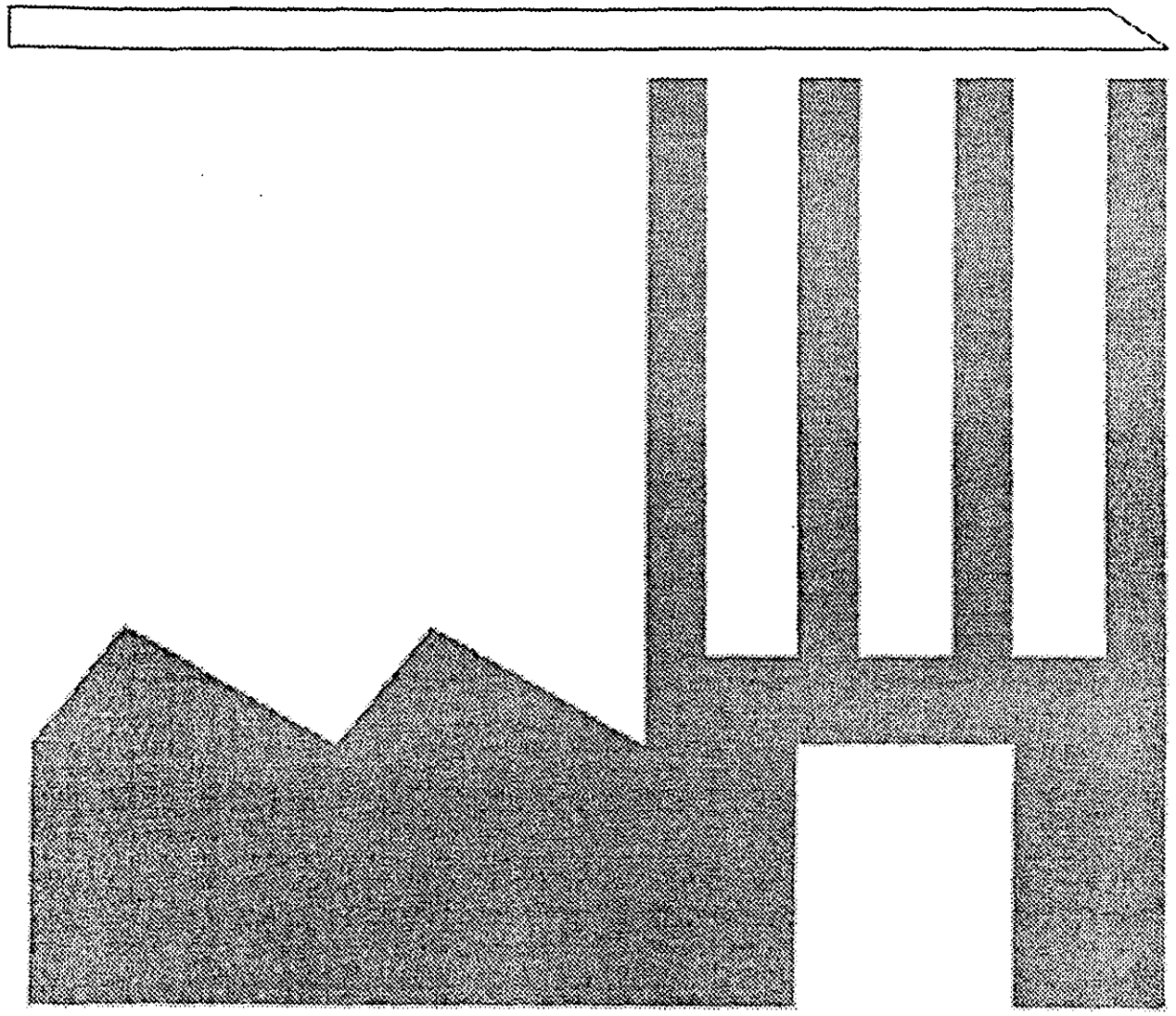
EPA Evaluation of Nitrogen Oxide Emissions Data From TVA Coal-Fired Boilers



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Prepared for Office of Air Quality Planning and Standards

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EVALUATION OF NITROGEN OXIDE EMISSIONS DATA FROM TVA COAL-FIRED BOILERS

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ABSTRACT

Current EPA emission factors (AP-42) for nitrogen oxides (NO_x) from utility coal-fired boilers do not account for variations either in emissions as a function of generating unit load, or in designs of boilers of the same general type, particularly wall-fired boilers. TVA has recently compiled short-term NO_x emissions data from 30 units at 11 TVA coal-fired plants. These units include cyclone, cell burner, single wall, opposed wall, single tangential, and twin tangential boiler firing designs. In this study, the NO_x emission rates from each boiler were calculated and compared with the calculated rate for each boiler type using AP-42. Additional recent NO_x data (from non-TVA boilers) were also obtained from the literature, along with the data used to develop the current AP-42 emission factors. Analysis of all these data indicates that: (1) to varying degrees, NO_x emissions increase with increasing load for all except single- and opposed wall-fired boilers; (2) using the current AP-42 quality rating scheme for the six boiler types, factoring in the TVA and recent literature data results in improved quality ratings for all NO_x emission factors -- "A" (excellent) for those of four of the six boiler types, "B" (good) for those of cell burners, and "C" (fair) for those of opposed wall-fired boilers; and (3) there was no evident relationship between NO_x emissions and fuel nitrogen content or fuel ratio (fixed carbon to volatile matter).

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SECTION 1

INTRODUCTION

The current AP-42[1] document provides emission factors to estimate nitrogen oxide (NO_x) emissions from various coal-fired utility boilers burning bituminous and subbituminous coal. The emission factors, expressed as pounds of NO_x per ton of coal burned, relate amount of NO_x emitted to amount of fuel burned.

Emission factors are provided for three major boiler types: cyclone, tangentially fired, and wall-fired utility boilers (Table 1). No emission factors are given for subclasses of these major boiler types, i.e., for single- or twin-furnace tangential units; single wall-fired units; horizontally opposed wall-fired units; or cell-burner wall-fired units.

The U.S. Environmental Protection Agency's (EPA's) Air and Energy Engineering Research Laboratory has initiated a study to determine whether the AP-42 document could be revised to include emission factors for each boiler subclass, and to account for factors such as boiler design and coal type.

To this purpose, NO_x emission data and corresponding operating conditions and coal information were obtained from the U.S. Tennessee Valley Authority (TVA) for 30 boilers at 10 different TVA coal-fired plants in Alabama, Kentucky, and Tennessee. These units encompass all three major boiler types, and all

TABLE 1. AP-42 EMISSION FACTORS

Utility Boiler Type	AP-42 Section	Applicable Load Range	Emission Factor lb of NO_x/ton of coal*
Cyclone	1.1	60 - 110%	37
Tangentially Fired[a]	1.1	60 - 110%	15
Wall-Fired[b]	1.1	60 - 110%	21

[a]Includes single-furnace and twin-furnace units.

[b]Includes single-wall, horizontally opposed-wall, and cell-burner units.

(*) Throughout this report, 1 lb NO_x/ton coal is the equivalent of 0.5 g NO_x/kg coal.

subclasses in the tangential and wall categories. These data were summarized and then compared to NO_x emissions data calculated from the AP-42 emission factor. Further analysis of the TVA data consisted of evaluating NO_x emissions as a function of unit load. Initially, only NO_x data from TVA units were to be evaluated. However, TVA data were limited for several boiler types, so it was necessary to include NO_x data from non-TVA units.

The most recent NO_x data were obtained through a literature search and from the seven references cited in the current AP-42 document that are the basis for the current AP-42 emission factors. These data were combined with the TVA data by specific boiler category and used to: (1) determine if the TVA data could be used to modify the AP-42 emission factors; (2) determine whether current AP-42 emission factors are consistent with measured values; (3) identify any trends, such as NO_x as a function of load; and (4) determine new average NO_x emission rates for each boiler subclass.

Finally, a review of the emission factor rating was conducted to determine whether including additional data would improve the factor ratings for each boiler type. The rating is a measure of the quantity and quality of data used to generate the emission factors.

SECTION 2

CONCLUSIONS AND RECOMMENDATIONS

Based on the review and analysis of the NO_x emission data from both TVA and non-TVA units, the following conclusions and recommendations for each boiler type are provided.

CYCLONE FURNACES

1. NO_x emissions from 12 cyclone furnaces ranged from 0.79 to 1.87 lb/mBtu*, with an average of 1.22 lb/mBtu (33 lb/ton). This average is 11 percent lower than the AP-42 rate of 1.37 lb/mBtu. However, the TVA units averaged 1.61 lb/mBtu, which is 18 percent higher than the AP-42 rate. The non-TVA units averaged 1.11 lb/mBtu.

2. There is a correlation between NO_x and unit load, i.e., NO_x increased with increasing load.

3. The emission factor rating improves from "B" to "A" with these data.

4. There are no correlations between NO_x and fuel nitrogen or fuel ratio (fixed carbon to volatile matter).

CELL-BURNER WALL-FIRED UNITS

1. NO_x emissions from five cell-burner units ranged from 0.71 to 1.7 lb/mBtu, with an overall average of 1.21 lb/mBtu (33 lb/ton). This average is 55 percent higher than the current AP-42 rate of 0.78 lb/mBtu. The TVA units averaged 1.53 lb/mBtu, which is approximately twice the

(*) Throughout this report, "m" represents million, and 1 lb/m Btu = 0.43 g/mJ.

AP-42 rate. The non-TVA units averaged 1.02 lb/mBtu. This clearly indicates that the cell-burner units should be in a separate category from other wall-fired boilers. However, data from more cell-burner units are needed to define the emission factor and improve the rating.

2. There is a correlation between NO_x and unit load, i.e., NO_x increases with unit load.

3. There is no current emission factor rating for cell-burner units; however, these five units would be rated "B."

4. There are no correlations between NO_x and fuel nitrogen or fuel ratio.

HORIZONTALLY OPPOSED WALL-FIRED UNITS

1. NO_x emissions from three horizontally opposed wall-fired units ranged from 0.69 to 1.24 lb/mBtu, with an overall average of 0.94 lb/mBtu (25 lb/ton). This average is 12 percent higher than the current AP-42 rate of 0.78 lb/mBtu. The TVA units averaged 0.76 lb/mBtu, which compares well with the AP-42 rate; however, the non-TVA units averaged 1.08 lb/mBtu. This shows that horizontally opposed units may need a separate category; however, more data are needed to define the emission factor and improve the rating.

2. There are not enough data to determine a correlation between unit load and NO_x emissions.

3. There is no current emission factor rating for horizontally opposed units; however, these three units would be rated "C."

4. There are no correlations between NO_x and fuel nitrogen or fuel ratio.

SINGLE WALL-FIRED UNITS

1. NO_x emissions from 15 single wall-fired units ranged from 0.59 to 1.12 lb/mBtu, with an overall average of 0.85 lb/mBtu (23 lb/ton). This average is 9 percent higher than the current AP-42 rate of 0.78 lb/mBtu. The TVA units averaged 0.81 lb/mBtu, which is only 3 percent higher than the AP-42 rate, while the non-TVA units averaged 0.90 lb/mBtu. There are sufficient data available to modify the emission factor for this category.

2. There is a correlation between NO_x and unit load, with NO_x increasing with increasing load.

3. There is no current emission factor rating for single wall-fired units; however, these 15 units would be rated "A."

4. There are no correlations between NO_x and fuel nitrogen or fuel ratio.

SINGLE-FURNACE TANGENTIALLY FIRED UNITS

1. NO_x emissions from 17 single-furnace tangentially fired units ranged from 0.38 to 0.75 lb/mBtu, with an overall average of 0.56 lb/mBtu (15 lb/ton), which corresponds exactly to the current AP-42 emission rate. The TVA units averaged 0.48 lb/mBtu, which is 16 percent lower than the AP-42 rate. The average for the non-TVA units was 0.60 lb/mBtu.

2. There is a slight increase in NO_x as unit load increases.

3. There is no current emission factor rating for this subclass; however, these 17 units would be rated "A."

4. There are no correlations between NO_X and fuel nitrogen or fuel ratio.

TWIN-FURNACE TANGENTIALLY FIRED UNITS

1. NO_x emissions from 12 twin-furnace tangentially fired units ranged from 0.55 to 0.72 lb/mBtu, with an overall average of 0.62 lb/mBtu (17 lb/ton). This average is 11 percent higher than the AP-42 rate of 0.56 lb/mBtu. The TVA units averaged 0.62 lb/mBtu and the non-TVA units averaged 0.63 lb/mBtu. There are sufficient data to modify the emission factor for this category.

2. There is a slight correlation between NO_x and load with NO_x increasing with increasing load.

3. There is no current emission factor rating for this subclass; however, these 12 units would be rated "A."

4. There are no correlations between NO_x and fuel nitrogen or fuel ratio.

Table 2 summarizes the average NO_x emissions from TVA and non-TVA units for each type of boiler.

TABLE 2. SUMMARY OF AVERAGE NO_x EMISSIONS FROM TVA AND NON-TVA UNITS

Boiler Type	TVA Units (lb/mBtu)	Non-TVA Units (lb/mBtu)	Average of TVA and Non-TVA Units (lb/mBtu)	AP-42* (lb/mBtu)
Cyclone Furnaces	1.61	1.11	1.22	1.37
Cell-Burner, Wall-Fired Units	1.53	1.02	1.21	0.78
Horizontally-Opposed, Wall-Fired Units	0.76	1.08	0.94	0.78
Single, Wall-Fired Units	0.81	0.90	0.85	0.78
Single-Furnace, Tangential Fired Units	0.48	0.60	0.56	0.56
Twin- Furnace, Tangential Fired Units	0.62	0.63	0.62	0.56

*Calculated by using 13,500 Btu/lb.

SECTION 3

BOILER POPULATION

TVA BOILERS

Beginning in 1989, the TVA began measuring NO_x emissions from its coal-fired utility boilers in order to develop a current emission inventory of representative boilers in its system. TVA used the data to formulate a strategy for complying with the Clean Air Act Amendments of 1990. Between 1989 and 1991, 30 boilers at 10 TVA coal-fired plants in Alabama, Kentucky, and Tennessee were inventoried for NO_x, oxygen (O_2), carbon monoxide (CO), carbon dioxide (CO_2), and sulfur dioxide (SO_2) by TVA Research and Development personnel.

Data Collection Procedure

The test programs conducted on each boiler were relatively short in duration. Each unit was tested for approximately 8 hours and the data were then averaged for specific test conditions. Testing was conducted at or near full load, and at normal operating conditions. When possible, testing was also conducted at reduced load and at varying boiler oxygen levels; however, there are very limited data for these conditions.

Measurements were taken after the air heater at a representative point in the duct with a single-point sampling probe. Gas was extracted from the duct through a heated probe and conveyed to a mobile CEM system through a heated sample

line. The following analyzers and measurement techniques were used to determine the gaseous constituents of the flue gas:

Gaseous Constituent	Analyzer	Technique
NO_x	TECO Model 10AR or Beckman Model 955	Chemiluminescence
O_2	Beckman 755	Paramagnetic
CO	Beckman 880	Nondispersive Infrared
CO_2	Beckman 880	Nondispersive Infrared
SO_2	Western Research Model 721	Ultraviolet Absorption

Each analyzer was calibrated prior to the first test of the day with a zero gas and an upscale calibration gas (greater than or equal to the expected concentrations). Additionally, each analyzer was checked periodically during the test day and, if necessary, the calibration was repeated. The calibration gases were either EPA Protocol 1 or NBS standard quality.

Data recorded from the control room instruments during each test were evaluated to determine whether the boiler was operating under steady conditions. If an upset occurred, data from that test were deleted from the data set. Data were also omitted from the data set if a calibration check showed excessive drift. Therefore, the data from each test period were subjected to the standard quality assurance/quality control procedures set forth in the Code of Federal Regulations Part 60[2] and were thoroughly screened for accuracy prior to any data analysis. These data sets were made available to EPA in the form of internal test reports and on diskette.

There are a total of 30 boilers in the TVA data set. The boilers are categorized as cyclone (2 boilers); cell-burner (2 boilers); opposed wall-fired

(1 boiler); single wall-fired (9 boilers); single furnace, tangential (13 boilers); and twin furnace, tangential (3 boilers).

Table 3 provides information on the TVA boilers that were tested. Each boiler was assigned an identification code to be used for graphing purposes in subsequent sections of this report. All the TVA boilers in Table 2 (1) are pre-NSPS, (2) fire bituminous coal, (3) have no controls for NO_x, and (4) are dry bottom boilers except for the cyclone furnaces.

NON-TVA BOILERS

Table 4 contains data for the 34 boilers identified through the literature search and from references in the AP-42 document. The boilers are categorized as cyclone (10 boilers); cell-burner (3 boilers); horizontally opposed wall-fired (2 boilers); single wall-fired (6 boilers); single-furnace, tangential (10 boilers); and twin-furnace, tangential (3 boilers). Data for these boilers were summarized by boiler type and added to the TVA data set for analysis.

For the boilers referenced in Table 43, only data for tests conducted under normal operating conditions were analyzed. Data from tests conducted under low NO_x conditions (i.e., low excess air, burners-out-of-service, overfire air in operation, etc.) were not used in the analysis. Units were added to the data set only if they were comparable in size to other units already in the data base. For example, units in the AP-42 references that were less than 30 MW were not included.

TABLE 3. TVA BOILERS THAT HAVE NO_x EMISSION DATA

ID	Plant	Unit No.	Boiler Mfgr.	Capacity MW	AP-42 Major Category	Subclass	Coal Type	Test Date
A	Allen	1	B&W	330	Cyclone	N/A	Bituminous	1/90
B	Paradise	3	B&W	1150	Cyclone	N/A	Bituminous	3/90
C	Cumberland	1	B&W	1300	Wall	Cell	Bituminous	7/89
D	Cumberland	2	B&W	1300	Wall	Cell	Bituminous	7/89
E	Colbert	5	B&W	550	Wall	Opposed	Bituminous	9/89, 7/91
F	Colbert	3	B&W	200	Wall	Single	Bituminous	7/91
G	Colbert	4	B&W	200	Wall	Single	Bituminous	3/90
H	Johnsonville	7	B&W	170	Wall	Single	Bituminous	8/90
I	Johnsonville	8	B&W	170	Wall	Single	Bituminous	8/90
J	Johnsonville	10	B&W	170	Wall	Single	Bituminous	8/90
K	Shawnee	2	B&W	175	Wall	Single	Bituminous	2/91
L	Shawnee	6	B&W	175	Wall	Single	Bituminous	12/89
M	Shawnee	8	B&W	175	Wall	Single	Bituminous	12/89
N	Shawnee	9	B&W	175	Wall	Single	Bituminous	5/89
O	Johnsonville	1	B&W	125	Wall	Single-Furnace	Bituminous	6/91
P	Johnsonville	2	CE	125	Tangential	Single-Furnace	Bituminous	4/90
Q	Johnsonville	3	CE	125	Tangential	Single-Furnace	Bituminous	6/91

(Continued)

TABLE 3. TVA BOILERS THAT HAVE NO_x EMISSION DATA
(CONTINUED)

ID	Plant	Unit No.	Boiler Mfgr.	Capacity MW	AP-42 Major Category	Subclass	Coal Type	Test Date
R	Johnsonville	4	CE	125	Tangential	Single-Furnace	Bituminous	6/91
S	Johnsonville	5	CE	125	Tangential	Single-Furnace	Bituminous	6/91
T	Johnsonville	6	CE	125	Tangential	Single-Furnace	Bituminous	6/91
U	Kingston	4	CE	175	Tangential	Single-Furnace	Bituminous	3/90
V	Gallatin	1	CE	300	Tangential	Single-Furnace	Bituminous	7/90
W	Gallatin	2	CE	300	Tangential	Single-Furnace	Bituminous	8/90
X	Gallatin	3	CE	300	Tangential	Single-Furnace	Bituminous	8/90
Y	John Sevier	2	CE	200	Tangential	Single-Furnace	Bituminous	10/90
Z	John Sevier	3	CE	200	Tangential	Single-Furnace	Bituminous	10/90
AA	John Sevier	4	CE	200	Tangential	Single-Furnace	Bituminous	10/90
BB	Kingston	5	CE	200	Tangential	Twin-Furnace	Bituminous	3/90
CC	Widows Creek	7	CE	575	Tangential	Twin-Furnace	Bituminous	4/90
DD	Widows Creek	8	CE	550	Tangential	Twin-Furnace	Bituminous	8/89

TABLE 4. BOILER POPULATION FROM CURRENT AP-42 REFERENCE LIST AND LITERATURE SEARCH

ID[a]	Plant	Unit No.	Boiler Mfgr.	Capacity MW	AP-42 Major Category	Subclass	Coal Type	Reference
E1	Unidentified	1	B&W	206	Cyclone	N/A	Unknown	3
E2	Unidentified	2	B&W	Unknown	Cyclone	N/A	Unknown	3
E3	Unidentified	3	B&W	200	Cyclone	N/A	Unknown	3
E4	Unidentified	4	B&W	Unknown	Cyclone	N/A	Unknown	3
E5	Unidentified	5	B&W	240	Cyclone	N/A	Unknown	3
E6	Unidentified	6	B&W	704	Cyclone	N/A	Unknown	3
E7	Unidentified	7	B&W	Unknown	Cyclone	N/A	Unknown	3
E8	Unidentified	8	B&W	300	Cyclone	N/A	Unknown	3
L1	Niles	1	B&W	108	Cyclone	N/A	Bituminous	4
L2	Nelson Dewey	2	B&W	100	Cyclone	N/A	Bituminous	5
E9	Four Corners[b]	4	B&W	800	Wall	Cell	Subbituminous	6
L3	Four Corners[b]	4	B&W	800	Wall	Cell	Subbituminous	7
E10	Harlee Branch	3	B&W	480	Wall	Cell	Bituminous	6
L4	Crist	7	FW	500	Wall	Opposed	Bituminous	8
L5	Hammond	4	FW	500	Wall	Opposed	Bituminous	9
E11	Widows Creek[c]	5	B&W	125	Wall	Single	Bituminous	6
E12	Widows Creek[c]	6	B&W	125	Wall	Single	Bituminous	6
E13	Crist	6	FW	320	Wall	Single	Bituminous	6

(Continued)

TABLE 4. BOILER POPULATION FROM CURRENT AP-42 REFERENCE LIST AND LITERATURE SEARCH (CONTINUED)

ID[a]	Plant	Unit No.	Boiler Mfgr.	Capacity MW	AP-42 Major Category	Subclass	Coal Type	Reference
E14	E.D. Edwards	2	RS	256	Wall	Single	Bituminous	6
E15	Dave Johnson	2	B&W	105	Wall	Single	Subbituminous	6
L6	Edgewater	4	B&W	105	Wall	Single	Bituminous	10
E16	Comanche[d]	1	CE	350	Tangential	Single Furnace	Subbituminous	6
E17	Naughton	3	CE	330	Tangential	Single Furnace	Subbituminous	6
E18	Barry[d]	2	CE	130	Tangential	Single Furnace	Bituminous	6
E19	Barry	4	CE	350	Tangential	Single Furnace	Bituminous	6
E20	Dave Johnson	4	CE	340	Tangential	Single Furnace	Subbituminous	6
L7	Smith	2	CE	180	Tangential	Single Furnace	Bituminous	11
L8	Hunter	2	CE	400	Tangential	Single Furnace	Bituminous	12
L9	Lawrence	5	CE	400	Tangential	Single Furnace	Bituminous	13
L10	Cherokee	4	CE	350	Tangential	Single Furnace	Bituminous	14
L11	Valmont	5	CE	165	Tangential	Single Furnace	Bituminous	14
E21	Barry	3	CE	250	Tangential	Twin Furnace	Bituminous	6
E22	Navajo[d]	2	CE	800	Tangential	Twin Furnace	Subbituminous	6
L12	Kingston	6	CE	200	Tangential	Twin Furnace	Bituminous	15

[a]E = units identified through AP-42 references, L = units identified through the literature search.
[b]Identified in both the AP-42 reference list and in the literature search.
[c]TVA boiler.
[d]Unit is equipped with overfire air ports for NO_x control. Data from baseline operation (i.e., normal firing with overfire air ports closed) were used in the analysis.

BOILER TYPE CHARACTERISTICS

Cyclone Furnaces

Cyclone furnaces consist of a water-cooled horizontal cylinder in which the fuel is fired and heat is released at extremely high rates. Originally, the cyclone furnace was designed to burn troublesome coals that had high ash content and low ash fusion temperatures. These characteristics can make fuel difficult to burn in a conventional pulverized coal combustion system.[3]

This type of firing has distinct advantages and disadvantages. The primary advantage is that troublesome coals can be burned economically. Other advantages include the ability to operate at lower excess air, low carbon loss with bituminous coals, higher boiler efficiency at full load, less total particulate matter emitted from the furnace, production of more suitable ash for landfill purposes, smaller furnace size, and low coal preparation costs (no pulverizers). In addition, cyclone furnaces are easily conveyed to burn other types of fuel. The main disadvantages include limited operating flexibility, high NO_x emissions, high pressure drop, and high carbon loss (Western coals). Also, these furnaces cannot be retrofit with conventional low-NO_x burners.

Cell-Burner Units

In the 1960's, economic considerations dominated boiler design and led to the development of the cell-burner. These units are a special category of wall-fired units in that (1) they are horizontally opposed, with two rows of burners on each wall, and (2) each burner consists of closely spaced vertical nozzles (2 or 3 nozzles in a cell). The burner produces a compact, intense flame compatible with the relatively small furnace volume. These compact furnaces produce high heat release rates and generally exhibit high NO_x characteristics.

Horizontally Opposed Wall-Fired Units

Horizontally opposed wall-fired units consist of several rows of standard circular burners on two opposed walls of the furnace. The burner spacing and the heat release rate are relatively the same as for the single wall-fired unit.

Single Wall-Fired Units

Single wall-fired units consist of several rows of standard circular burns on one wall (front or rear) of the furnace.

Tangentially Fired Units

Single-Furnace--

A tangentially fired unit with a single-furnace boiler system consists of four corner windboxes containing separate, vertically stacked nozzles that emit distinct levels of fuel and air. This design promotes strong ignition near each corner. The bulk mixing process caused by the rotating fireball pattern ensures complete mixing of the fuel and air. The tangential design emits lower NO_x than cyclone or wall-fired boilers.

Twin-Furnace--

A tangentially fired units with a twin-furnace boiler system consists of one furnace as the superheat furnace and an other as the reheat furnace. Therefore, there are eight corner windboxes containing separate, vertically stacked nozzles that emit distinct levels of fuel and air. As with the single furnace, this promotes strong ignition near each corner and ensures complete mixing of the fuel and air. This design also emits lower NO_x than cyclone furnaces or wall-fired boilers.

SECTION 4

DATA ANALYSIS

The data from each boiler (TVA, AP-42 referenced data, and data from the literature search) were analyzed by the following methodology:

1. The data from each boiler were categorized in a spreadsheet by AP-42 boiler type and subclass. Data consisted of load (MW) and NO_x (lb/mBtu) and were averaged for similar test conditions. For example, if there were 10 data points for a specific boiler taken near the same load (+/- 5 percent), then the NO_x emissions and unit load were averaged. The average values are reported in the summary tables for each boiler category (see Section 5).

2. The percent load for each test average was calculated and the data from loads less than 60 percent were excluded because the AP-42 factors are valid for loads of 60-110 percent only.

3. The NO_x values were then averaged for the entire data set and compared to the calculated emission rate. The difference between actual data and the calculated emission rate was then determined. The emission rate, lb/mBtu, was calculated as follows:

$$\left[\frac{\left(\text{AP-42 emission factor, } \frac{\text{lb}}{\text{ton}}\right)}{\left(\frac{\text{Btu}}{\text{lb}}\right) * \left(2000\ \frac{\text{lb}}{\text{ton}}\right)}\right] * 1{,}000{,}000\ \frac{\text{Btu}}{\text{mBtu}} = \frac{\text{lb}}{\text{mBtu}}$$

A heating value of 13,500 Btu/lb was used to calculate the emission rates for all boilers types. The calculated emission rates are cyclone = 1.37 lb/mBtu, wall = 0.78 lb/mBtu, and tangential = 0.56 lb/mBtu.

4. The percent difference between the average NO_x value and the calculated emission rate was calculated as follows:

$$\left[\frac{\text{Average } NO_x, \frac{lb}{mBtu} - \text{AP-42 } NO_x, \frac{lb}{mBtu}}{\text{AP-42 } NO_x, \frac{lb}{mBtu}}\right] * 100 = \text{Percent difference}$$

5. Bar graphs were generated for each boiler type category by using all available data.

SECTION 5

RESULTS

The results of the analysis of the NO_x emission data from both TVA and non-TVA units for each boiler type are discussed in this section. The NO_x emissions data for the TVA units given in Appendix A and fuel properties for the TVA units given in Appendix B.

CYCLONE FURNACE

The data used to determine the difference between actual NO_x emissions and emissions calculated from AP-42 emission factors for cyclone furnaces are summarized in Table 5. (Some of the data found in the AP-42 references did not specify unit load, but rather percent load tested.)

The NO_x data range from 0.79 to 1.87 lb/mBtu, with an overall average of 1.22 lb/mBtu, which is 11 percent lower than the AP-42 emission rate of 1.37 lb/mBtu. This corresponds to an emission factor of 33 lb/ton. The overall NO_x emission rate averaged 1.61 lb/mBtu for the TVA units and 1.11 lb/mBtu for the non-TVA units. The complete data set is shown graphically in Figure 1 (percent load is shown in for each boiler).

TABLE 5. SUMMARY OF NO_x EMISSIONS DATA FOR CYCLONE FURNACES

ID[a]	Plant	Unit No.	Capacity, MW	Average Test Load, %	Average NO_x, lb/mBtu	AP-42,[b] lb/mBtu	% Difference Average - AP-42
A	Allen	1	330	60	1.13	1.37	-18
A	Allen	1	330	82	1.71	1.37	25
B	Paradise	3	1150	77	1.68	1.37	23
B	Paradise	3	1150	85	1.64	1.37	20
B	Paradise	3	1150	91	1.87	1.37	36
E1	Unidentified	--	206	75	0.92	1.37	-33
E1	Unidentified	--	206	95	1.36	1.37	-1
E2	Unidentified	--	Unk.	75	1.19	1.37	-13
E3	Unidentified	--	200	95	1.19	1.37	-13
E4	Unidentified	--	Unk.	85	0.85	1.37	-38
E4	Unidentified	--	Unk.	95	1.14	1.37	-17
E5	Unidentified	--	240	95	1.12	1.37	-18
E6	Unidentified	--	704	75	1.04	1.37	-24
E6	Unidentified	--	704	95	1.4	1.37	2
E7	Unidentified	--	Unk.	65	0.94	1.37	-31
E7	Unidentified	--	Unk.	75	0.92	1.37	-33
E8	Unidentified	--	300	95	1.32	1.37	-4
L1	Niles	1	108	82	0.79	1.37	-42
L1	Niles	1	108	100	0.92	1.37	-33

(Continued)

TABLE 5. SUMMARY OF NO_x EMISSIONS DATA FOR CYCLONE FURNACES (CONTINUED)

ID[a]	Plant	Unit No.	Capacity, MW	Average Test Load, %	Average NO_x, lb/mBtu	AP-42,[b] lb/mBtu	% Difference Average - AP-42
L2	Nelson Dewey	2	100	75	1.24	1.37	-9
L2	Nelson Dewey	2	100	100	1.34	1.37	-2
Average					1.22	1.37	-11
Emission Factor					33	37	-11

[a]A and B = TVA units; E = units identified through AP-42 references; and L = units identified through the literature search.
[b]Calculated by using 13,500 Btu/lb.

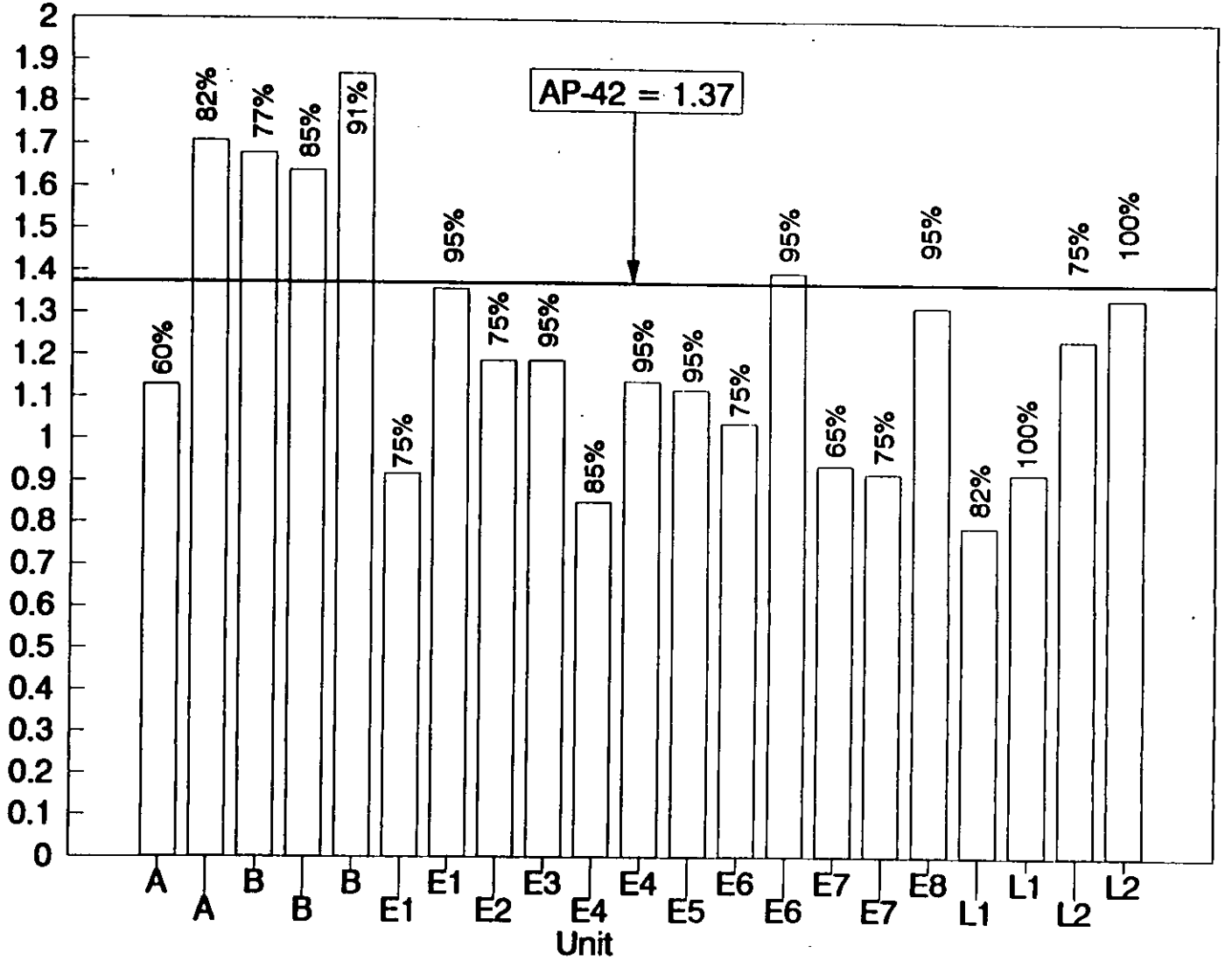

Figure 1. NOx emissions, cyclone furnaces.

There is a correlation between unit size and NO_x emission rate, with larger size units emitting higher levels of NO_x. Data from eight cyclone boilers are shown in Figure 2.

WALL-FIRED UNITS

Cell-Burner

Table 6 shows data from five cell-burner units ranging in size from 480 MW to 1300 MW. The NO_x data range from 0.71 to 1.7 lb/mBtu, with an overall average of 1.21 lb/mBtu, which is 55 percent higher than the AP-42 rate of 0.78 lb/mBtu. This corresponds to an emission factor of 33 lb/ton.

The TVA cell-burner units averaged 1.53 lb/mBtu, which is considerably higher than the overall average; however, the TVA units are the largest capacity units. The data from non-TVA units averaged 1.02 lb/mBtu. The complete data set is shown in Figure 3 (percent load is shown for each boiler).

Bearing in mind that this is a very small data set, there appears to be a correlation between capacity and NO_x emissions. The largest unit (1300 MW) emits the highest NO_x, and the smallest unit (480 MW) emits the lowest NO_x. Figure 4 shows this correlation.

Because this data set is so small, it is not evident whether there is a correlation between NO_x and percent load. However, it is clear that cell-burner units emit substantially higher NO_x than other wall-fired units and should not be included in this category.

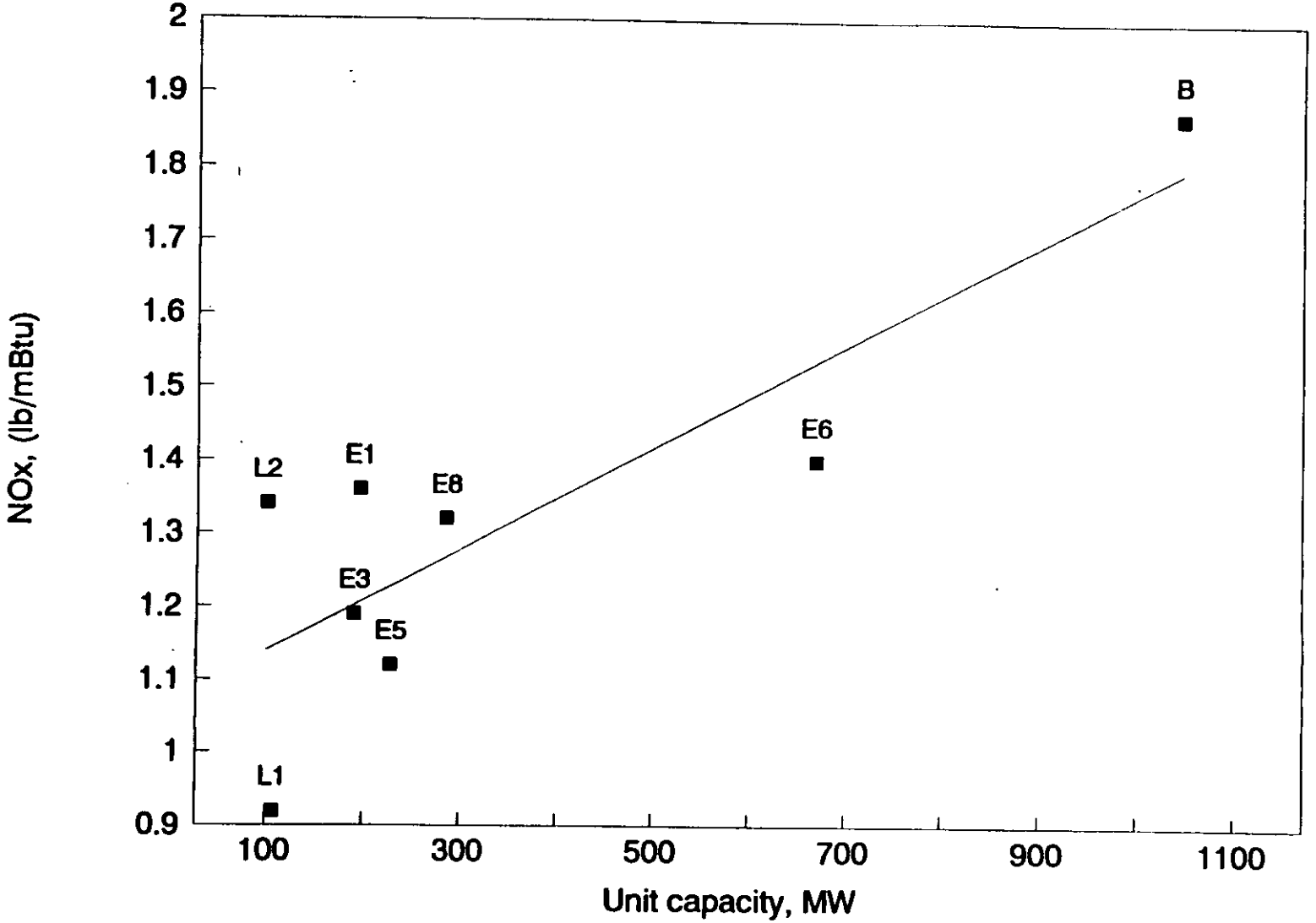

Figure 2. Effect of load on NOx from cyclone furnaces.

TABLE 6. SUMMARY OF NO_x EMISSIONS DATA FOR CELL BURNER UNITS

ID[a]	Plant	Unit No.	Capacity, MW	Average Test Load, %	Average NO_x, lb/mBtu	AP-42[b]	% Difference Average - AP-42
C	Cumberland	1	1300	78	1.7	0.78	118
D	Cumberland	2	1300	95	1.5	0.78	92
D	Cumberland	2	1300	100	1.4	0.78	79
E9	Four Corners	4	800	75	1.08	0.78	38
E9	Four Corners	4	800	95	1.09	0.78	40
L3	Four Corners	4	800	100	1.27	0.78	63
E10	Harlee Branch	3	480	83	0.71	0.78	-9
E10	Harlee Branch	3	480	100	0.95	0.78	22
Average					1.21	0.78	55
Emission Factor					33	21	55

[a]Letters C and D = TVA units; E = units identified through AP-42 references; and L = units identified through the literature search.

[b]Calculated by using 13,500 Btu/lb.

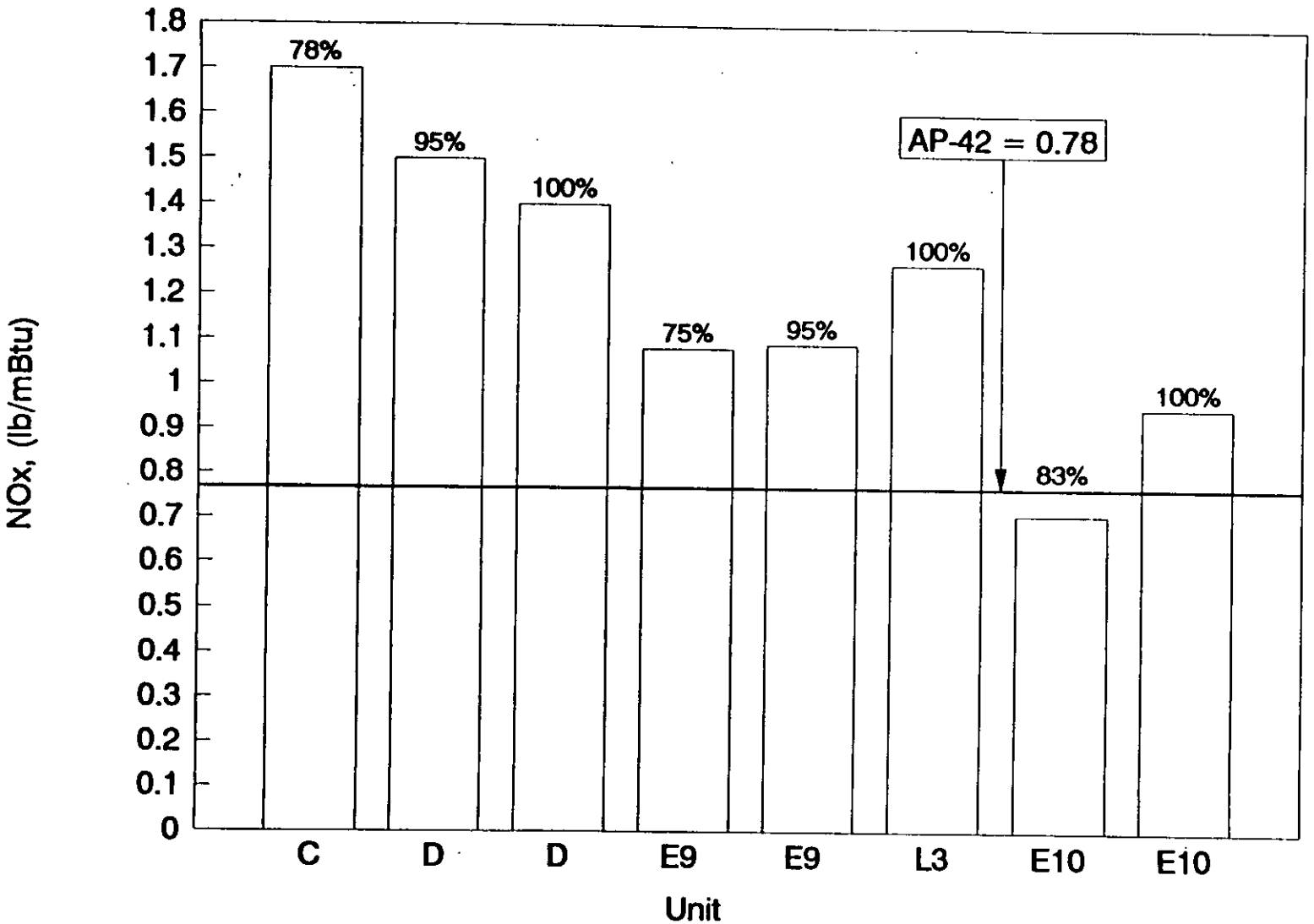

Figure 3. NOx emissions, cell-burner wall-fired units.

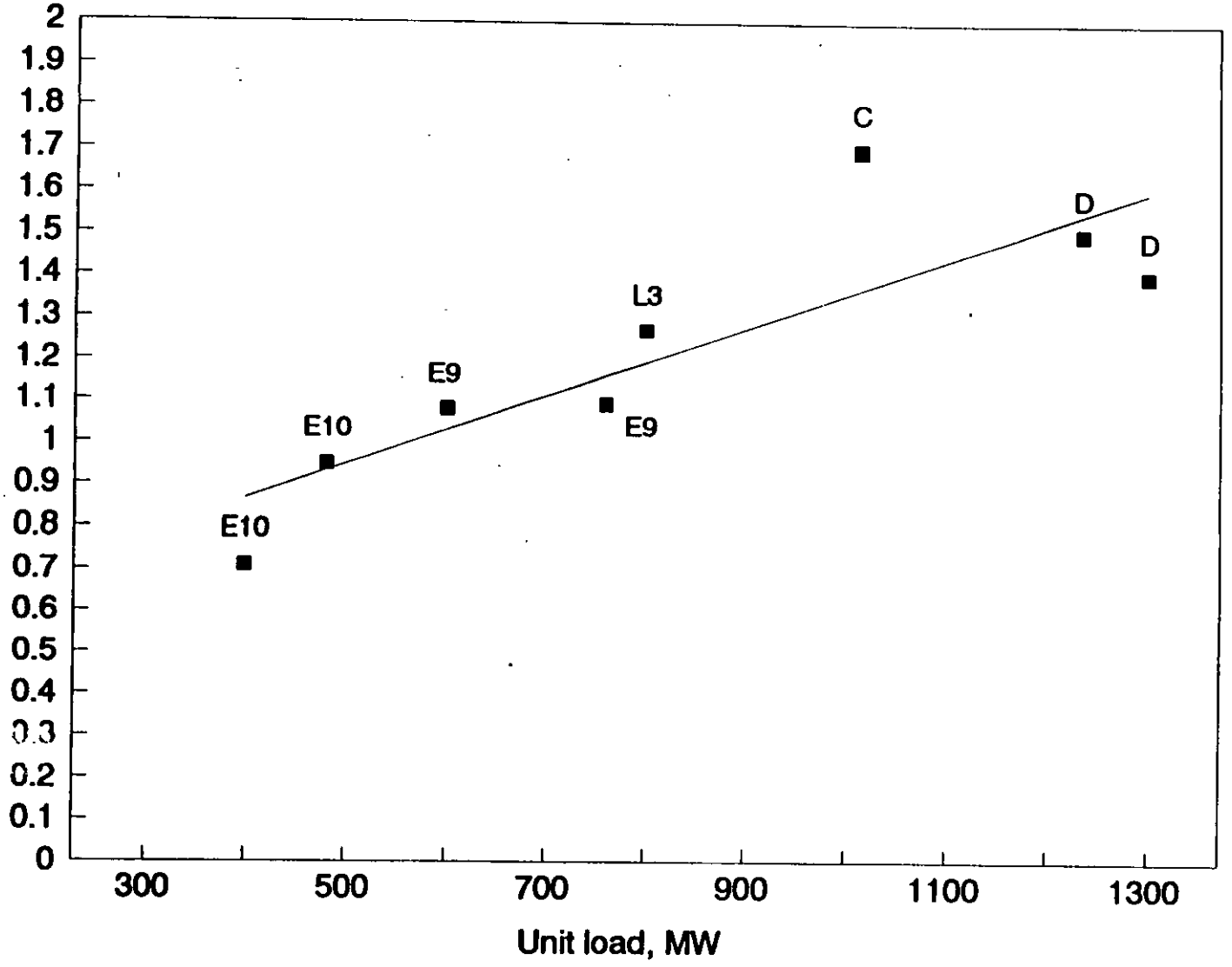

Figure 4. Effect of load on NOx emissions from cell-burner wall-fired units.

Horizontally Opposed

Table 7 shows data from three horizontally opposed wall-fired units that range in size from 500 MW to 550 Mw. The NO_x data range from 0.69 to 1.24 lb/mBtu, with an overall average of 0.94 lb/mBtu, which is 21 percent higher than the AP-42 rate of 0.78 lb/mBtu. This corresponds to an emission factor of 25 lb/ton.

The TVA unit averaged 0.76 lb/mBtu, which compares well with the AP-42 rate. The remaining data set averaged 1.08 lb/mBtu, which is considerably higher than the AP-42 rate. Because of the small size of the data set, it is difficult to determine any effect of unit capacity or percent load on NO_x emissions. The complete data set is shown in Figure 5 (percent load is shown for each boiler).

Single Wall-Fired

Table 8 shows data from 15 single wall-fired units that range in size from 105 MW to 340 MW. The NO_x data range from 0.59 to 1.12 lb/mBtu, with an overall average of 0.85 lb/mBtu, which is 9 percent higher than the AP-42 rate of 0.78 lb/mBtu. This corresponds to an emission factor of 23 lb/ton. The complete data set is shown in Figure 6 (percent load is shown for each boiler).

The TVA units averaged 0.81 lb/mBtu, which is only 3 percent higher than the AP-42 rate of 0.78 lb/mBtu. The remainder of the data set averaged 0.90 lb/mBtu, which is 13 percent higher than the AP-42 rate. As shown in Figure 7, there is considerable scatter in the NO_x emission data for units 200 MW and below. However, there is a trend of decreasing NO_x with decreasing load. Also, the larger size units tend to emit the highest NO_x.

TABLE 7. SUMMARY OF NO_x EMISSIONS DATA FOR HORIZONTALLY OPPOSED WALL-FIRED UNITS

ID[a]	Plant	Unit No.	Capacity, MW	Average Test Load, %	Average NO_x, lb/mBtu	AP-42[b]	% Difference Average - AP-42
E	Colbert	5	550	63	0.85	0.78	9
E	Colbert	5	550	70	0.69	0.78	-12
E	Colbert	5	550	86	0.75	0.78	-4
L4	Crist	7	500	100	0.95	0.78	22
L5	Hammond	4	500	60	0.98	0.78	26
L5	Hammond	4	500	80	1.13	0.78	45
L5	Hammond	4	500	96	1.24	0.78	59
Average					0.94	0.78	21
Emission Factor					25	21	21

[a]Letter E = TVA unit; and L = units identified through the literature search.

[b]Calculated by using 13,500 Btu/lb.

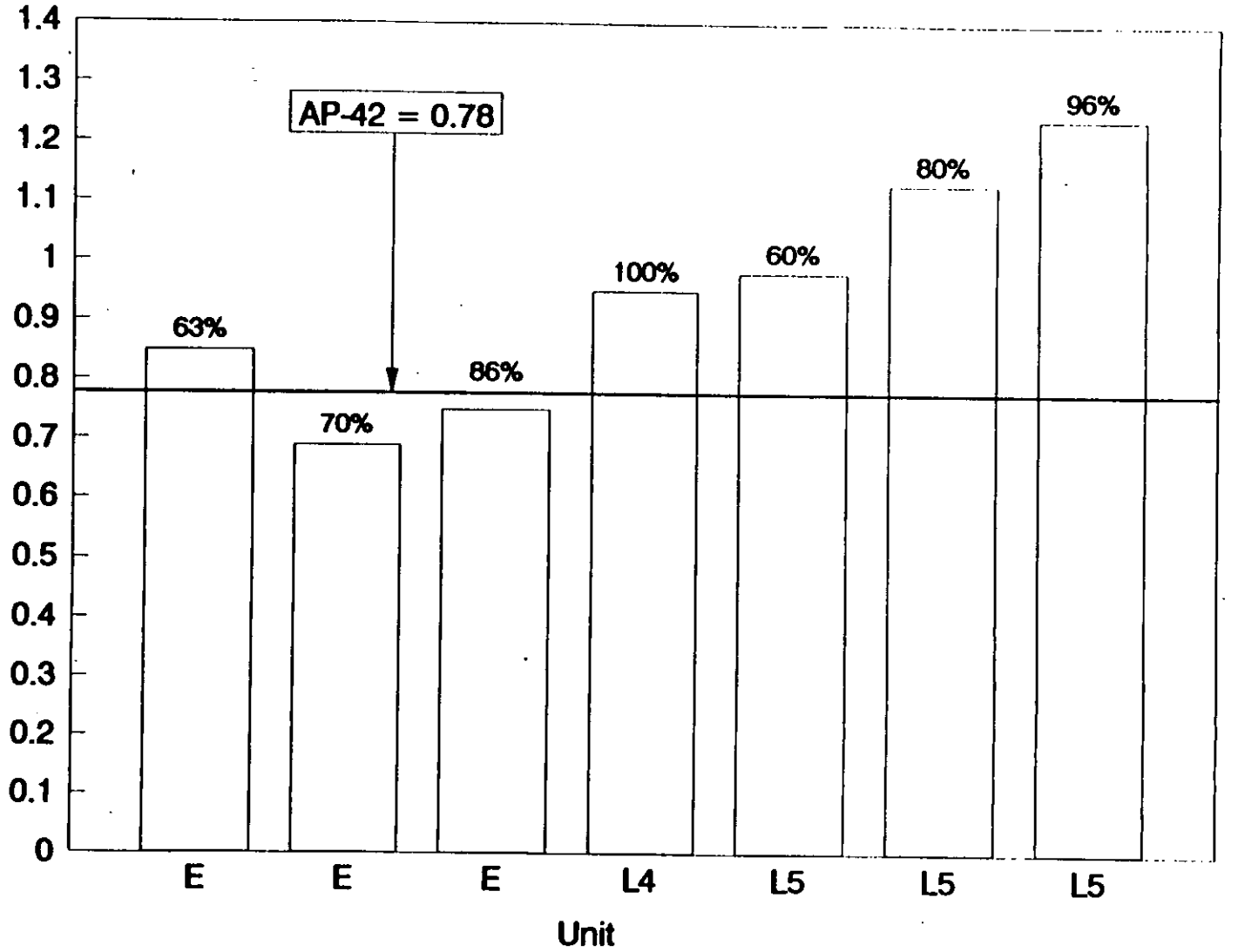

Figure 5. NOx emissions, horizontally opposed wall-fired units.

TABLE 8. SUMMARY OF NO_x EMISSIONS DATA FOR SINGLE WALL-FIRED UNITS

ID[a]	Plant	Unit No.	Capacity, MW	Average Test Load, %	Average NO_x, lb/mBtu	AP-42[b]	% Difference Average - AP-42
F	Colbert	3	200	67	0.68	0.78	-13
F	Colbert	3	200	100	0.77	0.78	-1
G	Colbert	4	200	63	0.67	0.78	-14
G	Colbert	4	200	100	0.68	0.78	-13
H	Johnsonville	7	170	76	1	0.78	28
I	Johnsonville	8	170	71	0.86	0.78	10
J	Johnsonville	10	170	79	0.97	0.78	24
K	Shawnee	2	175	79	0.8	0.78	3
L	Shawnee	6	175	88	0.79	0.78	1
L	Shawnee	6	175	87	0.85	0.78	9
M	Shawnee	8	175	85	0.77	0.78	-1
N	Shawnee	9	175	88	0.83	0.78	6
E11	Widows Creek	5	125	78	0.91	0.78	17
E11	Widows Creek	5	125	82	0.90	0.78	15
E11	Widows Creek	5	125	97	0.81	0.78	4
E12	Widows Creek	6	125	90	0.91	0.78	17
E12	Widows Creek	6	125	100	0.79	0.78	1
E13	Crist	6	340	80	1.06	0.78	36
E13	Crist	6	340	94	1.06	0.78	35

(Continued)

TABLE 8. SUMMARY OF NO_x EMISSIONS DATA FOR SINGLE WALL-FIRED UNITS (CONTINUED)

ID[a]	Plant	Unit No.	Capacity, MW	Average Test Load, %	Average NO_x, lb/mBtu	AP-42[b]	% Difference Average - AP-42
E13	Crist	6	340	103	1.12	0.78	44
E14	E.D. Edwards	2	260	81	0.89	0.78	14
E14	E.D. Edwards	2	260	97	0.96	0.78	23
E15	Dave Johnson	2	105	96	0.59	0.78	-24
L6	Edgewater	4	105	100	0.89	0.78	14
Average					0.85	0.78	9
Emission Factor					23	21	9

[a]Letters F through N = TVA units; E = units identified through AP-42 references; and L = units identified through the literature search.

[b]Calculated by using 13,500 Btu/lb.

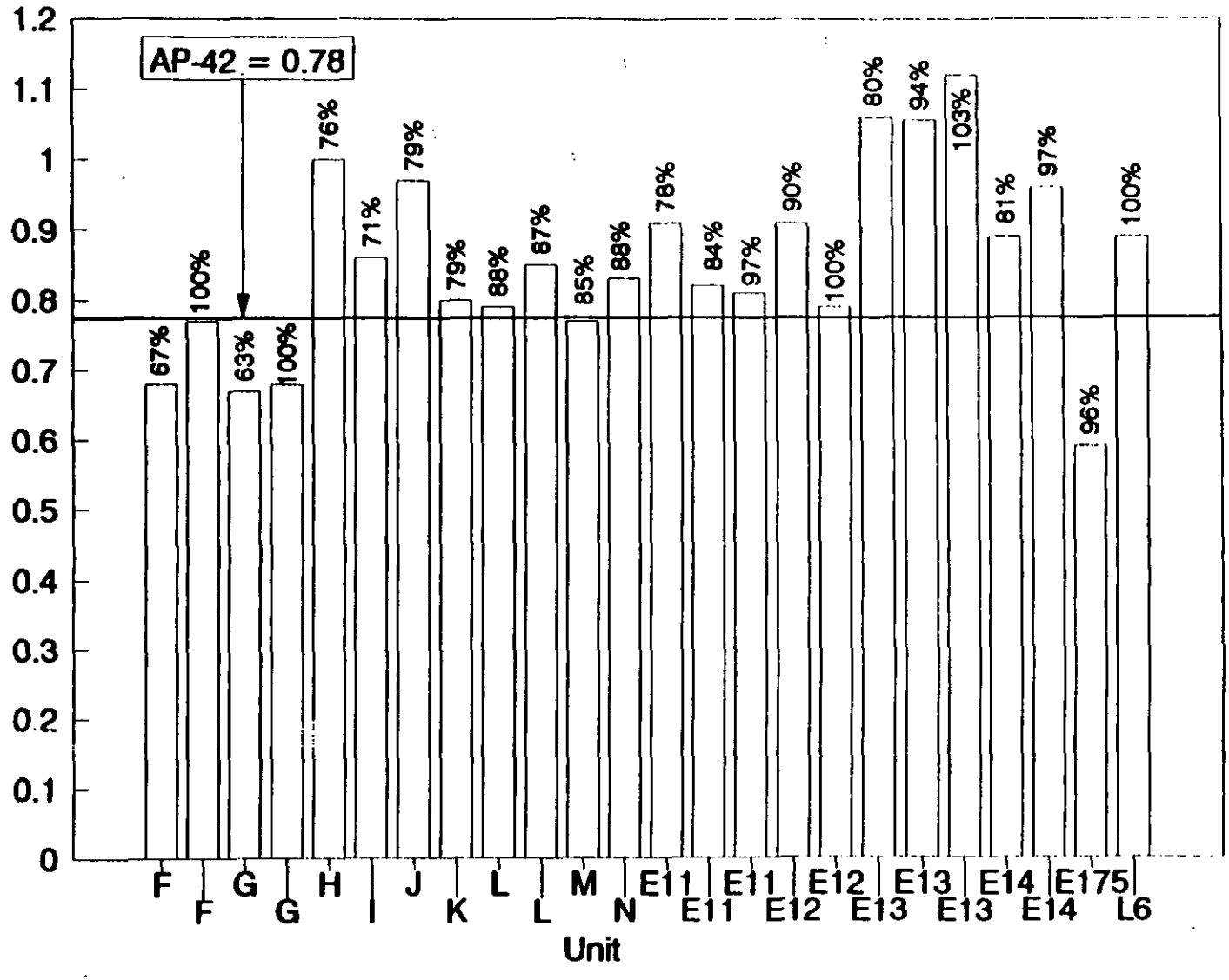

Figure 6. NOx emissions, single wall-fired units.

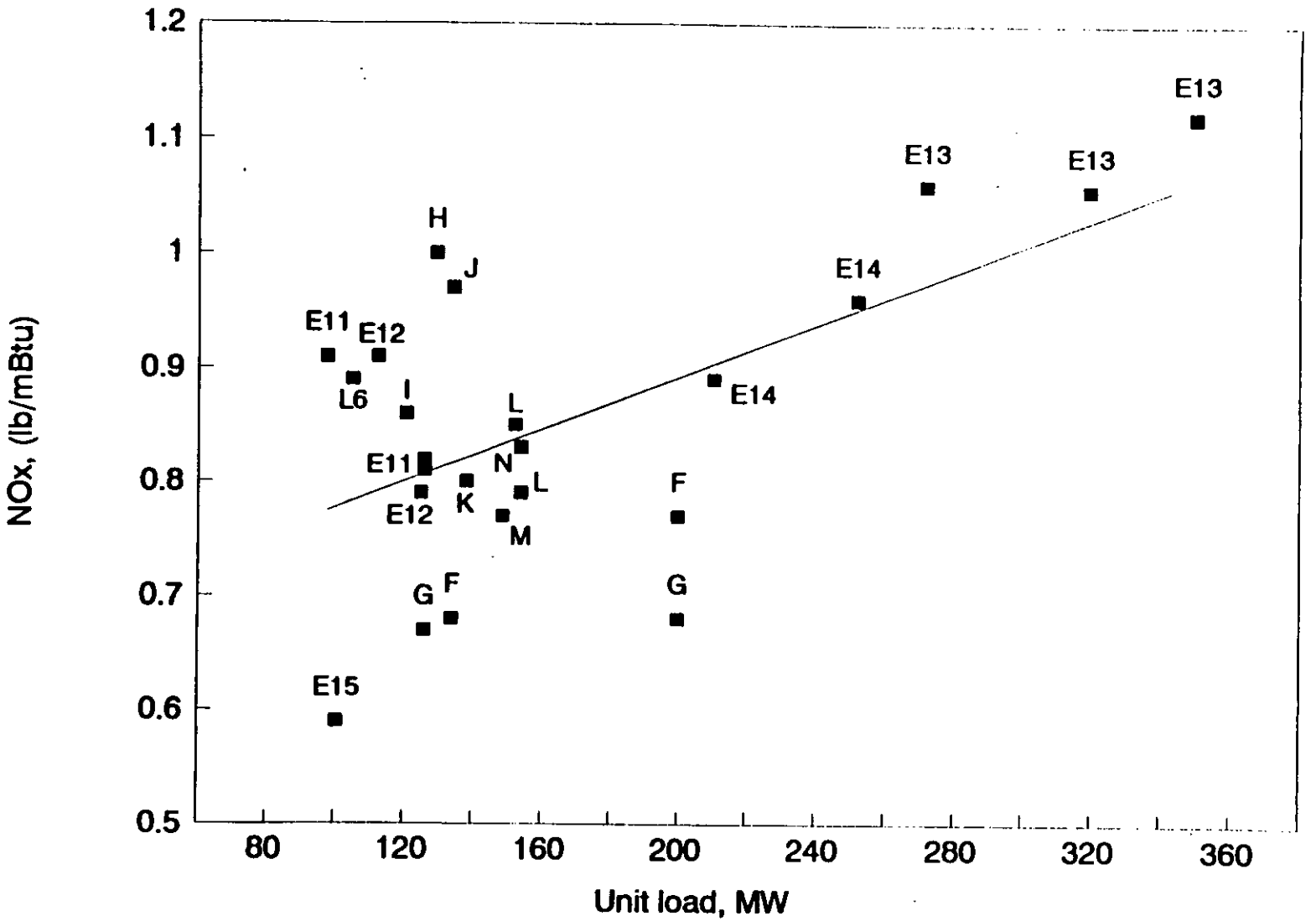

Figure 7. Effect of load on NOx emissions from single wall-fired units.

TANGENTIALLY FIRED BOILERS

Single-Furnace

Table 9 shows data for 17 single-furnace tangential units that range in size from 125 MW to 400 MW. The percent loads tested in this data set range from 60-100 percent. The complete data set is shown in Figure 8 (percent load is shown for each boiler).

The NO_x data range from 0.36 to 0.75 lb/mBtu, with an overall average of 0.56 lb/mBtu, which corresponds exactly with the AP-42 rate. The TVA units averaged 0.48 lb/mBtu, which is 16 percent lower than the AP-42 rate. The overall NO_x emission average for the non-TVA units is 0.60 lb/mBtu, which is slightly higher than the AP-42 rate.

As shown in Figure 9, there is considerable variation in the NO_x emissions from similar-size units. However, there is a slight trend of decreasing NO_x emissions with decreasing load.

Twin-Furnace

Table 10 shows data from 12 twin-furnace tangential units that range in size from 200 MW to 800 MW. The NO_x data range from 0.55-0.72 lb/mBtu. The overall average for the complete data set is 0.62 lb/mBtu, which is 11 percent higher than the AP-42 rate. This corresponds to an emission factor of 17 lb/ton. The complete data set is shown in Figure 10 (percent load is shown for each boiler).

TABLE 9. SUMMARY OF NO_x EMISSIONS DATA FROM SINGLE-FURNACE TANGENTIALLY FIRED UNITS

ID[a]	Plant	Unit No.	Capacity, MW	Average Test Load, %	Average NO_x, lb/mBtu	AP-42[b]	% Difference Average - AP-42
O	Johnsonville	1	125	91	0.52	0.56	-7
P	Johnsonville	2	125	94	0.36	0.56	-36
Q	Johnsonville	3	125	98	0.50	0.56	-11
R	Johnsonville	4	125	86	0.38	0.56	-32
S	Johnsonville	5	125	84	0.37	0.56	-34
T	Johnsonville	6	125	96	0.48	0.56	-14
U	Kingston	4	175	83	0.73	0.56	30
E16	Comanche[c]	1	350	95	0.54	0.56	-4
E17	Naughton	3	330	60	0.63	0.56	12
E17	Naughton	3	330	78	0.74	0.56	32
E17	Naughton	3	330	86	0.70	0.56	25
E17	Naughton	3	330	95	0.75	0.56	34
E18	Barry	2	130	95	0.46	0.56	-18
E19	Barry	4	350	83	0.54	0.56	-4
E19	Barry	4	350	95	0.55	0.56	-2
E20	Dave Johnson	4	340	91	0.52	0.56	-7
L7	Smith	2	180	61	0.60	0.56	7
L7	Smith	2	180	100	0.60	0.56	7
L8	Hunter	2	400	100	0.69	0.56	23

(Continued)

TABLE 9. SUMMARY OF NO_x EMISSIONS DATA FROM SINGLE-FURNACE TANGENTIALLY FIRED UNITS (CONTINUED)

ID[a]	Plant	Unit No.	Capacity, MW	Average Test Load, %	Average NO_x, lb/mBtu	AP-42[b]	% Difference Average - AP-42
L9	Lawrence	5	400	100	0.55	0.56	-2
L10	Cherokee	4	350	100	0.53	0.56	-5
L11	Valmont	5	165	100	0.66	0.56	18
Average					0.56	0.56	1
Emission Factor					15	15	1

[a]Letters O through U = TVA units; E = units identified through AP-42 references; and L = units identified through AP-42 references; and L = units identified through the literature search.

[b]Calculated by using 13,500 Btu/lb.

[c]Equipped with overfire air ports, therefore, baseline data without overfire air used in analysis.

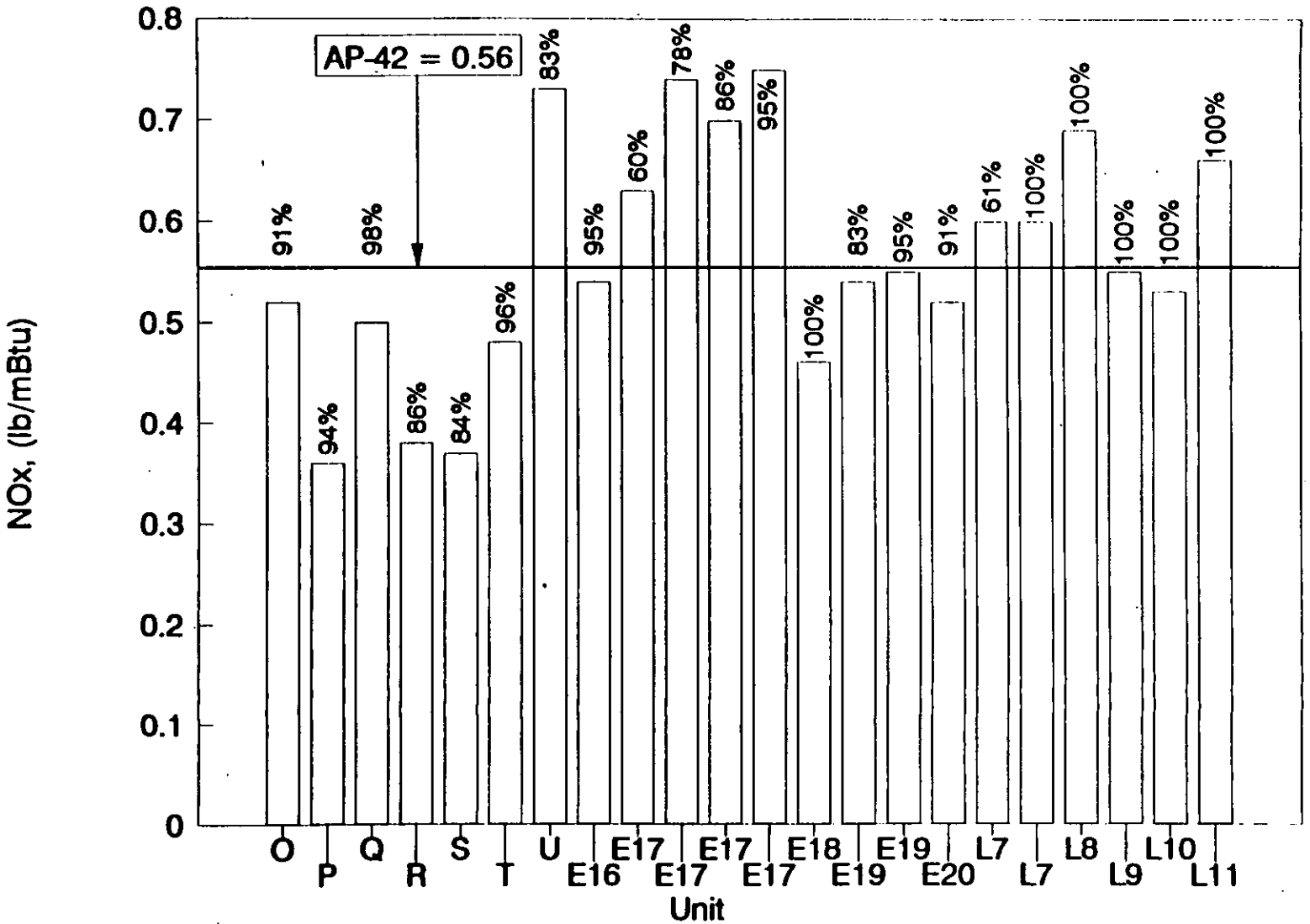

Figure 8. NOx emissions, single-furnace, tangential units.

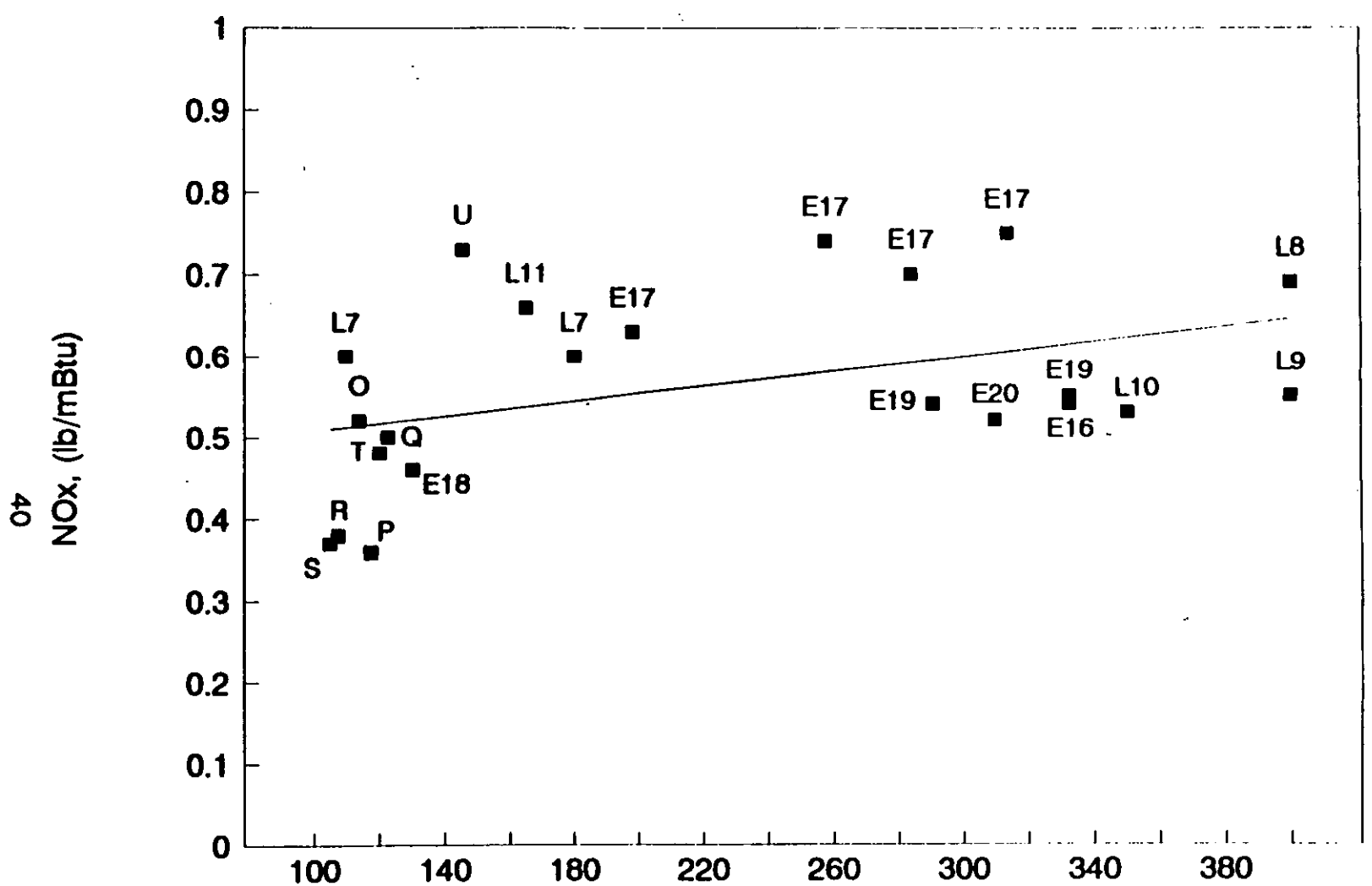

Figure 9. Effect of load on NOx emissions from single-furnace tangential units.

TABLE 10. SUMMARY OF NO_x EMISSIONS DATA FROM TWIN-FURNACE TANGENTIALLY FIRED UNITS

ID[a]	Plant	Unit No.	Capacity, MW	Average Test Load, %	Average NO_x, lb/mBtu	AP-42[b]	% Difference Average - AP-42
V	Gallatin	1	300	87	0.58	0.56	4
W	Gallatin	2	300	85	0.6	0.56	7
X	Gallatin	3	300	85	0.59	0.56	5
Y	John Sevier	2	200	100	0.56	0.56	0
Z	John Sevier	3	200	100	0.69	0.56	23
AA	John Sevier	4	200	100	0.64	0.56	14
BB	Kingston	5	200	100	0.64	0.56	14
CC	Widows Creek	7	575	90	0.72	0.56	29
DD	Widows Creek	8	550	76	0.57	0.56	2
E21	Barry	3	250	100	0.55	0.56	-2
E22	Navajo	2	800	100	0.67	0.56	20
L12	Kingston	6	200	90	0.67	0.56	20
Average					0.62	0.56	11
Emission Factor					17	15	11

[a]Letters V through DD = TVA units; E = units identified through AP-42 references; and L = units identified through the literature search.

[b]Calculated by using 13,500 Btu/lb.

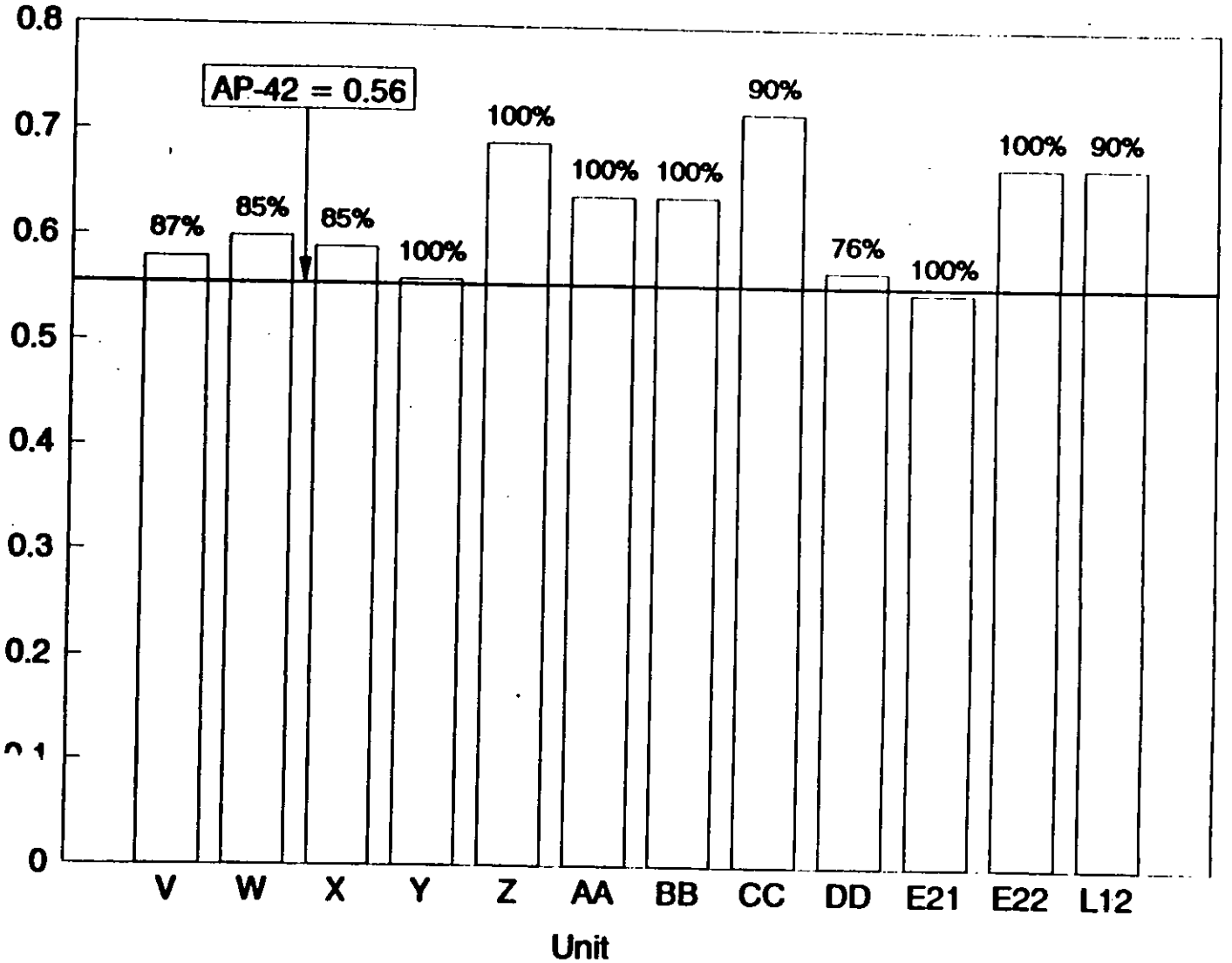

Figure 10. NOx emissions, twin-furnace, tangential units.

The TVA units averaged 0.62 lb/mBtu, which is 11 percent higher than the AP-42 rate. The remainder of the data set averaged 0.63 lb/mBtu, which again is higher than the AP-42 rate.

As shown in Figure 11, there is less scatter in the NO_x emissions from units of similar size than with the single-furnace tangential units. There appears to be a correlation between unit load and NO_x emissions, with higher NO_x being emitted from the larger units.

OTHER RESULTS

Effect of Fuel Nitrogen

Figure 12 represents NO_x as a function of fuel nitrogen for the TVA data. No clear trend is shown because most of the data fall within 0.4-0.8 lb/mBtu for fuel nitrogen values of 1.3-1.8 percent. The highest NO_x is from the cyclone and cell units. The fuel analysis for the TVA units is given in Appendix B.

Effect of Fuel Ratio

Figure 13 shows NO_x as a function of fuel ratio for the TVA data. The fuel ratio is the ratio of fixed carbon to volatile matter. Generally, NO_x increases as the fuel ratio increases;[16] however, no clear trend can be established with the TVA data.

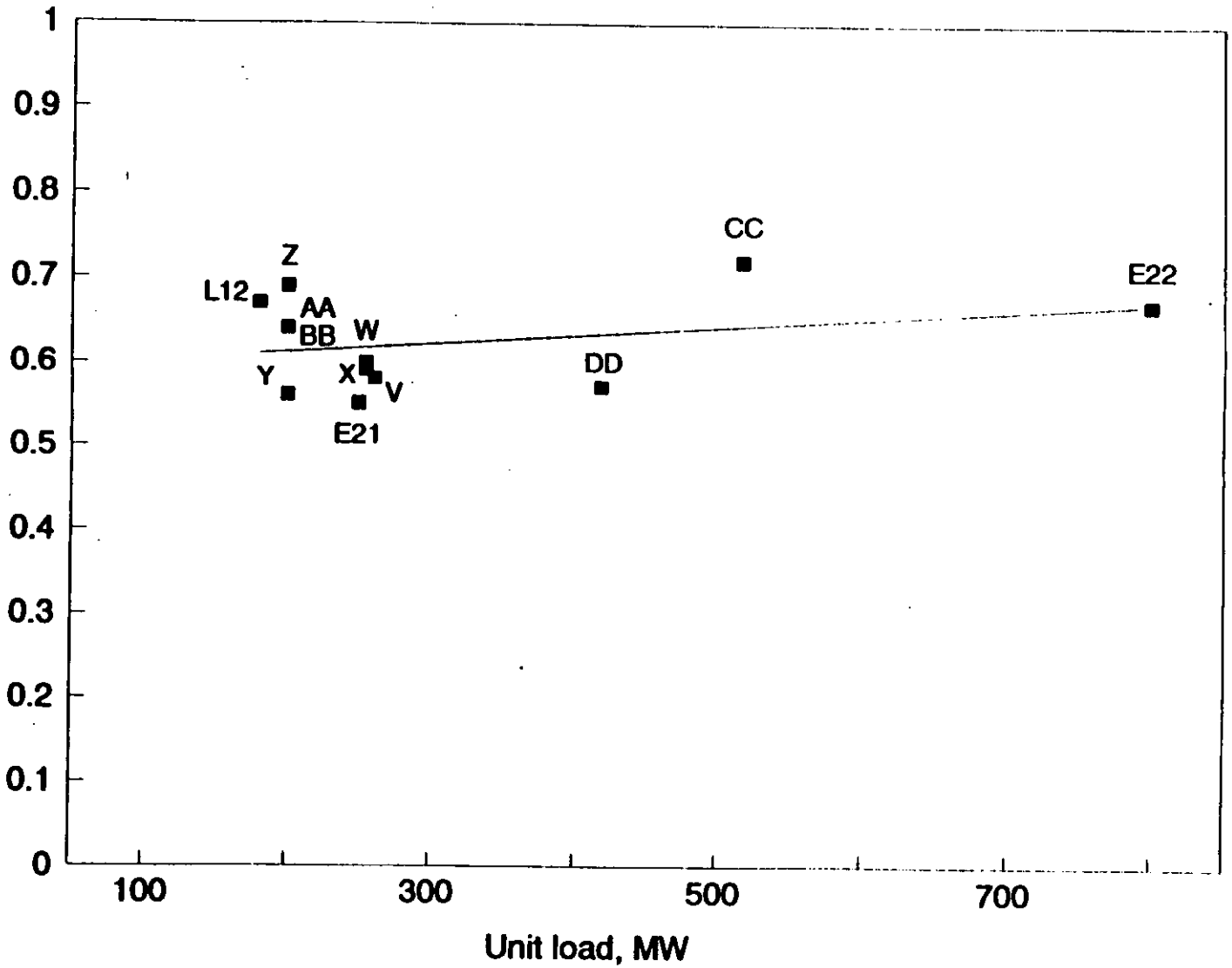

Figure 11. Effect of load on NOx emissions from twin-furnace tangential units.

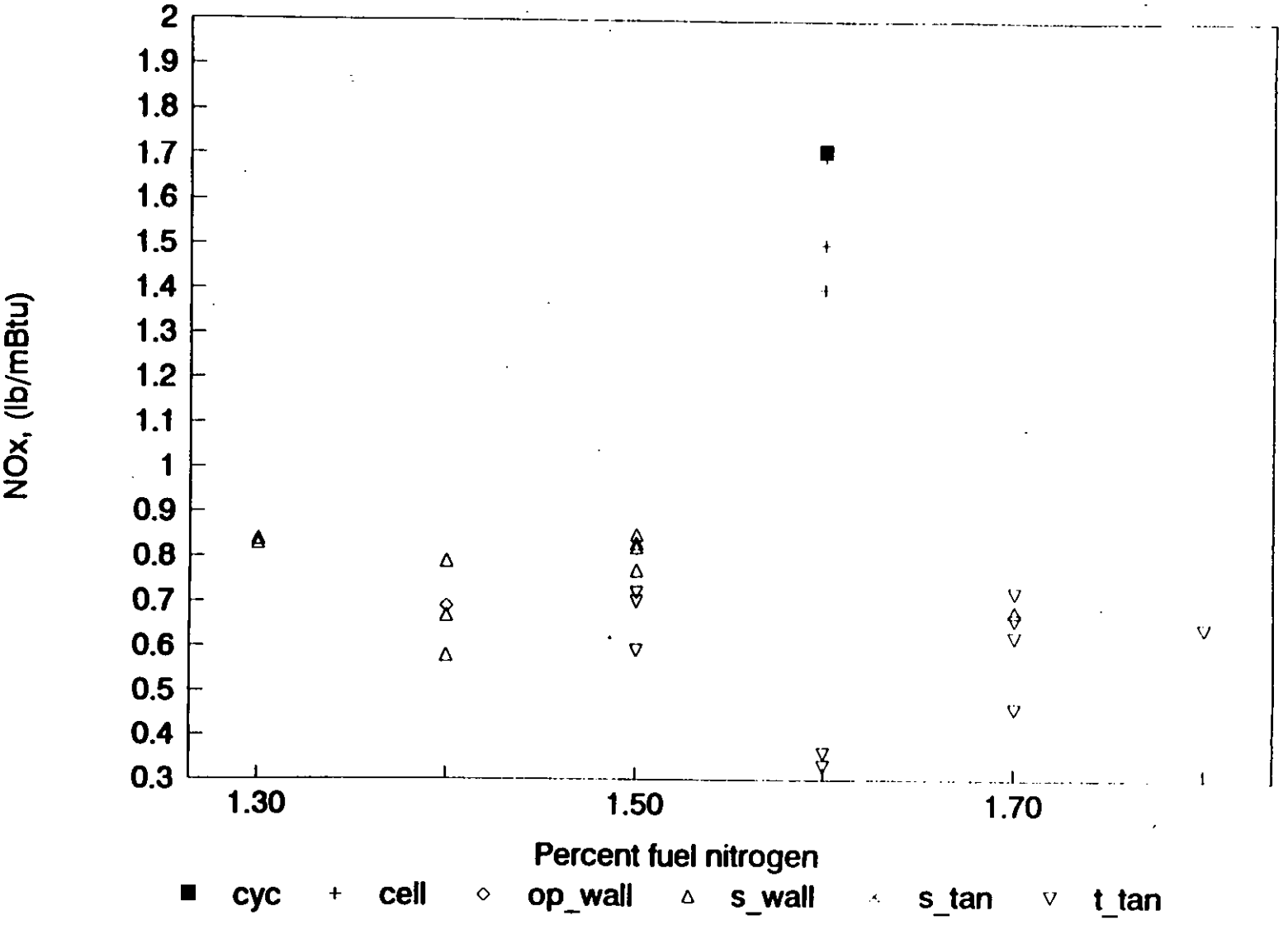

Figure 12. NOx vs. fuel nitrogen.

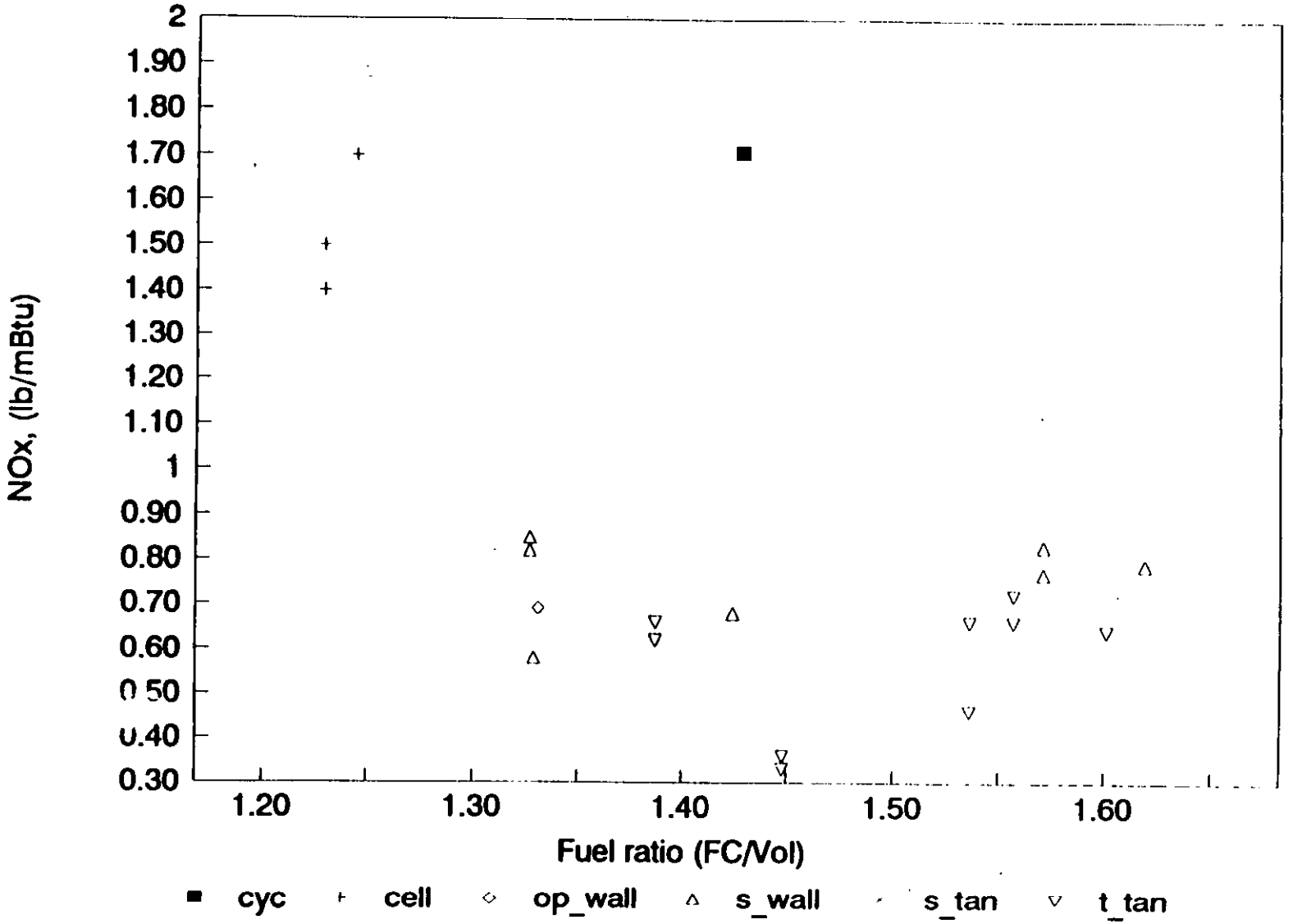

Figure 13. NOx vs. fuel ratio.

SECTION 6

EMISSION FACTOR RATINGS

The AP-42 document rates emission factors for pulverized coal-fired dry bottom units and cyclone furnaces. Ratings are based on the number of units tested, as follows:

A	=	10 or more units (excellent)
B	=	6-9 units
C	=	2-5 units
D	=	1 unit (poor)

The current AP-42 document shows an "A" Rating for pulverized coal, dry bottom boilers. This rating is deceptive in that it includes both tangentially fired and wall-fired boilers. The AP-42 references indicate that only seven tangentially fired boilers and seven wall-fired units were tested. The current rating for cyclone furnaces is "B."

A comparison of the number of units and ratings for the AP-42-references boilers, the TVA boilers, and the boilers identified from the literature are shown in Table 11. This table shows that emission factor ratings can be generated for boiler subclasses by combining all the data. By doing so, "A" ratings are obtained for all subclasses except for cell-burners ("B") and horizontally opposed wall-fired boilers ("C").

TABLE 11. COMPARISON OF AP-42 EMISSION FACTOR RATINGS

Firing Configuration	Number of Units				NO_x Emission Factor Rating			
	AP-42[a]	TVA	Literature[b]	Combined	AP-42[a]	TVA	Literature[b]	Combined
Pulverized Coal-Fired Dry Bottom[c]	14	28	10	52	A	A	A	A
Cell Burner Wall-Fired	2	2	1	5	NR[d]	C	D	B
Horizontally Opposed Wall-Fired	0	1	2	3	NR	D	C	C
Single Wall-Fired	5	9	1	15	NR	B	D	A
Single-Furnace Tangentially Fired	5	7	5	17	NR	B	C	A
Twin-furnace Tangentially Fired	2	9	1	12	NR	B	D	A
Cyclone Furnace	8	2	2	12	B	C	C	A

[a]AP-42 referenced boilers.

[b]Additional boilers from literature search.

[c]Includes cell-burner wall-fired; horizontally opposed wall-fired; single wall-fired; single-furnace tangentially fired; and twin-furnace tangentially fired units.

[d]NR = No rating given in AP-42 document.

SECTION 7

REFERENCES

1. Office of Air Quality Planning and Standards, Compilation of Air Pollution Emission Factors, Volume 1: Stationary Point and Area Sources, AP-42, Fourth Edition (GPO 055-000-00251-7). U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. September 1985 [supplemented October 1986 (GPO 055-000-00265-7) and September 1988 (GPO 055-000-00278-9)], pp 1.1-1 - 1.1-17.

2. U.S. Environmental Protection Agency. Code of Federal Regulations. Part 60, Appendix A, Methods 3A and 7E, 7-1-89 Edition.

3. Ctvrtnicek, T.E., and S.J. Rusek. Applicability of NO_x Combustion Modifications to Cyclone Boilers (Furnaces). EPA-600/7-77-006 (NTIS PB263-960), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, January 1977.

4. Booth, R.C., R.E. Hall, R.A. Lott, A. Kokkinos, D.F. Gyorke, S. Durrani, H.J. Johnson, J.J., Kienle, R.W. Borio, R.D. Lewis, and M.B. Keough. Reburn Technology for NO_x Control on a Cyclone-Fired Boiler. In Proceedings: 1991 Joint Symposium on Stationary Combustion NO_x Control, EPRI GS-7447, Volume I.

5. Yagiela, A.S., G.J. Maringo, R.J. Newell, and H. Farzan. Update on Coal Reburning Technology for Reducing NO_x in Cyclone Boilers. In Proceedings: 1991 Joint Symposium on Stationary Combustion NO_x Control, EPRI GS-7447, Volume I.

6. Crawford, A.R., E.H. Manny, and W. Bartok. Control of Utility Boiler and Gas Turbine Pollutant Emissions by Combustion Modification - Phase I. EPA-600/7-78-036a (NTIS PB281-078), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. March 1978.

7. Vatsky, J., and T.W. Sweeney. Development of an Ultra-Low NO_x Pulverized Coal Burner. In Proceedings: 1991 Joint Symposium on Stationary Combustion NO_x Control, EPRI GS-7447, Volume I.

8. Sawyer, J.W., and E.B. Higginbotham. Combustion Modification NO_x Controls for Utility Boilers. Volume II: Pulverized-Coal Wall-Fired Unit Field Test, EPA-600/7-81-124b (NTIS PB82-227273), July 1981.

9. Wilson, S.M., J.N. Sorge, L.L. Smith, and L.L. Larsen. Demonstration of Low NO_x Combustion Control Technologies on a 500 MWe Coal Fired Utility Boiler. In Proceedings: 1991 Joint Symposium on Stationary Combustion NO_x Control, EPRI GS-7447, Volume I.

10. LaRue, A.D. The XCL Burner - Latest Developments and Operating Experience. In Proceedings: 1989 Joint Symposium on Stationary Combustion NO_x Control, Volume I, EPA-600/9-89/062a (NTIS PB89-220529), June 1989.

11. Hardman, R.R., S.M. Wilson, and J.D. McDonald. Advanced Tangentially-Fired Combustion Techniques for the Reduction of Nitrogen Oxide (NO_x) Emissions from Coal-Fired Boilers. Presented at the Eighth Annual International Pittsburgh Coal Conference, Pittsburgh, Pennsylvania, October 14-18, 1991.

12. Kokkinos, A., and R.D. Lewis. Field Evaluation of a Low-NO_x Firing System for Tangentially Coal-Fired Utility Boilers. EPA-600/7-85-018 (NTIS PB85-201093), May 1985.

13. Thompson, R.E., G.H. Shiomoto, D.E. Shore, M.D. McDannel, and D. Eskinazi. NO_x Emissions Results for a Low-NO_x PM Burner Retrofit. In Proceedings: 1989 Joint Symposium on Stationary Combustion NO_x Control, Volume 1, EPA-600/9-89/062a (NTIS PB89-220529), June 1989.

14. Hunt, T.G., R.R. Hawley, R.C. Booth, and B.P. Breen. Retrofit Experience Using LNCFS on 350 MW and 165 MW Coal-Fired Tangential Boilers. In Proceedings: 1991 Joint Symposium on Stationary Combustion NO_x Control, EPRI GS-7447, Volume I.

15. Higginbotham, E.B., and P.M. Goldberg. Combustion Modification NO_x Controls for Utility Boilers: Volume 1. Tangential Coal-Fired Unit Field Test. EPA-600/7-81-124a (NTIS PB82-227265), July 1981.

16. How Fuel Quality Affects NO_x Formation - and CAA Compliance. Power Magazine, July 1991, Volume No. 135, No. 7, p. 54-56, 81.

APPENDIX A

TVA TEST DATA

ALLEN UNIT 1

TIME	(1) LOAD MW	(2) BOILER %O2	(3) VAN %O2 DRY	(4) VAN NO, PPM 3%O2	(5) VAN NO LB/MBTU	(6) CEM NO, PPM 3%O2	(7) CEM NO LB/MBTU	(8) CEM %O2
01/09/90								
1033-1100	270	2.8	8.02	1188	1.71	843	1.21	7.20
1100-1115	273	2.8	8.03	1201	1.72	882	1.26	7.20
1115-1127	271	2.8	8.04	1181	1.71	878	1.26	7.20
1130-1145	272	2.8	8.02	1215	1.74	907	1.30	7.20
1145-1200	273	2.8	8.01	1218	1.75	914	1.31	7.20
1200-1215	273	2.8	8.00	1223	1.76	895	1.28	7.20
1215-1230	272	2.7	7.86	1246	1.78	928	1.33	7.20
1248-1300	271	2.7	7.41	1150	1.65	932	1.33	7.00
1300-1315	271	2.7	7.95	1200	1.72	904	1.29	7.00
1315-1330	266	2.7	7.97	1184	1.70	998	1.43	7.00
1330-1345	268	2.7	8.00	1189	1.71	938	1.34	7.00
1345-1400	268	2.7	8.06	1201	1.73	910	1.30	7.00
1417-1430	267	3.1	8.19	1149	1.65	877	1.25	7.00
1450-1445	267	3.2	8.16	1151	1.65	838	1.20	7.00
1445-1500	268	3.0	8.24	1152	1.66	884	1.26	7.20
UNIT 1 AIR HEATER OUTLET "B" SIDE								
01/10/90								
0930-0945	270	2.9	7.99	1215	1.74	898	1.28	7.20
0945-1000	270	3.2	7.96	1218	1.75	881	1.26	7.40
1035-1045			8.48	1181	1.70			
1045-1100			8.92	1040	1.50			
1100-1111			8.48	1120	1.61			
1305-1315			8.46	772	1.11			
1315-1330	190	2.80	8.84	716	1.03	631	0.90	7.60
1330-1345	180	4.00	8.64	753	1.08	487	0.71	8.20
1345-1400	193	3.80	8.78	853	1.23	578	0.83	8.30
1400-1415	210	3.20	7.86	798	1.16	573	0.82	7.70
1415-1430	200	3.60	8.40	818	1.18	623	0.89	8.20

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period. (most cases)
(4) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(5) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.
(6) CEM measurement of NO, ppm, corrected to 3% O2, 15 min. readings from control board.
(7) Emission rate, NO, lb/mBTU, calculated from CEM NO measurements and CEM O2 readings.
(8) CEM measurement of stack O2, 15 min. readings from control board.

COLBERT UNIT 3

COLBERT UNIT 3 BASELINE HIGH LOAD TEST

			VAN							
07-23-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
1717-1730	199	5.0	493	7.63	33.5	11.27	393	530	0.73	1.27
1730-1745	199	5.0	484	7.75	33.4	11.08	405	552	0.76	1.25
1745-1800	199	5.0	481	7.78	33.3	10.97	407	555	0.76	1.25
1800-1815	200	5.0	483	7.77	31.2	10.93	406	555	0.76	1.25
18150830	200	5.0	483	7.77	34.0	10.86	409	558	0.76	1.25
1830-1845	200	5.0	477	7.78	36.0	10.75	409	558	0.76	1.24
1845-1900	200	5.0	472	7.81	34.3	10.73	409	559	0.76	1.23
1900-1915	200	5.1	474	7.80	37.6	10.70	410	560	0.77	1.23
1915-1930	200	5.1	474	7.81	38.1	10.68	413	565	0.77	1.23
1930-1945	200	5.1	474	7.80	37.1	10.62	418	571	0.78	1.23
1945-2000	200	5.1	484	7.80	40.5	10.62	418	571	0.76	1.26
2000-2015	200	5.1	492	7.75	41.7	10.64	416	567	0.78	1.27
2015-2030	200	5.1	490	7.80	40.4	10.51	413	564	0.77	1.27
2030-2045	200	5.1	495	7.75	43.0	10.43	414	563	0.77	1.28
2045-2100	200	5.0	500	7.73	43.9	10.43	417	567	0.78	1.29
2100-2115	200	5.0	499	7.75	41.9	10.44	417	568	0.78	1.29
2115-2130	200	5.0	502	7.75	46.1	10.47	414	564	0.77	1.30
FILE AVG:	200	5.0	486	7.77	38.0	10.71	411	560	0.77	1.26

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

COLBERT UNIT 3

COLBERT UNIT 3 BASELINE MEDIUM LOAD TEST

07-24-1991 TIME	(1) LOAD MW	(2) BOILER O2	VAN (3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
0148-0200	133	5.2	512	8.35	37.2	11.04	349	498	0.68	1.39
0200-0215	133	5.2	513	8.39	33.9	11.03	345	493	0.68	1.40
0215-0230	133	5.3	516	8.36	36.8	11.09	349	498	0.68	1.40
0230-0245	133	5.3	517	8.38	33.1	11.14	346	495	0.68	1.41
0245-0300	133	5.3	513	8.37	36.6	11.14	344	491	0.67	1.39
0300-0315	133	5.3	513	8.39	36.5	11.12	344	493	0.67	1.40
0315-0330	134	5.3	515	8.36	36.2	11.14	346	493	0.68	1.40
0330-0345	134	5.2	518	8.33	39.0	11.12	345	492	0.67	1.40
0345-0400	134	5.3	516	8.32	38.3	11.10	345	491	0.67	1.40
0400-0415	134	5.3	505	8.36	41.7	11.04	345	493	0.67	1.37
0415-0430	134	5.3	516	8.35	38.5	11.04	348	497	0.68	1.40
0430-0445	134	5.0	519	8.33	43.9	11.05	350	499	0.68	1.41
0445-0500	134	5.0	520	8.35	42.5	11.07	344	491	0.67	1.41
FILE AVG:	134	5.2	515	8.36	38.0	11.09	346	494	0.68	1.40

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

COLBERT UNIT 3

17-22-1991

COLBERT UNIT 3 LOW NOX BURNER TEST

TIME	(1) LOAD MW	(2) BOILER O2	VAN (3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mBtu	(10) SO2 lb/mBtu
1030-1045	199	4.1	536	7.61	51.3	11.76	428	576	0.79	1.37
1045-1100	199	3.8	536	7.47	51.0	11.84	415	554	0.75	1.36
1100-1115	199	3.3	553	7.10	82.9	12.11	399	517	0.71	1.37
1115-1130	196	3.3	564	6.94	157.2	12.19	393	503	0.69	1.38
1130-1145	195	3.3	568	6.88	185.2	12.19	393	502	0.69	1.38
1145-1200	194	3.3	565	6.87	184.1	12.15	396	505	0.69	1.37
1200-1215	193	3.3	563	6.89	189.9	12.09	397	508	0.69	1.37
1215-1230	193	3.3	562	6.86	198.7	12.08	399	509	0.70	1.36
1230-1245	194	3.3	551	6.83	198.6	11.99	400	509	0.70	1.33
1245-1300	194	3.3	556	6.84	198.6	11.88	404	514	0.70	1.35
1315-1330	194	3.3	556	6.82	204.6	11.67	404	514	0.70	1.35
1330-1345	194	3.3	558	6.83	214.2	11.50	406	517	0.71	1.35
1345-1400	194	3.2	555	6.81	214.2	11.40	410	520	0.71	1.34
1400-1415	194	3.2	557	6.79	209.0	11.32	410	519	0.71	1.35
1415-1430	195	3.2	553	6.78	220.2	11.24	410	519	0.71	1.34
1430-1445	195	3.2	555	6.74	222.7	11.19	410	519	0.71	1.34
1445-1500	194	3.0	556	6.72	217.5	11.17	413	521	0.71	1.33
1500-1517	194	3.1	552	6.71	240.1	11.20	410	518	0.71	1.33
FILE AVG:	195	3.3	555	6.92	180.0	11.72	405	519	0.71	1.35

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

COLBERT UNIT 3

COLBERT UNIT 3 BASELINE LOW LOAD

07-23-1991 TIME	(1) LOAD MW	(2) BOILER O2	VAN (3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
0130-0145	59	6.1	477	9.19	90.0	9.93	148	224	0.31	1.39
0145-0200	59	6.1	481	9.05	85.2	10.05	145	219	0.30	1.38
0200-0215	59	6.1	485	8.90	120.4	10.14	139	207	0.28	1.38
0215-0230	60	5.7	472	9.15	93.4	9.90	140	213	0.29	1.37
0230-0245	61	5.6	469	9.20	83.8	9.85	141	215	0.29	1.37
0245-0300	60	6.3	463	9.25	95.9	9.76	139	213	0.29	1.36
0300-0315	60	6.3	460	9.37	78.6	9.69	142	221	0.30	1.36
0315-0330	60	6.2	457	9.40	73.3	9.62	148	230	0.31	1.35
0330-0345	60	6.2	448	9.40	67.1	9.63	150	234	0.32	1.33
0345-0400	60	6.1	457	9.31	69.5	9.70	151	234	0.32	1.34
0400-0415	60	6.1	459	9.36	70.6	9.66	148	230	0.31	1.35
0415-0430	60	6.0	465	9.28	69.3	9.76	146	225	0.31	1.36
0430-0445	60	6.0	459	9.23	70.9	9.79	148	224	0.31	1.34
0445-0500	60	6.1	455	9.26	69.4	9.69	145	225	0.31	1.34
0500-0515	60	5.8	458	9.20	77.0	9.77	143	219	0.30	1.33
0515-0530	60	6.0	455	9.30	71.9	9.69	144	223	0.30	1.33
0530-0540	60	6.0	452	9.29	74.6	9.66	146	225	0.31	1.33
FILE AVG:	60	6.0	463	9.25	80.1	9.78	145	222	0.30	1.35

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

RESULTS

A summary of the testing is listed below. The data is shown is the attached graph.

3/7/90 UNIT 4 ESP INLET

TIME PERIOD	(1) LOAD	(2) BOILER O2	(3) VAN %O2 DRY	(4) VAN NO,ppm 3% O2	(5) VAN NO lb/mBtu
0909-0915	198	3.4	7.9	457	0.66
0915-0930	199	3.2	7.9	454	0.65
0930-0945	199	3.2	8.0	468	0.67
0945-1000	199	3.2	8.1	463	0.67
1030-1045	199	3.2	8.5	512	0.74
1045-1100	198	3.2	8.5	471	0.68
1100-1115	200	3.2	8.4	472	0.68
1115-1130	200	3.1	8.4	481	0.69
AVERAGES	200	3.2	8.2	472	0.68
1219-1230	125	4.1	9.0	520	0.75
1230-1245	125	4.1	9.0	501	0.72
1245-1252	125	4.2	9.1	500	0.72
1530-1545	125	4.5	9.1	406	0.59
1545-1600	125	4.6	9.0	399	0.58
AVERAGES	125	4.3	9.0	475	0.67

NOTES:

(1) Average unit load, recorded every 15 min. from control board.

(2) Average boiler O2%, recorded every 15 min. from control board.

(3) VAN measurement of O2% on a dry basis; 15-sec. readings averaged over a 15 min. period.

(4) VAN measurement of NO, ppm, corrected to 3% O2; 15-sec. readings averaged over a 15 min. period.

(5) Emission rate, NO, lb/mBtu, calculated from VAN NO measurements and VAN %O2.

COLBERT UNIT 5

COLBERT UNIT 5 SCR INLET S-1 DUCT FIGH LOAD

07-16-1991	(1)	(2)	VAN (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
TIME	LOAD MW	BOILER O2	SO2 ppm,dry	O2 %,dry	CO ppm,dry	CO2 %,dry	NO ppm,dry	NO PPM @ 3% O2	NO lb/mBtu	SO2 lb/mBtu
1630-1645	467	3.0	1248	6.96	47.7	12.15	378	486	0.67	3.05
1645-1700	468	3.0	1274	6.79	65.7	12.31	396	504	0.69	3.08
1700-1715	470	3.0	1275	6.75	75.0	12.31	403	509	0.70	3.07
1715-1730	472	3.9	1277	6.73	70.6	12.33	405	512	0.70	3.07
1730-1745	473	3.9	1269	6.64	75.2	12.39	401	504	0.69	3.08
1745-1800	470	3.7	1279	6.72	70.5	12.35	403	508	0.70	3.07
1800-1815	473	3.7	1288	6.63	96.1	12.44	401	503	0.69	3.07
1815-1830	473	3.6	1281	6.65	79.0	12.41	403	506	0.69	3.06
FILE AVG:	471	3.5	1276	6.73	72.5	12.34	399	504	0.69	3.07

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

COLBERT UNIT 5

COLBERT UNIT 5 ESP INLET A-1 DUCT HIGH LOAD

07-17-1991 TIME	(1) LOAD MW	(2) BOILER O2	VAN (3) SO2 ppm,dry	VAN (4) O2 %,dry	VAN (5) CO ppm,dry	VAN (6) CO2 %,dry	VAN (7) NO ppm,dry	VAN (8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
1119-1130	474	3.7	1150	8.02	14.4	11.54	423	588	0.81	3.04
1130-1145	474	3.7	1187	7.97	19.3	11.52	426	589	0.81	3.13
1145-1200	469	3.5	1193	8.01	23.1	11.45	423	587	0.80	3.15
1200-1215	469	3.5	1193	7.98	24.2	11.48	424	588	0.80	3.14
1215-1230	470	3.5	1181	8.01	25.8	11.40	425	590	0.81	3.12
1230-1245	473	3.7	1181	7.98	26.4	11.40	424	587	0.80	3.11
1245-1300	473	3.7	1183	7.94	29.3	11.42	422	583	0.80	3.11
1300-1318	475	3.7	1176	7.99	28.6	11.38	424	588	0.80	3.10
FILE AVG:	472	3.6	1180	7.99	23.9	11.45	424	587	0.80	3.11

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

COLBERT UNIT 5

07-17-1991
COLBERT UNIT 5 ESP INLET B-1 DUCT LOW LOAD

TIME	(1) LOAD MW	(2) BOILER O2	VAN (3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mBtu	(10) SO2 lb/mBtu
0345-0400	346	5.5	1155	7.95	20.7	11.56	433	599	0.83	3.04
0400-0415	346	5.5	1197	8.02	21.4	11.47	432	601	0.82	3.17
0415-0430	348	5.7	1198	8.02	22.3	11.47	432	601	0.82	3.16
0430-0445	351	5.7	1198	8.05	21.7	11.48	429	598	0.82	3.17
0445-0500	343	5.2	1194	8.06	22.2	11.46	427	596	0.82	3.17
0500-0515	343	5.2	1204	7.98	22.5	11.56	429	595	0.81	3.18
0515-0530	343	5.2	1203	7.98	23.6	11.61	429	595	0.81	3.17
0530-0545	348	5.2	1204	7.99	23.6	11.64	426	591	0.81	3.18
FILE AVG:	346	5.4	1194	8.01	22.3	11.53	430	597	0.82	3.15

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

COLBERT UNIT 5

COLBERT UNIT 5 ESP INLET A-1 DUCT

07-17-1991 TIME	(1) LOAD MW	(2) BOILER O2	VAN (3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mmbtu	(10) SO2 lb/mmbtu
0645-0700	348	6.0	1072	9.24	21.2	10.58	430	660	0.90	3.13
0700-0715	346	6.0	1075	9.29	22.0	10.50	431	665	0.91	3.15
0715-0730	347	6.0	1076	9.31	23.5	10.48	425	654	0.90	3.16
0730-0745	351	6.1	1079	9.24	24.0	10.56	416	639	0.87	3.15
0745-0800	351	6.1	1073	9.29	24.4	10.51	412	636	0.87	3.15
0800-0815	348	5.9	1077	9.23	25.5	10.55	413	633	0.87	3.14
0815-0830	348	5.9	1083	9.22	26.1	10.54	410	627	0.86	3.16
0830-0845	349	5.9	1080	9.25	27.2	10.52	410	630	0.86	3.16
FILE AVG:	349	5.8	1077	9.26	24.2	10.53	418	643	0.88	3.15

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

COLBERT UNIT 5

9/26/89 ESP INLET -- LOW LOAD
FIGURES 5 & 6

TIME PERIOD	(1) LOAD	(2) BOILER O2	(3) VAN %O2 DRY	(4) VAN NO,ppm 3% O2	(5) VAN NO lb/mBtu	(6) CEM %O2	(7) CEM NO,ppm 3% O2	(8) CEM NO lb/mBtu
-2100	385	5.5	8.4	488	0.70	8.6	627	0.90
2100-2115	384	5.3	8.4	486	0.70	8.7	653	0.94
2115-2130	384	5.4	8.5	477	0.70	8.7	658	0.95
2130-2145	386	5.3	8.5	462	0.67	8.7	651	0.94
2145-2200	385	5.3	8.5	460	0.66	8.6	643	0.93
-2230	387	5.5	8.6	478	0.71	8.6	649	0.93
2330-2345	386	5.3	8.6	482	0.69	8.6	646	0.93
2345-2300	385	5.3	8.6	470	0.68	8.6	645	0.93
AVERAGES	**385**	**5.4**	**8.5**	**475**	**0.69**	**8.6**	**647**	**0.93**

NOTES:

(1) Unit load recorded every 15 min. from control board.

(2) Average boiler O2%, recorded every 15 min. from control board.

(3) VAN measurement of O2% on a dry basis; 15-sec. readings averaged over a 15 min. period.

(4) VAN measurement of NO, ppm, corrected to 3% O2; 15-sec. readings averaged over a 15 min. period.

(5) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.

(6) CEM measurement of O2%, actual basis, read on a 15-min. basis from strip chart in control room.

(7) CEM measurement of NO, ppm, corrected to 3% O2, read on a 15-min. basis from strip chart in control room.

(8) Emission rate, NO, lb/mBTU, calculated from CEM NO and CEM %O2.

RESULTS

The results of the testing are as follows:

UNIT 1
7/6/89

TIME PERIOD	LOAD	BOILER O2	VAN %O2 DRY	VAN NO,PPM 3% O2	VAN NO LB/MBTU	CEM %O2 DRY	CEM NO,PPM DRY	CEM NO LB/MBTU
1200-1215	1020	6.3	8.0	1156	1.7	8.1	855	1.2
1215-1230	1016	6.6	8.2	1157	1.7	7.3	848	1.2
1230-1245	1015	6.4	8.3	1152	1.7	8.1	833	1.2
1245-1300	1015	6.5	8.3	1145	1.7	7.3	805	1.2
1300-1315	1015	6.5	8.2	1125	1.6	8.1	855	1.3
1315-1330	1030	6.7	8.3	1124	1.6	8.1	900	1.3
1330-1345	1015	6.5	8.4	1133	1.6	8.1	809	1.2
1345-1400	1010	6.7	8.4	1120	1.6	8.1	855	1.2
AVERAGE	1015	6.5	8.3	1140	1.7	7.9	845	1.2

UNIT 2
6/27/89

TIME PERIOD	LOAD	BOILER O2	VAN %O2 DRY	VAN NO,PPM 3% O2	VAN NO LB/MBTU	CEM %O2 DRY	CEM NO,PPM 3% O2	CEM NO LB/MBTU
1200-1215	1223	-4.2	6.7	1012	1.4	6.1	935	1.3
1215-1230			6.6	1003	1.4			
1245-1300			6.6	1106	1.5			
1300-1315	1235	4.2	6.5	1055	1.5	6.1	935	1.3
1315-1330			6.5	1030	1.5			
1345-1400			6.7	1055	1.5			
1400-1415	1235	4.2	6.7	1064	1.5	6.5	961	1.4
1415-1430			6.8	1066	1.5			
1430-1445	1236	4.0	6.9	1065	1.5	6.5	921	1.3
AVERAGE	1230	4.2	6.7	1050	1.5	6.3	938	1.3

UNIT 2
6/29/89

TIME PERIOD	LOAD	BOILER O2	VAN %O2 DRY	VAN NO,PPM 3% O2	VAN NO LB/MBTU	CEM %O2 DRY	CEM NO,PPM 3% O2	CEM NO LB/MBTU
945-1000	1285	4.4	6.7	1021	1.5	6.7	894	1.3
1000-1015	1290	4.4	6.7	1003	1.4	6.5	921	1.3
1015-1030	1294	4.3	6.5	972	1.4	6.5	921	1.3
1100-1115	1292	4.1	6.4	1052	1.5	6.2	902	1.3
1115-1130	1292	4.1	6.3	1019	1.5	6.2	941	1.3
1245-1300	1294	3.7	5.7	989	1.4	6.2	941	1.3
1300-1315	1293	3.6	5.7	1011	1.4	6.2	902	1.3
1315-1330	1298	3.4	5.7	1009	1.4	6.2	902	1.3
1330-1345	1294	3.6	5.6	996	1.4	6.2	902	1.3
1345-1400	1298	3.4	5.5	989	1.4			
1415-1430	1309	4.1	6.0	1014	1.4	6.5	1001	1.5
1430-1445	1302	4.0	6.2	1016	1.5	6.5	974	1.4
1445-1500	1293	4.2	6.1	1004	1.4	6.7	974	1.4
1500-1515	1293	4.0	6.1	995	1.4	6.7	934	1.3
1515-1530	1293	4.2	6.1	987	1.4	6.7	934	1.3
1530-1545	1281	4.7	6.6	980	1.5	6.7	934	1.3
AVERAGES	1295	4.0	6.1	1005	1.4	6.5	932	1.3

CONCLUSIONS:

The conclusions from the NOx testing are as follows:

1. CEM and Van correlated well for Unit 2; however, CEM reads approximately 0.5 lb/mbtu lower than the Van for Unit 1.

2. At reduced load (1240 MW) on Unit 2, NOx emissions were slightly higher than at full load. This is probably due to the higher boiler O levels at reduced load.

3. At reduced load (1015 MW) on Unit 1, NOx emissions were high. Again, this is probably due to the extremely high boiler O2 levels.

4. Reducing boiler O2 on Unit 2 from 4.4 to 3.6 % showed slight reduction of NOx. However, on a unit of this size with so many other operational factors to be considered, it may be difficult to see a significant reduction in NOx when boiler O2 is reduced.

RESULTS

UNIT 1

7/12/89 TIME PERIOD	(1) LOAD	(2) BOILER O2	(3) VAN %O2 DRY	(4) VAN NO,PPM 3% O2	(5) VAN NO LB/MBTU	(6) CEM %O2 DRY	(7) CEM NO,PPM 3% O2	(8) CEM NO LB/MBTU
0845-0900			7.4	244	0.35			
0900-0915			7.4	240	0.34			
0915-0930	262	3.0	7.1	227	0.33	5.7	304	0.43
1015-1030	263	2.8	7.0	231	0.33	5.5	263	0.37
1030-1045	262	2.9	7.0	240	0.34	5.5	263	0.37
1045-1100	262	2.8	7.2	248	0.36	5.6	258	0.37
1100-1115	262	2.8	7.1	239	0.34	5.6	252	0.37
1115-1130	262	2.9	7.1	236	0.34	5.6	252	0.36
1130-1145	263	2.9	7.1	233	0.33	5.6	246	0.35
1145-1200	263	3.0	7.1	231	0.33	5.6	246	0.35
1200-1215	263	3.1	7.0	228	0.33	5.6	258	0.37
1215-1300	262	3.0	7.0	232	0.33	5.6	251	0.36
1300-1315	262	2.8	6.9	226	0.32	5.5	250	0.36
1315-1330	263	2.7	6.9	222	0.32	5.5	250	0.36
1330-1345	262	2.4	6.8	216	0.31	5.3	247	0.35
1345-1400	262	2.3	6.7	222	0.32	5.3	197	0.32
1400-1415	262	2.3	7.0	226	0.32	5.3	197	0.32
1415-1430	262	2.7	7.2	230	0.33	5.4	217	0.31
1430-1445	262	3.2	7.2	227	0.32	5.6	264	0.38
2200-2215	152	4.2	8.2	254	0.36	7.1	237	0.36
2215-2230	149	4.1	8.2	250	0.36	7.0	235	0.34
2230-2245	148	3.9	8.1	245	0.35	7.1	233	0.33
2245-2300	149	4.0	8.2	251	0.36	7.2	231	0.33
2300-2315	150	4.2	8.2	250	0.36	7.2	232	0.33
2315-2330	151	4.1	8.2	252	0.36	7.2	229	0.33

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2 from superheat and reheat furnaces, recorded every 15 min. from control board.
(3) VAN measurement of % O2 on a dry basis; 15-sec. readings averaged over a 15 min. period.
(4) VAN measurement of NO, ppm, corrected to 3% O2; 15-sec. readings averaged over a 15 min. period.
(5) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.
(6) CEM measurement of % O2 on a dry basis, read on a 15-min. basis from strip chart in control room.
(7) CEM measurement of NO, ppm, corrected to 3% O2, read on a 15-min. basis from strip chart in control room.
(8) Emission rate, NO, lb/mBTU, calculated from CEM NO and CEM %O2.

07-31-1990 17310930

Gallatin Unit 1, b Duct, ~260 MW

TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO @ 3% O2	(9) NO lb/mbtu
				VAN					
0930-0945	262	2.7	1717	5.7	13	13.26	328	387	0.55
0945-1000	262	2.7	1712	5.8	13	13.14	334	396	0.56
1000-1015	262	2.6	1726	5.7	13	13.17	340	401	0.57
1015-1030	263	2.7	1716	5.8	13	13.23	345	407	0.58
Gallatin Unit 1, c Duct, ~260 MW									
1045-1100	263	2.8	1736	5.6	13	13.40	353	413	0.59
1100-1115	261	2.8	1758	5.4	12	13.63	359	415	0.59
1115-1130	263	2.8	1753	5.4	12	13.70	360	415	0.59
1130-1145	261	2.8	1751	5.3	11	13.75	362	415	0.59
1145-1200	262	2.9	1772	5.2	11	13.81	359	410	0.58
1230-1245	259	2.9	1745	5.4	10	13.54	360	415	0.59
1245-1300	260	2.8	1758	5.4	10	13.61	359	413	0.59
1300-1315	258	2.8	1737	5.5	9	13.48	360	417	0.59
1315-1330	258	2.7	1727	5.5	9	13.40	362	420	0.60
1330-1345	259	2.7	1728	5.5	9	13.40	363	422	0.60
1345-1400	260	2.8	1743	5.4	8	13.58	366	421	0.60
1400-1415	259	2.9	1746	5.3	8	13.72	365	418	0.59
1415-1430	259	3.2	1735	5.3	8	13.63	318	365	0.52

(1) Unit load recorded every 15 min. from control board.
(2) Boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.

GALLATIN UNIT 2

08-01-1990 I8010810

Gallatin Unit 2, b Duct, ~255 MW

VAN

TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO @ 3% O2	(9) NO lb/mbtu
0815-0830	255	3.2	1741	5.4	18	13.56	353	407	0.58
0830-0845	255	3.2	1772	5.4	19	13.76	358	414	0.59
0845-0900	255	3.3	1774	5.4	19	13.84	367	423	0.60
0900-0914	254	3.3	1767	5.5	19	13.65	368	426	0.61

(1) Unit load recorded every 15 min. from control board.
(2) Boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.

08-01-1990 18010958
Gallatin Unit 3, b Duct, ~255 MW

	VAN								
TIME PERIOD	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO @ 3% O2	(9) NO lb/mbtu
1000-1015	255	3.8	1632	6.0	21	12.99	347	417	0.59
1015-1030	260	4.0	1659	6.0	127	13.13	339	405	0.58
1030-1045	252	4.1	1639	6.1	23	12.85	343	413	0.59
1045-1100	254	4.0	1652	6.0	26	12.94	340	408	0.58

(1) Unit load recorded every 15 min. from control board.
(2) Boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.

JOHN SEVIER UNIT 2

10-17-1990
JOHN SEVIER UNIT 2 SUPERHEAT DUCT TEST 1

TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO @ 3% O2	(9) NO lb/mBtu
0820-0830	200	2.60	963	5.72	20	13.02	367	432	0.63
0830-0845	200	2.60	1020	5.37	22	13.02	391	458	0.57
0845-0900	200	2.60	1030	5.91	22	13.02	389	464	0.66
0900-0915	200	2.60	1026	5.93	22	13.02	388	463	0.65

10-17-1990
JOHN SEVIER UNIT 2 REHEAT FURNACE TEST 2

1018-1030	200	2.55	1071	4.98	42	15.72	291	327	0.47
1030-1045	197	2.55	1167	3.71	58	15.72	305	318	0.45
1045-1100	198	2.55	1165	3.51	32	15.72	324	334	0.47
1100-1115	198	2.60	1161	3.44	32	15.72	325	333	0.47

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.

JOHN SEVIER UNIT 3

10-11-1990
JOHN SEVIER UNIT 3 SUPER HEATER DUCT TEST 3

TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO @ 3% O2	(9) NO lb/mmBTU
1145-1200	200	3.25	1172	4.91	22	13.96	463	518	0.74
1200-1215	200	3.20	1167	4.92	23	13.98	461	516	0.73
1215-1230	200	3.15	1092	4.98	22	13.92	445	500	0.71
1230-1240	200	3.05	1101	4.90	22	13.97	447	500	0.71

10-11-1990
JOHN SEVIER UNIT 3 REHEAT FURNACE TEST 4

1300-1315	200	3.25	1111	7.46	19	11.60	343	456	0.65
1315-1330	200	3.15	1125	7.42	18	11.62	348	461	0.66
1330-1340	200	3.25	1118	7.47	18	11.55	349	464	0.66

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.

JOHN SEVIER UNIT 4

10-11-1990
JOHN SEVIER UNIT 4 SUPER HEATER DUCT TEST 1

TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO @ 3% O2	(9) NO lb/mbtu
0730-0745	200	2.95	1023	5.60	22	12.4	374	437	0.62
0745-0800	200	2.95	1015	5.80	21	12.2	377	446	0.64
0800-0815	200	3.30	1017	5.78	21	12.3	378	447	0.64
0815-0830	200	3.05	1018	5.80	21	12.3	377	447	0.64

10-11-1990
JOHN SEVIER UNIT 4 REHEAT DUCT TEST 2

0900-0915	200	3.05	1249	5.34	21	12.73	392	451	0.64
0915-0930	200	3.30	1243	5.22	22	12.87	395	450	0.64
0930-0945	200	3.35	1243	5.30	21	12.84	392	449	0.64
0945-1000	200	3.25	1253	5.24	22	12.92	396	453	0.64

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.

JOHNSONVILLE UNIT 1

JOHNSONVILLE UNIT 1 PRECIPITATOR OUTLET COMMON DUCT (LOW LOAD)

			VAN								
06-13-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu	(11) SO2 LB @ 3% O2
0810-0830	45.00	6.9	854	9.65	22.3	9.92	239	378	0.52	2.59	4.10
0830-0845	45.00	6.9	894	9.64	22.6	9.89	241	381	0.52	2.70	4.29
0845-0900	45.00	6.9	914	9.61	23.3	9.95	241	381	0.52	2.76	4.35
0900-0915	45.00	6.9	909	9.63	22.1	9.90	245	387	0.53	2.75	4.35
0915-0930	45.00	7.0	914	9.54	23.6	9.93	241	379	0.52	2.74	4.30
0930-0945	45.00	7.2	902	9.64	22.4	9.81	239	379	0.52	2.73	4.32
0945-1000	45.00	7.2	878	9.87	21.3	9.55	221	358	0.49	2.71	4.39
1000-1015	45.00	7.2	872	9.91	21.3	9.49	214	347	0.48	2.70	4.39
1015-1030	45.00	6.9	857	10.03	21.0	9.30	209	344	0.47	2.69	4.41
1030-1045	45.00	6.9	849	10.03	23.0	9.23	199	326	0.45	2.66	4.36
1045-1110	45.00	6.9	831	10.25	62.7	9.01	203	340	0.47	2.66	4.45
AVERAGE	45.00	7.0	879	9.80	26.1	9.63	227	364	0.50	2.70	4.34

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.
(11) Van measurement of SO2, lb/mbtu, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.

JOHNSONVILLE UNIT 1

JOHNSONVILLE UNIT 1 PRECIPITATOR OUTLET COMMON DUCT (HIGH-LOAD)

			VAN								
06-13-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu	(11) SO2 lb @ 3% O2
1204-1215	114	4.3	1082	6.90	28.4	11.75	311	396	0.54	2.63	3.36
1215-1230	114	4.3	1093	6.78	29.1	11.81	293	371	0.51	2.64	3.34
1215-1230	114	4.3	1084	6.82	28.2	11.78	299	380	0.52	2.62	3.33
1245-1300	114	4.3	1086	6.84	30.8	11.73	303	385	0.53	2.63	3.35
1300-1315	114	4.3	1077	6.85	26.5	11.71	300	382	0.52	2.61	3.32
1315-1330	114	4.2	1079	6.79	28.2	11.80	295	374	0.51	2.64	3.30
1330-1345	114	4.2	1081	6.78	31.4	11.87	295	373	0.51	2.61	3.30
1345-1400	114	4.2	1083	6.76	30.4	11.91	296	375	0.51	2.61	3.30
1400-1415	115	4.0	1078	6.76	28.0	11.97	298	376	0.52	2.60	3.29
1415-1430	115	4.0	1082	6.77	38.1	11.98	294	372	0.51	2.61	3.30
1430-1445	114	4.1	1075	6.78	34.9	12.02	298	377	0.52	2.59	3.28
1445-1500	114	4.1	1070	6.76	45.1	11.99	299	378	0.52	2.58	3.26
AVERAGE	114	4.2	1081	6.80	31.2	11.86	298	378	0.52	2.61	3.31

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.
(11) Van measurement of SO2, lb/mbtu, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.

JOHNSONVILLE UNIT 2

04-10-1990 14100926 SUMMARY

J'Ville Unit 2 ESP Outlet High Load

TIME	(1) LOAD MW	(2) BOILER O2	(3) VAN O2 % dry	(4) CO ppm dry	(5) CO2 % dry	(6) NO ppm wet	(7) NO ppm dry	(8) NO dry 3%	(9) NO lb/mbtu	..... O2 % dry	PLANT CEM SO2 PPM	..... SO2 LB/MBTU
0930-0945	*126		7.39	631	11.14	201	216	286	0.41			
0945-1000	*126		7.39	673	11.16	199	214	283	0.40			
1000-1004	*126		7.53	527	11.06	180	194	258	0.37			
1115-1130	127	3.10	7.79	626	10.86	329	354	483	0.69	6.50	920	2.60
1130-1145	127	3.10	7.82	510	10.97	342	368	502	0.72	6.50	920	2.60
1145-1200	127	3.20	7.82	588	10.98	340	366	500	0.72	6.50	920	2.50
1200-1215	127	2.80	7.74	713	10.58	334	359	487	0.70	6.50	920	2.50
1221-1230	127	3.00	7.67	866	10.61	161	234	317	0.34	6.40	920	2.50
1230-1245	127	2.60	7.71	838	10.81	164	239	324	0.34	6.40	920	2.50
1245-1300	127	3.30	7.71	821	11.25	159	231	314	0.33	6.50	900	2.60
1300-1309	128	3.37	7.83	673	11.17	159	233	319	0.33	6.43	907	2.53
1333-1345	121	4.60	8.50	305	11.12	174	187	269	0.39	6.40		
1345-1400	122	4.70	8.77	166	11.20	174	187	276	0.40	6.50	910	2.50
1400-1415	123	4.39	8.56	163	11.19	171	184	266	0.38	6.60	910	2.40
1520-1530	122	4.40	8.10	108	11.02	183	197	274	0.39	6.50	900	2.40
1530-1545	122	4.40	8.08	131	11.09	178	191	266	0.38	6.50	900	2.40
1545-1600	122	4.30	8.13	234	11.04	168	181	253	0.36	6.60	900	2.40
1600-1615	122	5.10	8.02	444	11.00	167	180	249	0.35	6.60	900	2.50

J'Ville Unit 2 ESP Outlet Low Load

2134-2145	45	9.30	12.83	19	7.16	251	270	594	0.88	6.80	900	2.70
2145-2200	45	9.30	12.90	20	7.13	247	265	590	0.88	6.80	900	2.70
2200-2215	45	9.30	12.92	20	7.14	246	265	590	0.88	7.20	900	2.50
2215-2230	45	9.40	12.91	19	7.13	250	268	597	0.89	7.20	910	2.50

JOHNSONVILLE UNIT 2

04-11-1990 SUMMARY

J'Ville Unit 2 High Load (High Pressure Heaters Bypassed)

TIME	(1) LOAD MW	(2) BOILER O2	(3) O2 % dry	(4) CO ppm dry	(5) CO2 % dry	(6) NO ppm wet	(7) NO ppm dry	(8) NO dry 3%	(9) NO lb/mmbtu	O2 % dry	SO2 PPM	SO2 LB/MBTU
0829-0845	112	3.00	7.36	487	11.72	162	174	229	0.33	6.50	960	2.70
0845-0900	112	3.30	7.48	421	11.66	162	174	232	0.33	6.50	960	2.70
0900-0915	112	3.30	7.57	367	11.61	165	177	237	0.34	6.50	960	2.70
0915-0930	112	3.10	7.59	434	11.56	165	177	238	0.34	6.50	960	2.70
0930-0933	112	3.10	7.65	437	11.90	165	177	239	0.34	6.50	960	2.70

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period. (most cases)
(4) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO2, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of NO, ppm, wet basis, 15 sec. readings averages over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.

** Assumed moisture content = 7%

JOHNSONVILLE UNIT 3

JOHNSONVILLE UNIT 3 PRECIPITATOR OUTLET COMMON DUCT (HIGH LOAD)

06-11-1991	(1)	(2)	VAN (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
TIME	LOAD MW	BOILER O2	SO2 ppm,dry	O2 %,dry	CO ppm,dry	CO2 %,dry	NO ppm,dry	NO PPM @ 3% O2	NO lb/mbtu	SO2 lb/mbtu	SO2 LB @ 3% O2
1300-1315	121	5.6	1066	7.26	63.8	11.70	262	343	0.47	2.66	3.49
1315-1330	122	5.6	1066	7.28	51.7	11.67	269	352	0.48	2.67	3.50
1330-1345	122	5.6	1068	7.24	54.5	11.78	266	348	0.48	2.66	3.48
1345-1400	122	5.6	1074	7.24	50.6	11.90	269	352	0.48	2.68	3.51
1400-1415	121	5.6	1071	7.25	47.2	11.97	268	351	0.48	2.67	3.50
1415-1430	121	5.6	1069	7.20	73.9	12.08	267	348	0.48	2.66	3.47
1430-1445	122	5.4	1069	7.22	49.3	12.07	268	350	0.48	2.66	3.48
1445-1500	122	5.6	1066	7.21	42.0	12.03	277	362	0.50	2.65	3.46
1500-1515	122	5.6	1075	7.20	25.6	12.06	313	409	0.56	2.67	3.49
1515-1530	123	5.6	1068	7.26	25.1	12.08	305	400	0.55	2.67	3.50
1530-1545	121	5.6	1076	7.23	25.2	12.11	296	388	0.53	2.68	3.51
1545-1600	121	5.6	1075	7.15	32.7	12.24	298	387	0.53	2.66	3.46
AVERAGE	122	5.6	1070	7.23	45.1	11.97	280	366	0.50	2.67	3.49

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.
(11) Van measurement of SO2, lb/mbtu, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.

JOHNSONVILLE UNIT 3

JOHNSONVILLE UNIT 3 PRECIPITATOR OUTLET COMMON DUCT (LOW LOAD)

			VAN								
06-12-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu	(11) SO2 LB @ 3% O2
0845-0900	46	>10	702	11.54	17.0	8.07	255	490	0.67	2.58	4.96
0900-0915	46	>10	735	11.60	17.7	8.07	255	489	0.67	2.69	5.16
0915-0930	46	>10	737	11.63	18.3	8.01	255	490	0.67	2.71	5.20
0930-0945	46	>10	737	11.57	18.3	8.04	256	489	0.67	2.69	5.14
0945-1000	47	>10	738	11.55	18.2	8.07	257	489	0.67	2.69	5.12
1000-1015	47	>10	740	11.54	18.4	8.06	255	485	0.67	2.69	5.13
1015-1030	47	>10	740	11.49	18.2	8.10	259	491	0.68	2.68	5.08
1030-1045	47	>10	729	11.50	18.4	8.08	263	498	0.68	2.64	5.01
1045-1100	47	>10	722	11.48	18.3	8.12	263	498	0.69	2.61	4.93
1100-1115	47	>10	721	11.50	18.5	8.10	260	492	0.68	2.61	4.95
1115-1130	48	>10	728	11.43	18.5	8.19	265	499	0.69	2.62	4.92
1130-1145	48	>10	725	11.37	18.6	8.26	260	485	0.67	2.59	4.84
AVERAGE	47	>10	729	11.52	18.2	8.10	259	491	0.68	2.65	5.04

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.
(11) Van measurement of SO2, lb/mbtu, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.

JOHNSONVILLE UNIT 4

JOHNSONVILLE UNIT 4 PRECIPITATOR OUTLET COMMON DUCT

			VAN							
06-20-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
0745-0800	45	*	681	11.00	19.6	8.14	207	372	0.51	2.34
0800-0815	45	*	749	11.44	20.6	8.29	219	413	0.57	2.70
0815-0830	45	*	766	11.36	20.4	8.29	218	409	0.56	2.74
0830-0845	45	*	770	11.39	20.2	8.27	220	411	0.57	2.76
0845-0900	45	*	763	11.42	20.2	8.22	219	412	0.57	2.74
0900-0915	45	*	758	11.45	20.2	8.20	220	415	0.57	2.73
0915-0930	45	*	761	11.39	20.4	8.25	220	411	0.57	2.73
0930-0945	45	*	756	11.43	20.3	8.23	222	418	0.58	2.72
AVERAGE	45	*	751	11.36	20.2	8.24	218	408	0.56	2.68

JOHNSONVILLE UNIT 4 PRECIPITATOR OUTLET COMMON DUCT

			VAN							
06-20-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
1036-1045	107	*	1064	6.54	573.2	11.40	224	279	0.38	2.53
1045-1100	107	*	1146	6.80	464.9	12.25	230	292	0.40	2.77
1100-1130	107	*	1171	6.53	583.8	12.39	220	274	0.37	2.77
1115-1130	107	*	1176	6.49	640.7	12.31	216	268	0.37	2.78
1130-1145	107	*	1154	6.58	575.3	12.22	224	280	0.38	2.75
1145-1200	107	*	1151	6.61	525.2	12.16	224	281	0.38	2.74
1200-1215	107	*	1141	6.65	561.6	12.08	225	282	0.39	2.73
1215-1221	107	*	1133	6.64	408.9	12.03	229	287	0.39	2.71
AVERAGE	107	*	1142	6.61	541.7	12.11	224	280	0.38	2.72

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

(*) BAD DATA

JOHNSONVILLE UNIT 5

JOHNSONVILLE UNIT 5 PRECIPITATOR OUTLET COMMON DUCT

06-19-1991	(1)	(2)	VAN (3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
TIME	LOAD MW	BOILER O2	SO2 ppm,dry	O2 %,dry	CO ppm,dry	CO2 %,dry	NO ppm,dry	NO PPM @ 3% O2	NO lb/mmbtu	SO2 lb/mmbtu
0730-0745	44	*	653	10.91	22.2	8.39	250	447	0.61	2.23
0745-0800	44	*	706	11.29	22.2	8.64	257	476	0.65	2.50
0800-0815	44	*	724	11.32	22.4	8.60	255	475	0.65	2.57
0815-0830	44	*	732	11.34	22.5	8.58	253	471	0.65	2.61
0830-0845	44	*	735	11.34	22.5	8.58	250	466	0.64	2.62
0845-0900	44	*	740	11.28	22.4	8.59	249	461	0.63	2.62
0900-0915	44	*	738	11.24	22.5	8.59	248	458	0.63	2.60
0915-0930	44	*	736	11.21	23.2	8.55	248	455	0.63	2.59
AVERAGE	44	*	720	11.24	22.62	8.56	251	464	0.64	2.54

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

(*) BAD DATA

JOHNSONVILLE UNIT 5

06-18-1991 TIME	(1) LOAD MW	(2) BOILER O2	VAN (3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mBtu	(10) SO2 lb/mBtu
1100-1115	105	*	1055	7.04	430.4	11.76	195	251	0.34	2.59
1115-1130	105	*	1124	7.31	387.8	12.07	204	268	0.37	2.82
1130-1145	105	*	1117	7.33	390.6	11.97	205	270	0.37	2.80
1145-1200	105	*	1119	7.32	380.5	11.93	207	272	0.37	2.81
1200-1215	105	*	1125	7.31	431.9	11.89	206	271	0.37	2.82
1215-1230	105	*	1121	7.29	423.2	11.90	208	273	0.37	2.81
1230-1245	105	*	1110	7.33	400.9	11.89	210	276	0.38	2.79
1245-1300	105	*	1107	7.27	423.2	11.93	209	274	0.38	2.77
AVERAGE	105	*	1110	7.27	408.6	11.92	205	269	0.37	2.78

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

(*) BAD DATA

JOHNSONVILLE UNIT 6

JOHNSONVILLE UNIT 6 PRECIPITATOR OUTLET COMMON DUCT

			VAN							
06-17-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
1415-1430	119	5.4	1129	6.98	66.2	12.35	269	348	0.47	2.76
1430-1445	119	5.4	1158	7.01	49.8	12.02	268	345	0.47	2.84
1445-1500	119	5.4	1165	6.98	50.0	11.98	271	349	0.48	2.85
1500-1515	120	5.1	1178	6.94	60.6	11.99	277	355	0.49	2.87
1732-1745	119	4.9	1164	6.95	79.7	12.50	267	342	0.47	2.84
1745-1800	120	4.9	1193	6.97	89.0	12.56	270	346	0.47	2.92
1800-1815	120	4.9	1201	6.95	85.9	12.57	269	345	0.47	2.93
1815-1830	120	4.9	1208	6.94	98.7	12.53	270	345	0.47	2.95
AVERAGE	120	5.1	1174	6.96	72.7	12.30	270	346	0.48	2.87

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

JOHNSONVILLE UNIT 6

JOHNSONVILLE UNIT 6 PRECIPITATOR OUTLET COMMON DUCT

			VAN							
06-18-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
0720-0730	48	5.5	892	8.40	187.6	11.20	181	259	0.36	2.43
0730-0745	48	5.6	922	8.27	198.3	11.21	175	247	0.34	2.49
0745-0800	48	5.6	983	8.24	196.3	11.19	173	244	0.33	2.64
0800-0815	48	5.5	998	8.23	179.3	11.21	175	247	0.34	2.68
0815-0830	48	5.5	1014	8.16	163.6	11.19	174	244	0.33	2.71
0830-0845	48	5.5	1012	8.16	172.7	11.15	173	243	0.33	2.71
0845-0900	48	5.5	1009	8.18	167.8	11.13	174	245	0.34	2.70
0900-0915	48	5.5	1006	8.22	162.0	11.15	175	246	0.34	2.70
AVERAGE	48	5.5	979	8.23	177.6	11.18	175	247	0.34	2.63

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

JOHNSONVILLE UNIT 3 & UNIT 7

	VAN									CEM	
TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO @ 3% O2	(9) NO lb/mbtu	(10) O2 %	SO2 ppm
J'VILLE UNIT 3 ESP OUT											
0800-0815	48	*	608	11.2	17	6.92	274	502	0.73	*	*
0815-0830	48	*	636	11.1	18	7.00	274	499	0.73	9.6	750
0830-0845	49	*	652	11.0	19	7.17	277	498	0.73	*	*
0845-0900	83	*	731	10.3	84	8.02	252	422	0.62	9.6	750
0900-0915	80	*	844	8.7	188	9.70	265	388	0.57	*	*
0915-0930	80	*	835	8.8	21	9.64	285	421	0.61	7.9	960
UNIT 7 ESP OUT											
1600-1615	75	*	844	10.3	12	8.09	333	539	0.81	*	*
1615-1630	75	*	808	10.6	12	7.69	328	569	0.83	*	*
1630-1645	75	*	793	10.8	11	7.50	327	577	0.84	*	*
1645-1700	75	*	800	10.7	11	7.62	324	565	0.82	*	*

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.
(10) Control room readings of %O2 and SO2, ppm, from strip chart on 15 minute intervals.

08-09-1990 I8090839
J'Ville Unit 8 & UNIT 10

TIME	(1) LOAD MW	(2) BOILER O2	VAN (3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO @ 3% O2	(9) NO lb/mbtu
J'VILLE UNIT 8 ~130 MW									
0845-0900	130	*	1000	7.7	22	10.8	513	694	0.99
0900-0915	130	*	1037	7.7	23	10.9	520	703	1.01
0915-0930	130	*	1048	7.6	25	11.1	520	701	1.00
0930-0940	130	*	1051	7.6	26	11.1	524	703	1.01
J'VILLE UNIT 10 ~135 MW									
1045-1100	134	*	1108	6.5	166	12.3	463	575	0.82
1100-1115	135	*	1026	7.6	36	11.2	529	709	1.02
1115-1130	134	*	1031	7.5	36	11.3	533	709	1.01
1130-1145	135	*	1035	7.4	36	11.4	536	708	1.01
1145-1200	134	*	1032	7.4	37	11.3	536	707	1.01

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.

Johnsonville Unit 10 ESP Outlet

TIME 11/07/89	(1) LOAD MW	(2) BOILER %O2	(3) VAN %O2 DRY	(4) VAN NO,PPM 3%O2	(5) VAN NO LB/MBTU
1035-1050	120	3.3	7.95	493	0.71
1050-1105	121	3.2	8.04	504	0.72
1230-1249	122	3.0	7.92	594	0.86
1313-1333	122	2.7	7.67	664	0.96
1336-1408	122	3.0	7.56	644	0.93
1427-1509	122	3.1	7.40	654	0.94
1530-1600	120	3.4	7.34	650	0.93
1600 -1630	120	3.1	7.31	633	0.91
1630-1705	121	3.5	7.60	603	0.86
2040-2110	55	7.4	10.84	534	0.78
2110-2140	58	6.6	10.97	554	0.80
2140-2148	58	6.8	11.15	595	0.87
2150-2220	58	7.0	11.05	580	0.85
2220-2250	57	6.5	10.80	563	0.82

(1) Unit load recorded every 30 min. from control board.
(2) Average boiler O2, recorded every 30 min. from control board.
(3) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 30 min. period. (most cases)
Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 30 min. period.
Emission rate, NO, lb/mBTU, calculated from VAN NO measurements and VAN %O2.

KINGSTON UNIT 4

3/23/90 UNIT 4

(1) TIME PERIOD	(2) LOAD	(3) BOILER O2	(4) VAN %O2 DRY	(5) VAN NO,ppm 3% O2	(6) VAN NO LB/mBtu	(7) VAN CO,ppm DRY	VAN CO2, % DRY
1030-1045	145	4.2	6.7	488	0.70	19.0	11.65
1045-1100	145	4.2	7.0	506	0.72	18.0	11.48
1100-1115	145	4.2	6.7	513	0.73	18.2	11.62
1115-1130	145	3.9	6.7	509	0.73	18.4	11.60
1140-1145	145	3.9	6.7	519	0.74	18.8	11.71
1145-1200	145	4.1	6.7	508	0.73	18.8	11.58
1200-1215	145	4.5	6.7	509	0.73	18.7	11.67
AVERAGES	**145**	**4.1**	**6.7**	**507**	**0.73**	**18.6**	**11.62**

NOTES:

(1) Unit load, recorded every 15 min. from control board.

(2) Boiler O2%, recorded every 15 min. from control board.

(3) VAN measurement of O2% on a dry basis; 15-sec. readings averaged over a 15 min. period.

(4) VAN measurement of NO, ppm, corrected to 3% O2; 15-sec. readings averaged over a 15 min. period.

(5) Emission rate, NO, lb/mBtu, calculated from VAN NO measurements and VAN %O2.

(6) Van measurement of CO, ppm, dry basis, 15-sec. readings averaged over a 15-min. period.

(7) Van measurement of CO2, ppm, dry basis, 15-sec. readings average over a 15-min. period.

CO analyzer out of service until 3/14/90, 0950.

** Assumed moisture content = 7%

3/13/90 UNIT 5

TIME PERIOD	(1) LOAD	(2) BOILER O2	(3) VAN %O2 DRY	(4) VAN NO,ppm 3% O2	(5) VAN NO LB/mBtu	(6) VAN CO,ppm DRY	(7) VAN CO2, % DRY
0815-0830	200	3.2	7.0	429	0.61		11.84
0830-0845	200	2.9	7.1	429	0.61		12.15
0845-0900	200	2.9	7.2	431	0.62		11.91
0900-0915	200	2.9	7.2	430	0.62		11.87
0915-0930	200	2.9	7.2	428	0.61		11.89
0930-0945	200	2.9	7.2	429	0.61		11.77
0945-1000	200	2.9	7.2	424	0.61		11.82
1000-1015	200	3.0	7.3	431	0.62		11.63
1030-1045	200	2.7	7.2	431	0.62		11.59
1045-1100	200	2.9	7.3	433	0.62		11.55
1100-1115	200	3.2	7.3	434	0.62		11.73
1115-1130	200	2.7	7.4	436	0.62		11.70
1145-1200	200	2.8	7.3	442	0.63		11.58
1200-1215	200	2.7	7.4	435	0.62		11.64
1215-1230	200	2.8	7.4	434	0.62		11.69
1230-1245	200	2.9	7.4	434	0.62		11.59
AVERAGE	**200**	**2.9**	**7.3**	**432**	**0.62**		**11.75**

3/14/90 UNIT 5

TIME PERIOD	LOAD	BOILER O2	VAN %O2 DRY	VAN NO,ppm 3% O2	VAN NO LB/mBtu	VAN CO,ppm DRY	VAN CO2, % DRY
0830-0845	200	3.0	7.3	457	0.65		11.70
0845-0900	200	2.8	7.4	464	0.60		11.69
0900-0915	200	3.0	7.4	472	0.68		11.49
0915-0930	200	2.9	7.3	458	0.66		11.84
0930-0945	200	2.9	7.3	466	0.67		11.83
0950-1000	200	3.0	7.3	466	0.67	16.5	11.70
1000-1015	200	3.0	7.3	464	0.66	19.9	11.79
1015-1030	200	3.0	7.3	470	0.67	18.4	11.75
1030-1045	200	3.2	7.2	479	0.69	17.5	11.82
1045-1100	200	3.0	7.3	476	0.68	17.6	11.92
AVERAGES	**200**	**3.9**	**7.3**	**467**	**0.66**	**18.0**	**11.75**

PRELIMINARY BASELINE TEST PARADISE UNIT 3

			VAN							
03-05-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
2018-2030	972	3.5	2112	5.06	41.4	13.37	1198	1353	1.85	4.54
2030-2045	966	3.6	2110	5.07	44.9	13.35	1196	1351	1.85	4.54
2045-2050	903	3.7	2084	5.25	47.0	13.19	1141	1304	1.79	4.54
2125-2145	905	3.6	2116	5.20	58.5	12.77	1094	1246	1.71	4.59
2145-2200	898	3.6	2108	5.21	61.4	12.61	1083	1235	1.69	4.58
2200-2213	892	3.5	2111	5.21	66.1	12.51	1081	1233	1.69	4.59
2306-2315	791	3.7	2059	5.48	80.1	12.13	957	1110	1.52	4.55
2315-2330	799	3.7	2055	5.45	85.2	12.09	964	1117	1.53	4.53
2330-2340	793	3.7	2043	5.48	86.1	11.98	961	1115	1.53	4.51
AVERAGE	880	3.6	2089	5.27	63.4	12.67	1075	1229	1.68	4.55

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

PARADISE UNIT 3

PARADISE UNIT 3 PRECIPITATOR OUTLET F DUCT

			VAN							
04-03-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
0812-0830	1043	3.6	1554	5.25	20.2	13.44	1196	1367	1.87	3.38
0830-0845	1045	3.6	1597	5.36	21.3	13.92	1236	1423	1.95	3.50
0845-0900	1046	3.5	1595	5.35	21.5	13.93	1235	1421	1.95	3.49
0900-0915	1046	3.4	1604	5.25	21.6	14.00	1244	1421	1.95	3.49
0915-0930	1046	3.4	1611	5.31	21.9	13.97	1214	1392	1.91	3.52
0930-0945	1046	3.5	1610	5.32	22.1	13.97	1209	1388	1.90	3.52
0945-1000	1047	3.5	1594	5.35	22.1	13.97	1198	1378	1.89	3.49
1000-1015	1046	3.5	1583	5.35	22.1	14.00	1191	1370	1.88	3.47
1015-1030	1046	3.5	1565	5.35	22.6	14.01	1182	1359	1.86	3.43
1030-1045	1050	3.5	1564	5.41	22.5	13.97	1161	1340	1.84	3.44
1045-1100	1048	3.7	1569	5.46	22.7	13.94	1149	1331	1.82	3.46
1100-1115	1047	3.5	1582	5.44	22.7	13.96	1155	1336	1.83	3.49
1115-1130	1047	3.5	1589	5.41	22.8	13.96	1157	1337	1.83	3.49
1130-1145	1047	3.5	1599	5.37	23.0	13.98	1160	1336	1.83	3.51
1145-1200	1046	3.5	1614	5.38	23.0	13.97	1157	1332	1.83	3.54
1200-1215	1044	3.6	1616	5.42	22.9	13.93	1139	1315	1.80	3.56
1215-1230	1045	3.5	1639	5.41	22.7	13.95	1139	1315	1.80	3.61
1230-1245	1041	3.5	1657	5.37	22.6	14.00	1147	1321	1.81	3.64
1245-1300	1043	3.5	1676	5.35	22.3	14.04	1172	1348	1.85	3.67
1300-1315	1041	3.4	1706	5.30	22.5	14.12	1204	1380	1.89	3.73
1315-1330	1042	3.5	1728	5.38	22.3	14.08	1189	1370	1.88	3.79
1330-1345	1042	3.4	1752	5.31	22.7	14.14	1221	1400	1.92	3.83
1345-1404	1040	3.5	1758	5.34	22.8	14.11	1217	1399	1.92	3.85
AVERAGE	1045	3.5	1625	5.36	22.3	13.97	1186	1364	1.87	3.56

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

PARADISE BASELINE TEST UNIT 3

			VAN							
03-06-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu	(10) SO2 lb/mbtu
1002-1015	971	3.5	1859	5.08	30.6	13.25	983	1111	1.52	4.00
1015-1030	971	3.7	1862	5.14	33.3	13.21	987	1120	1.53	4.02
1030-1045	976	3.6	1873	5.24	36.8	13.15	990	1130	1.55	4.08
1045-1100	972	3.7	1926	5.06	41.3	13.31	917	1036	1.42	4.14
1131-1145	970	3.5	1978	5.08	28.4	13.34	990	1119	1.53	4.26
1145-1200	967	3.5	1990	5.06	36.2	13.35	1002	1132	1.55	4.28
1231-1245	976	3.5	1966	5.18	26.2	13.20	1058	1203	1.65	4.26
1245-1300	971	3.6	1956	5.28	32.5	13.12	1084	1241	1.70	4.27
1300-1315	975	3.7	1970	5.18	37.5	13.20	1099	1250	1.71	4.27
1315-1330	971	3.7	1970	5.24	42.5	13.17	1064	1216	1.67	4.29
1330-1345	973	3.7	1967	5.24	51.6	13.15	1059	1209	1.66	4.28
1345-1400	974	3.6	1969	5.20	55.0	13.19	1073	1222	1.67	4.27
1400-1415	978	3.6	1964	5.22	63.5	13.19	1091	1244	1.71	4.27
1415-1430	971	3.7	1964	5.21	62.6	13.25	1098	1251	1.71	4.27
1430-1441	978	3.6	1958	5.25	71.9	13.26	1094	1250	1.71	4.26
1445-1500	975	3.7	1952	5.27	75.5	13.24	1088	1246	1.71	4.26
1500-1515	973	3.7	1949	5.29	86.2	13.21	1086	1244	1.70	4.25
1515-1530	970	3.9	1956	5.30	90.8	13.18	1075	1233	1.69	4.27
1530-1543	971	3.6	1974	5.11	97.7	13.33	1125	1274	1.75	4.26
AVERAGE	973	3.6	1948	5.19	52.6	13.23	1051	1196	1.64	4.22

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.
(10) Emission rate, SO2, lb/mBTU, calculated from VAN SO2 measurements.

SHAWNEE UNIT 2

SHAWNEE UNIT 2 BASELINE TEST

			VAN						
02-08-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu
0809-0815	153	2.4	416	6.84	22.8	11.89	477	606	0.79
0815-0830	153	2.4	428	6.80	23.5	11.97	470	596	0.77
0830-0845	153	2.4	428	6.76	24.4	12.12	476	601	0.78
0845-0900	153	2.4	425	6.80	24.5	12.19	480	609	0.79
0900-0915	153	2.4	426	6.78	24.4	12.28	482	610	0.79
0915-0930	156	2.3	421	6.85	24.6	12.27	486	618	0.80
0930-0945	156	2.3	421	6.83	25.2	12.34	485	616	0.80
0945-1000	156	2.3	417	6.91	24.5	12.30	487	621	0.81
1000-1015	156	2.3	416	6.87	24.6	12.32	489	623	0.81
1015-1030	156	2.4	416	6.80	25.2	12.40	488	618	0.80
1030-1045	155	2.3	416	6.80	25.6	12.46	490	621	0.80
1045-1100	156	2.3	414	6.80	25.2	12.48	489	620	0.80
1100-1115	155	2.2	414	6.75	25.9	12.57	489	618	0.80
1115-1126	156	2.5	412	6.78	26.4	12.59	490	621	0.80
1200-1215	154	2.6	400	6.99	26.4	12.33	491	632	0.82
1215-1230	155	2.6	403	7.04	26.3	12.31	498	642	0.83
1230-1245	154	2.3	401	7.03	26.2	12.36	499	643	0.83
1245-1300	154	2.6	375	7.65	26.3	11.77	460	620	0.80
1300-1315	154	2.6	399	6.92	27.1	12.45	504	644	0.83
1315-1330	154	2.6	398	6.98	26.7	12.35	502	644	0.83
1330-1345	153	2.6	397	6.99	27.1	12.32	497	638	0.83
1345-1410	153	2.6	397	7.00	27.7	12.30	496	638	0.83
1430-1445	152	2.6	426	6.04	31.4	13.13	487	586	0.76
1445-1500	153	2.6	426	6.06	30.9	13.09	492	592	0.77
1500-1515	153	2.4	428	6.03	31.5	13.08	487	585	0.76
1515-1530	153	2.5	427	6.06	31.9	13.03	486	586	0.76
1530-1545	152	2.7	426	6.09	32.0	12.99	490	592	0.77
1545-1600	152	2.6	425	6.08	31.8	12.95	491	592	0.77
1600-1615	152	2.4	425	6.06	32.4	12.96	489	589	0.76
1615-1630	152	2.6	425	6.04	32.8	12.96	490	590	0.76
1630-1645	152	2.6	426	6.06	32.4	12.93	489	589	0.76
1645-1700	152	2.6	428	6.00	32.9	13.00	489	587	0.76
1700-1711	153	2.4	428	6.02	33.4	12.96	488	587	0.76

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.

SHAWNEE UNIT 2

SHAWNEE UNIT 2 PERFORMANCE TEST

			VAN						
03-21-1991 TIME	(1) LOAD MW	(2) BOILER O2	(3) SO2 ppm,dry	(4) O2 %,dry	(5) CO ppm,dry	(6) CO2 %,dry	(7) NO ppm,dry	(8) NO PPM @ 3% O2	(9) NO lb/mbtu
1115-1130	158	2.1	423	6.23	24.0	12.30	467	569	0.78
1130-1145	157	1.8	447	6.41	24.6	12.82	486	600	0.82
1145-1200	153	2.0	441	6.44	24.5	12.74	485	600	0.82
1200-1215	155	2.1	443	6.41	24.3	12.67	480	592	0.81
1228-1245	154	1.9	455	6.23	25.2	12.97	453	552	0.76
1245-1300	157	1.8	456	6.19	25.5	13.15	456	554	0.76
1300-1315	155	1.9	460	6.16	25.3	13.19	452	549	0.75
1315-1330	157	1.8	457	6.19	25.7	13.31	450	547	0.75
1330-1345	152	1.5	446	6.36	25.0	13.16	451	555	0.76
1345-1400	152	2.0	447	6.25	24.9	13.01	445	542	0.74
1400-1422	151	2.1	441	6.29	25.1	12.97	448	549	0.75
1432-1445	151	1.9	458	5.60	25.6	13.69	480	561	0.77
1445-1500	153	1.9	452	5.67	25.4	13.51	485	569	0.78
1540-1600	137	1.6	453	5.32	25.8	13.51	452	519	0.71
1600-1615	139	2.3	445	5.54	25.5	13.30	468	545	0.75
1615-1630	137	2.0	445	5.47	26.0	13.27	463	537	0.74
1630-1645	137	2.0	439	5.62	25.8	13.16	472	552	0.76
1645-1700	138	2.9	417	6.14	24.7	12.70	494	599	0.82
1700-1715	137	2.7	420	6.19	24.1	12.68	497	604	0.83
1715-1730	137	2.4	426	6.07	24.0	12.83	494	595	0.82
1730-1745	141	2.4	423	6.07	24.0	12.88	494	596	0.82
1745-1800	142	2.8	417	6.27	23.6	12.65	499	610	0.84
1800-1815	143	2.6	421	6.14	23.6	12.77	503	609	0.83
1815-1830	138	2.8	418	6.20	23.4	12.76	502	610	0.84
1830-1845	140	2.8	417	6.22	23.4	12.73	502	611	0.84
1900-1915	143	2.8	419	6.18	23.5	12.78	502	610	0.84

(1) Unit load recorded every 15 min. from control board.
(2) Average boiler O2, recorded every 15 min. from control board.
(3) Van measurement of duct SO2, dry basis, 15 sec. readings averaged over a 15 min. period.
(4) Van measurement of duct O2, dry basis, 15 sec. readings averaged over a 15 min. period.
(5) Van measurement of CO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(6) Van measurement of CO2, % dry basis, 15 sec. readings averaged over a 15 min. period.
(7) Van measurement of NO, ppm, dry basis, 15 sec. readings averaged over a 15 min. period.
(8) Van measurement of NO, ppm, corrected to 3% O2, 15 sec. readings averaged over a 15 min. period.
(9) Emission rate, NO, lb/mBTU (actual), calculated from VAN NO measurements.

SHAWNEE UNIT 6

SHAWNEE

UNIT 6

DATE	TIME	TEST ID	MW	'B' BOILER O2	O2 % dry	CO ppm dry	NO ppm wet	CO2 % dry	NO ppm dry	NO dry @ 3%	NO lb/mmBtu
12-05-89	1117/1217	A	154	3.36	6.79	23.10	485.26	13.18	521.79	660.82	0.94
12-05-89	1414/1513	B	154	3.10	6.35	25.27	456.61	13.55	490.98	603.42	0.86
12-06-89	0830/0909	C	149	3.08	6.48	23.39	417.97	12.53	449.43	557.14	0.80
12-06-89	1415/1515	D	150	2.56	5.55	20.55	456.24	13.53	490.58	571.78	0.81
12-06-89	1633/1731	E	67	6.10	9.51	19.31	362.89	10.18	390.20	611.33	0.88
12-06-89	1803/1905	F	67	6.08	9.35	20.42	358.77	10.32	385.78	596.18	0.86
12-07-89	0804/0846	G	70	5.86	9.44	23.22	372.44	10.28	400.47	623.71	0.90
12-07-89	0916/1004	H	69	5.20	8.77	14.24	361.96	10.87	389.20	572.78	0.83
12-07-89	1044/1117	BB	69	5.11	8.43	21.97	278.31	11.15	299.26	428.66	0.62
12-07-89	1344/1412	AA	154	2.36	5.40	79.87	414.14	13.66	445.31	513.72	0.73
UNIT 8											
12-12-89	0935/1007	A	150	2.42	6.28	28.70	442.54	13.33	475.84	582.07	0.83
12-12-89	1106/1138	B	149	1.77	5.50	37.34	401.19	13.92	431.39	500.89	0.71
12-12-89	1214/1224	*C	146	1.21	4.92	167.07	383.00	14.36	411.83	460.95	0.66
12-12-89	1225/1246	D	147	1.43	5.32	44.87	406.27	13.72	436.85	501.40	0.71
12-12-89	1328/1400	I	153	3.27	7.04	28.31	488.22	12.21	516.37	665.65	0.94
12-14-89	1219/1297	E	72	4.46	8.24	29.79	333.68	11.11	358.79	506.25	0.73
12-14-89	1300/1335	E	71	4.44	8.12	30.82	328.86	10.92	352.75	493.10	0.71
12-14-89	1419/1453	H	71	3.39	7.35	34.43	287.00	11.75	308.60	406.99	0.58

TEST ID: A - HIGH LOAD NORMAL O2
B & C - .3 REDUCTION IN O2
D - HIGH LOAD MINIMUM O2
E - LOW LOAD NORMAL O2
F & G - .3 REDUCTION IN O2
H - LOW LOAD MINIMUM O2
AA - UNBALANCED BURNERS HIGH LOAD
BB - UNBALANCED BURNERS LOW LOAD
I - HIGH LOAD HIGH O2

SHAWNEE UNIT 9

SHAWNEE UNIT 9, AIR HEATER OUTLET

AVERAGE FOR EACH TEST PERFORMED ON 5/11/89.

TIME	(%) O2	(PPM) CO	(%) CO2	(PPM) NOx	(PPM) NOx @ 3%	(MW) LOAD	(%) BLR O2	(F) AIR IN	(F) AIR OUT	(F) PMRY AIR	(F) SCDY AIR	(#) BURNERS
0930-1030	5.98	76.18	12.87	436.37	522.87	165.00	2.78	115.09	650.68	167.75	644.34	1
1115-1215	6.50	28.21	11.94	430.95	535.16	153.00	3.22	118.22	649.21	166.57	641.54	1
1248-1330	6.46	26.92	12.04	438.89	543.30	154.00	3.26	120.57	654.00	168.00	644.15	1
1335-1420	6.47	28.63	12.01	435.92	539.98	154.00	3.13	121.34	655.00	167.11	645.00	1
1442-1514	6.36	32.03	12.07	413.97	509.00	154.00	3.04	122.05	654.97	167.13	644.63	1

* (NOI) IS ACTUAL VALUE
(NOI @ 3% IS ACTUAL CORRECTED TO 3% O2)

RESULTS

UNIT 7 SCRUBBER INLET
4/5/90

See notes:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TIME PERIOD	LOAD	BOILER O2	VAN %O2 DRY	VAN NO,ppm 3% O2 WET	VAN NO lb/mBtu	VAN CO PPM DRY	VAN CO2 % DRY	VAN SO2 PPM DRY
1000-1015	491	2.6	6.4	440	0.68	22	11.8	1872
1015-1030	490	2.6	6.5	448	0.69	23	11.9	1946
1030-1045	502	2.3	6.6	456	0.70	23	11.7	1955
1045-1055	494	2.8	7.2	485	0.75	22	11.6	1953
1130-1145	488	2.9	7.1	486	0.75	23	11.6	1714
1145-1200	491	2.5	7.4	479	0.75	24	11.5	1758
AVERAGES	493	2.6	6.9	466	0.72	23	11.7	1866
1250-1300	310	3.5	8.7	430	0.67	15	10.2	1557
1300-1315	311	3.8	8.6	434	0.67	16	10.3	1608
1315-1330	293	4.1	9.3	463	0.72	16	10.1	1583
1330-1345	296	4.3	8.8	450	0.70	16	10.1	1586
1345-1400	309	4.4	9.1	469	0.73	16	10.1	1614
AVERAGES	304	4.0	8.9	449	0.70	16	10.2	1590

NOTES:
(1) Unit load recorded every 10-15 min. from control board.
(2) Average boiler O2% from superheat and reheat furnaces, recorded every 10-15 min. from control board.
(3) VAN measurement of O2% on a dry basis, average of 10-second readings.
(4) VAN measurement of NO, ppm, corrected to 3% O2; average of 10-second readings.
(5) Emission rate, NO, lb/mBtu, calculated from VAN NO measurements and VAN %O2.
(6) VAN measurement of CO, ppm, on a dry basis, average of 10-second readings.
(7) VAN measurement of CO2, %, on a dry basis, average of 10-second readings.
(8) VAN measurement of SO2, ppm, on a dry basis, average of 10-second readings.

RESULTS

UNIT 8 SCRUBBER INLET

Time PERIOD	(1) LOAD	(2) BOILER O2	(3) VAN %O2 DRY	(4) VAN NO,ppm 3% O2 WET	(5) VAN NO lb/mBtu	(6) CEM %O2	(7) CEM NO,ppm 3% O2 WET	(8) CEM NO lb/mBt
0940-0950	419	3.4	7.6	368	0.57	10.0	286	0.45
0950-1000	419	3.4	7.5	365	0.56	10.0	286	0.45
1020-1030	406	3.2	7.4	364	0.56	10.0	295	0.46
1030-1050	418	3.3	7.6	374	0.58	10.0	286	0.45
1050-1110	430	2.8	7.5	371	0.57	10.0	286	0.45
1110-1125	435	3.4	7.5	370	0.57	10.0	286	0.45
1140-1150	414	3.2	7.6	379	0.58	10.0	286	0.45
1150-1210	403	3.3	7.3	361	0.56	10.0	286	0.45
1210-1230	422	3.3	7.6	370	0.57	10.0	278	0.43
1230-1245	418	3.2	7.5	368	0.57	10.0	278	0.43
AVERAGES	418	3.2	7.5	369	0.57	10.0	285	0.45

WIDOWS CREEK UNIT 8

UNIT 8 SCRUBBER INLET
8/31/89

See notes:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TIME PERIOD	LOAD	BOILER O2	VAN %O2 DRY	VAN NO,ppm 3% O2 WET	VAN NO lb/mBtu	CEM %O2	CEM NO,ppm 3% O2 WET	CEM NO lb/mBtu
0830-0850	420	3.4	7.8	380	0.59	10.0	286	0.45
0850-0910	414	3.4	7.8	376	0.58	11.0	252	0.39
0930-0940	414	3.7	7.9	390	0.60	12.0	306	0.55
AVERAGES	**416**	**3.5**	**7.8**	**382**	**0.59**	**11.0**	**296**	**0.46**
1015-1030	300	4.0	9.1	375	0.58	12.0	270	0.43
1030-1050	305	3.9	8.3	348	0.54	12.0	270	0.43
1050-1110	295	3.6	8.2	338	0.52	12.0	270	0.43
1110-1130	293	3.5	8.2	336	0.52	12.0	270	0.43
130-1150	300	3.6	8.1	333	0.51	12.0	260	0.43
1210-1230	294	3.5	8.0	339	0.52	12.0	270	0.43
230-1250	295	3.4	7.8	333	0.51	12.0	270	0.43
AVERAGES	**297**	**3.6**	**8.2**	**343**	**0.53**	**12.0**	**270**	**0.43**

NOTES:

(1) Unit load recorded every 10-15 min. from control board.
(2) Average boiler O2% from superheat and reheat furnaces, recorded every 10-15 min. from control board.
(3) VAN measurement of O2% on a dry basis, average of 10-second readings
(4) VAN measurement of NO, ppm, corrected to 3% O2; average of 10-second readings.
(5) Emission rate, NO, lb/mBtu, calculated from VAN NO measurements and VAN %O2.
(6) CEM measurement of O2%, stack conditions, read every 10-15-min. from strip chart in control room.
(7) CEM measurement of NO, ppm, corrected to 3% O2, read every 10-15-min. from strip chart in control room.
(8) Emission rate, NO, lb/mBtu, calculated from CEM NO and CEM %O2.

Date: 3-8-90

ALLEN UNIT 1

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	Allen Unit #1
Date Sampled	1-10-90
Laboratory No.	90-1526
Air Dry Moisture	10.1
Residual Moisture	2.3
Total Moisture	12.2
Proximate Analysis	
% Volatile Matter	37.4
% Ash	9.2
% Fixed Carbon	53.4
% Total Sulfur	2.56
Btu/lb	
As Received	
Dry	13,312
A and MF	14,663
Ultimate Analysis	
% Carbon	74.5
% Hydrogen	4.9
% Nitrogen	1.6
% Oxygen	7.24
Forms of S	
% Sulfate	
% Pyritic	
% Organic	
% Total	
Grindability Index	
% Chlorine	

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: BCH/ASG (0917L)

Date Analyzed: 3-6-90

Distribution:

BCH:RMM

Date: November 8, 1989

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	CFP Unit #5	CFP Unit #3
Date Sampled	9-25-89	9-28-89
Laboratory No.	90-0007	90-0008
Air Dry Moisture	6.8	6.0
Residual Moisture	2.6	2.5
Total Moisture	9.2	8.4
Proximate Analysis		
% Volatile Matter	37.5	37.4
% Ash	12.6	12.9
% Fixed Carbon	49.9	49.7
% Total Sulfur	2.55	2.52
Btu/lb		
As Received		
Dry	12,702	12,597
A and MF	14,538	14,466
Ultimate Analysis		
% Carbon	71.1	70.7
% Hydrogen	5.0	4.9
% Nitrogen	1.4	1.4
% Oxygen	7.35	7.58
Forms of S	E	C
% Sulfate		
% Pyritic		
% Organic		
% Total		
Grindability Index		
% Chlorine		

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: B. C.Hudson/A. S. Gary (13990)

Distribution:

Date: 3-27-90

COLBERT UNIT 4

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	Colbert Unit #4 "NOX TEST"
Date Sampled	
Laboratory No.	90-2398
Air Dry Moisture	12.0
Residual Moisture	3.7
Total Moisture	15.3
Proximate Analysis	
% Volatile Matter	37.5
% Ash	9.1
% Fixed Carbon	53.4
% Total Sulfur	2.21
Btu/lb	
As Received	
Dry	13,249
A and MF	14,582
Ultimate Analysis	
% Carbon	74.9
% Hydrogen	5.0
% Nitrogen	1.7
% Oxygen	7.09
Forms of S	
% Sulfate	
% Pyritic	
% Organic	
% Total	
Grindability Index	
% Chlorine	

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: BCH (1045L)

Date Analyzed: 3-22-90

Distribution:

BCH:RMM

August 14, 1989

CUMBERLAND UNITS 1 AND 2

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER
STOCK EMISSION TEST - CUMBERLAND FOSSIL PLANT

Sample Identity	Unit 2 PL-351-BuS 2nd Shift	Unit 2 PL-352-BuS 3rd Shift	Unit 1 PL-360 2nd Shift
Date Sampled	6/30/89	6/30/89	7/7/89
Laboratory No.	89-3317	89-3318	89-3319
Air Dry Moisture			
Residual Moisture	2.8	3.5	3.4
Total Moisture			
Proximate Analysis			
% Volatile Matter	40.8	39.8	40.2
% Ash	9.6	9.9	9.8
% Fixed Carbon	49.6	50.3	50.0
% Total Sulfur	3.27	3.06	3.17
Btu/lb			
As Received			
Dry	13,095	13,056	13,064
A and MF	14,480	14,498	14,489
Ultimate Analysis			
% Carbon	73.0	73.1	73.1
% Hydrogen	5.2	5.2	5.1
% Nitrogen	1.6	1.6	1.6
% Oxygen	7.33	7.14	7.23
Forms of S			
% Sulfate			
% Pyritic			
% Organic			
% Total			
Grindability Index			
% Chlorine	.12	.12	.12

NOTE: All results are on dry basis unless stated otherwise.

Date: August 14, 1989

CUMBERLAND UNIT 2

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER
STOCK EMISSION TEST - CUMBERLAND FOSSIL PLANT

Sample Identity	Unit 2 PL-344-BuS 2nd Shift	Unit 2 PL-345-BuS 2nd Shift	Unit 2 PL-346-BuS 3rd Shift	Unit 2 PL-348-BuS- 2nd Shift	Unit 2 PL-349-BuS 3rd Shift
Date Sampled	6/27/89	6/28/89	6/28/89	6/29/89	6/29/89
Laboratory No.	89-3312	89-3313	89-3314	89-3315	89-3316
Air Dry Moisture					
Residual Moisture	2.4	2.3	2.3	2.6	2.5
Total Moisture					
Proximate Analysis					
% Volatile Matter	40.6	40.9	40.7	40.5	40.6
% Ash	9.4	9.2	9.2	10.0	9.8
% Fixed Carbon	50.0	49.9	50.1	49.5	49.6
% Total Sulfur	3.17	3.10	3.14	3.25	3.25
Btu/lb					
As Received					
Dry	13,016	13,190	13,187	13,089	13,037
A and MF	14,469	14,529	14,525	14,537	14,461
Ultimate Analysis					
% Carbon	73.3	73.5	73.7	73.0	72.7
% Hydrogen	5.2	5.3	5.3	5.2	5.2
% Nitrogen	1.6	1.6	1.6	1.6	1.6
% Oxygen	7.33	7.30	7.06	6.95	7.45
Forms of S					
% Sulfate					
% Pyritic					
% Organic					
% Total					
Grindability Index					
% Chlorine	.12	.11	.11	.12	.12

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: Billie Hudson/Robert Brannan (3593C)

GALLATIN UNITS 1 AND 2

Date: August 3, 1989

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	Gallatin #1	Gallatin #2
Date Sampled	7/10/89	7/11/89
Laboratory No.	89-3279	89-3280
Air Dry Moisture		
Residual Moisture	2.5	2.3
Total Moisture		
Proximate Analysis		
% Volatile Matter	34.8	38.9
% Ash	11.2	8.7
% Fixed Carbon	50.4	52.4
% Total Sulfur	3.15	3.01
Btu/lb		
As Received		
Dry	12,919	13,425
A and MF	14,545	14,704
ULtimate Analysis		
% Carbon	72.4	74.9
% Hydrogen	4.9	5.1
% Nitrogen	1.6	1.7
% Oxygen	6.75	6.59
Forms of S		
% Sulfate		
% Pyritic		
% Organic		
% Total		
Grindability Index		
% Chlorine		

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: Billie Hudson/A. Scott Gary (3576C)

Date: August 24, 1990

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	Gallatin G-2 Unit #2 Coal Scales
Date Sampled	8/1/90
Laboratory No.	90-4676
Air Dry Moisture	6.6
Residual Moisture	3.1
Total Moisture	9.5
Proximate Analysis	
% Volatile Matter	
% Ash	10.6
% Fixed Carbon	
% Total Sulfur	2.65
Btu/lb	
As Received	
Dry	13,301
A and MF	14,883
Ultimate Analysis	
% Carbon	73.9
% Hydrogen	5.1
% Nitrogen	1.5
% Oxygen	6.25
Forms of S	
% Sulfate	
% Pyritic	
% Organic	
% Total	
Grindability Index	
% Chlorine	

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: Billie Hudson/W. L. Roes, Jr. (4317C)

Date Analyzed: 8/17/90

JOHN SEVIER UNITS 2, 3, AND 4

Date: 12/28/90

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	SEV-Unit 3	SEV-Unit 4	SEV-Unit 2
	10:45-2:00	7:30-10:00	
Date Sampled	10-11-90	10-11-90	10-17-90
Laboratory No.	91-0183	91-0184	91-0365
Air Dry Moisture	5.6	6.5	3.1
Residual Moisture	1.1	1.1	1.3
Total Moisture	6.6	7.5	6.1
Proximate Analysis			
% Volatile Matter	35.2	35.1	35.6
% Ash	10.0	8.7	9.7
% Fixed Carbon	54.8	56.2	54.7
% Total Sulfur	2.07	1.82	1.71
Btu/lb			
As Received			
Dry	13,665	13,978	13,613
A and MF	15,185	15,309	15,080
Ultimate Analysis			
% Carbon	76.7	78.1	76.5
% Hydrogen	5.1	5.1	5.0
% Nitrogen	1.7	1.8	1.7
% Oxygen	4.43	4.48	5.39
Forms of S			
% Sulfate			
% Pyritic			
% Organic			
% Total			
Grindability Index			
% Chlorine			

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: BCH:WLR(4574C)

Date of Analysis: 12/7/90

JOHNSONVILLE UNIT 10

Date: December 7, 1989

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	Johnsonville Unit No. 10 from Coal Scale
Date Sampled	11/7/89
Laboratory No.	90-0721
Air Dry Moisture	
Residual Moisture	3.7
Total Moisture	
Proximate Analysis	
% Volatile Matter	37.9
% Ash	11.8
% Fixed Carbon	50.3
% Total Sulfur	1.65
Btu/lb	
As Received	
Dry	12,613
A and MF	14,306
Ultimate Analysis	
% Carbon	71.6
% Hydrogen	4.8
% Nitrogen	1.5
% Oxygen	8.65
Forms of S	
% Sulfate	
% Pyritic	
% Organic	
% Total	
Grindability Index	
Chlorine	

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: Billie Hudson/A. Scott Gary (3896C)

KINGSTON UNIT 5

Date: 3-26-90

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	K Unit # 5 ABC Scales 1:00 p.m.
Date Sampled	3-13-90
Laboratory No.	90-2516
Air Dry Moisture	5.4
Residual Moisture	1.6
Total Moisture	6.9
Proximate Analysis	
% Volatile Matter	37.2
% Ash	11.2
% Fixed Carbon	51.6
% Total Sulfur	1.55
Btu/lb	
As Received	
Dry	13,278
A and MF	14,950
Ultimate Analysis	
% Carbon	74.2
% Hydrogen	5.0
% Nitrogen	1.7
% Oxygen	4.55
Forms of S	
% Sulfate	
% Pyritic	
% Organic	
% Total	
Grindability Index	
% Chlorine	

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: BCH (1031L)

Date: May 10, 1991

SHAWNEE UNIT 2

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	S2-C-1045-1445 Unit 2C Mill 1045-1445	S-6007M Unit 2B Mill 0900-1130	S-6008M Unit 2B Mill 1215-1515	S-6009M Unit 2B Mill 1000-1100	S-6010M Unit 2B Mi 1200-1300
Date Sampled	2/26/91	2/20/91	2/20/91	2/21/91	2/21/91
Laboratory No.	91-2997	91-2998	91-2999	91-3000	91-3001
Air Dry Moisture	3.6	7.9	8.3	6.3	5.8
Residual Moisture	1.9	2.3	2.2	1.5	1.3
Total Moisture	5.4	10.0	10.3	7.7	7.0
Proximate Analysis					
% Volatile Matter	34.4	34.7	34.8	33.5	33.8
% Ash	9.7	11.3	11.0	9.5	9.6
% Fixed Carbon	55.9	54.0	54.2	57.0	56.6
% Total Sulfur	.67	.69	.70	.62	.61
Btu/lb					
As Received					
Dry	13,559	13,027	13,072	13,604	13,664
A and MF	15,012	14,679	14,694	15,039	15,119
Ultimate Analysis					
% Carbon	76.6	74.3	74.5	77.3	77.3
% Hydrogen	5.0	4.8	4.9	4.9	4.9
% Nitrogen	1.4	1.5	1.4	1.4	1.4
% Oxygen	6.63	7.41	7.50	6.28	6.19
Forms of S					
% Sulfate					
% Pyritic					
% Organic					
% Total					
Grindability Index					
% Chlorine					

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: Billie Hudson/Verinda Smith (SAV - 5086C)
Date of Analysis: 4/29/91

DISTRIBUTION: Phil D. Tingle, MR 3B-C
Donna Crabtree, E-Mail

Date: May 10, 1991

SHAWNEE UNIT 2

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	S-Unit 2 Raw Coal RPT A-1	S-Unit 2 Raw Coal PT A2 9:30 - 3:00	S-Unit 2 Raw Coal PT A-3 3:00 - 6:00
Date Sampled	3/20/91	3/21/91	3/21/91
Laboratory No.	91-3003	91-3004	91-3005
Air Dry Moisture	6.1	7.7	5.0
Residual Moisture	1.9	1.9	2.5
Total Moisture	7.9	9.5	7.4
Proximate Analysis			
% Volatile Matter	34.8	34.5	34.9
% Ash	10.3	10.2	11.8
% Fixed Carbon	54.9	55.3	53.3
% Total Sulfur	.69	.69	.63
Btu/lb			
As Received			
Dry	13,322	13,283	12,951
A and MF	14,851	14,791	14,683
Ultimate Analysis			
% Carbon	75.7	75.7	73.8
% Hydrogen	5.0	4.9	4.9
% Nitrogen	1.5	1.5	1.4
% Oxygen	6.81	7.01	7.47
Forms of S			
% Sulfate			
% Pyritic			
% Organic			
% Total			
Grindability Index	43	46	42
% Chlorine			

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: Billie Hudson (SAV - 5086.3C)
Date of Analysis: 4/29/91

Date: 2-28-90

SHAWNEE UNIT 6

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

	Shawnee				
Sample Identity	S. Unit 6 Test 1	S. Unit 6 Test 2	S. Unit 6 Test 3	S. Unit 6 Test AA	S. Unit 6 Test BB
Date Sampled	12-5-89	12-5-89	12-6-89	12-7-89	.2-7-89
Laboratory No.	90-1223	90-1224	90-1225	90-1226	90-1227
Air Dry Moisture					
Residual Moisture	1.8	1.7	2.1	1.3	1.3
Total Moisture					
Proximate Analysis					
% Volatile Matter					
% Ash	12.8	13.1	13.8	14.7	15.8
% Fixed Carbon					
% Total Sulfur	.70	.67	.70	.67	.70
Btu/lb					
As Received					
Dry					
A and MF					
Ultimate Analysis					
% Carbon	74.4	74.6	72.3	73.3	72.7
% Hydrogen	4.7	4.7	4.7	4.5	4.4
% Nitrogen	1.4	1.4	1.3	1.3	1.3
% Oxygen	6.00	5.53	7.20	5.53	5.10
Forms of S					
% Sulfate					
% Pyritic					
% Organic					
% Total					
Grindability Index					
% Chlorine					

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: BCH-ASG (OBB2L)

Date Analyzed: 2-27-90

Date: 2-28-90

SHAWNEE UNIT 6

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Shawnee

Sample Identity	S. Unit 6 Test D	S. Unit 6 Test E	S. Unit 6 Test F	S. Unit 6 Test G	S. Unit 6 Test H
Date Sampled	12-6-89	12-6-89	12-6-89	12-7-89	12-7-89
Laboratory No.	90-1228	90-1229	90-1230	90-1231	90-1232
Air Dry Moisture					
Residual Moisture	1.6	2.4	2.1	2.1	2.1
Total Moisture					
Proximate Analysis					
% Volatile Matter					
% Ash	13.6	13.7	15.1	16.0	15.7
% Fixed Carbon					
% Total Sulfur	.70	.68	.64	.64	.65
Btu/lb					
As Received					
Dry					
A and MF					
Ultimate Analysis					
% Carbon	72.7	73.7	73.0	72.1	72.4
% Hydrogen	4.8	4.7	4.5	4.6	4.6
% Nitrogen	1.3	1.3	1.2	1.3	1.3
% Oxygen	6.90	5.92	5.56	5.36	5.35
Forms of S					
% Sulfate					
% Pyritic					
% Organic					
% Total					
Grindability Index					
% Chlorine					

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: BCH-ASG (0882L)

Date Analyzed: 2-27-90

BCH:RMM

Date: 3-5-90

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	Shawnee Unit 8 Coal Feeders A	Shawnee Unit 8 Coal Feeders A-1	Shawnee Unit 8 Coal Feeders B	Shawnee Unit 8 Coal Feeders B-1
Date Sampled	12-12-89	12-14-89	12-12-89	12-14-89
Laboratory No.	90-1313	90-1314	90-1315	90-1316
Air Dry Moisture				
Residual Moisture	2.2	3.1	2.0	3.2
Total Moisture				
Proximate Analysis				
% Volatile Matter				
% Ash	10.9	12.9	9.8	12.6
% Fixed Carbon				
% Total Sulfur	.60	.71	.62	.70
Btu/lb				
As Received				
Dry				
A and MF				
Ultimate Analysis				
% Carbon	73.4	72.7	74.7	73.4
% Hydrogen	4.6	4.5	4.8	4.5
% Nitrogen	1.4	1.4	1.4	1.5
% Oxygen	9.10	7.79	8.68	7.30
Forms of S				
% Sulfate				
% Pyritic				
% Organic				
% Total				
Grindability Index				
% Chlorine				

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: BCH/ASG (0901L))

BCH:RMM

SHAWNEE UNIT 8

Date: 3-5-90

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	S. Unit 8 Coal Feeder	S. Unit 8 Coal Feeder
Date Sampled	12-12-89	12-12-89
Laboratory No.	90-1317	90-1318
Air Dry Moisture		
Residual Moisture	1.8	2.0
Total Moisture		
Proximate Analysis		
% Volatile Matter		
% Ash	9.8	9.8
% Fixed Carbon		
% Total Sulfur	.62	.69
Btu/lb		
As Received		
Dry		
A and MF		
Ultimate Analysis		
% Carbon	74.7	74.6
% Hydrogen	4.8	4.9
% Nitrogen	1.5	1.5
% Oxygen	8.58	8.51
Forms of S		
% Sulfate		
% Pyritic		
% Organic		
% Total		
Grindability Index		
% Chlorine		

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: BCH/ASG (0901L)

Date: 5/18/90

WIDOWS CREEK UNIT 7

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER

Sample Identity	Widows Creek Steam Plant Unit 7
Date Sampled	4/5/90
Laboratory No.	90-3045
Air Dry Moisture	7.2
Residual Moisture	1.5
Total Moisture	8.6
Proximate Analysis	
% Volatile Matter	
% Ash	16.1
% Fixed Carbon	
% Total Sulfur	3.87
Btu/lb	
As Received	
Dry	12,308
A and MF	14,677
Ultimate Analysis	
% Carbon	68.7
% Hydrogen	4.6
% Nitrogen	1.5
% Oxygen	5.23
Forms of S	
% Sulfate	
% Pyritic	
% Organic	
% Total	
Grindability Index	
% Chlorine	

NOTE: All results are on dry basis unless stated otherwise.

Date of Analysis: 5/14/90

Analyzed by: Billie C. Hudson/A. Scott Gary/Mary E. Card (1498S)

SWH

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/R-92-242		

4. TITLE AND SUBTITLE	5. REPORT DATE
Evaluation of Nitrogen Oxide Emissions Data from TVA Coal-Fired Boilers	December 1992
	6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Susan Stamey-Hall	DCN No. 92-239-022-02-06

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Radian Corporation P. O. Box 13000 Research Triangle Park, North Carolina 27709	11. CONTRACT/GRANT NO. 68-D1-0013, Task 002

12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
EPA, Office of Research and Development Air and Energy Engineering Research Laboratory Research Triangle Park, NC 27711	Task Final; 6/91 - 7/92 14. SPONSORING AGENCY CODE EPA/600/13

15. SUPPLEMENTARY NOTES AEERL project officer is Julian W. Jones, Mail Drop 62, 919/541-2489.

16. ABSTRACT The report gives results of a study during which nitrogen oxide (NOx) emission rates from 30 boilers at 11 TVA coal-fired plants were calculated and compared with the calculated rate for each boiler type using EPA emission factors (AP-42). Current AP-42 emission factors for NOx from utility coal-fired boilers do not account for variations in either emissions as a function of generating unit load, or designs of boilers of the same general type, particularly wall-fired boilers. TVA recently compiled short-term NOx emissions data from 30 units at 11 TVA coal-fired plants. These units include cyclone, cell-burner, single-wall, opposed-wall, single-tangential, and twin-tangential boiler firing designs. Additional recent NOx data (from non-TVA boilers) were also obtained from the literature, along with the data used to develop the current AP-42 emission factors. Analysis of these data indicates that: (1) to varying degrees, NOx emissions increase with increasing load for all but single- and opposed-wall-fired boilers; (2) using the current AP-42 quality rating scheme for each of the six boiler types, factoring in the TVA and recent literature data results in improved quality ratings for all NOx emission factors; and (3) there was no evident relationship between NOx emissions and fuel nitrogen content or fuel ratio (fixed carbon to volatile matter).

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Pollution Control	13B
Nitrogen Oxides	Stationary Sources	07B
Emission	Emission Factors	14G
Boilers		13A
Coal		21D
Combustion		21B

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
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EPA-600/R-92-242
December 1992

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5

EVALUATION OF NITROGEN OXIDE EMISSIONS DATA FROM TVA COAL-FIRED BOILERS

by

Susan Stamey-Hall
Radian Corporation
Post Office Box 13000
Research Triangle Park, NC 27709

EPA Contract No. 68-D1-0031
Work Assignment No. 002

Project Officer: Julian W. Jones
U.S. Environmental Protection Agency
Air and Energy Engineering Research Laboratory
Research Triangle Park, NC 27711

Prepared for:

U.S. Environmental Protection Agency
Office of Research and Development
Washington, DC 20460

TABLE 6. SUMMARY OF NO_x EMISSIONS DATA FOR CELL BURNER UNITS

ID[a]	Plant	Unit No.	Capacity, MW	Average Test Load, %	Average NO_x, lb/mBtu	AP-42[b]	% Difference Average - AP-42
C	Cumberland	1	1300	78	1.7	0.78	118
D	Cumberland	2	1300	95	1.5	0.78	92
D	Cumberland	2	1300	100	1.4	0.78	79
E9	Four Corners	4	800	75	1.08	0.78	38
E9	Four Corners	4	800	95	1.09	0.78	40
L3	Four Corners	4	800	100	1.27	0.78	63
E10	Harlee Branch	3	480	83	0.71	0.78	-9
E10	Harlee Branch	3	480	100	0.95	0.78	22
Average					1.21	0.78	55
Emission Factor					33	21	55

[a]Letters C and D = TVA units; E = units identified through AP-42 references; and L = units identified through the literature search.

[b]Calculated by using 13,500 Btu/lb.

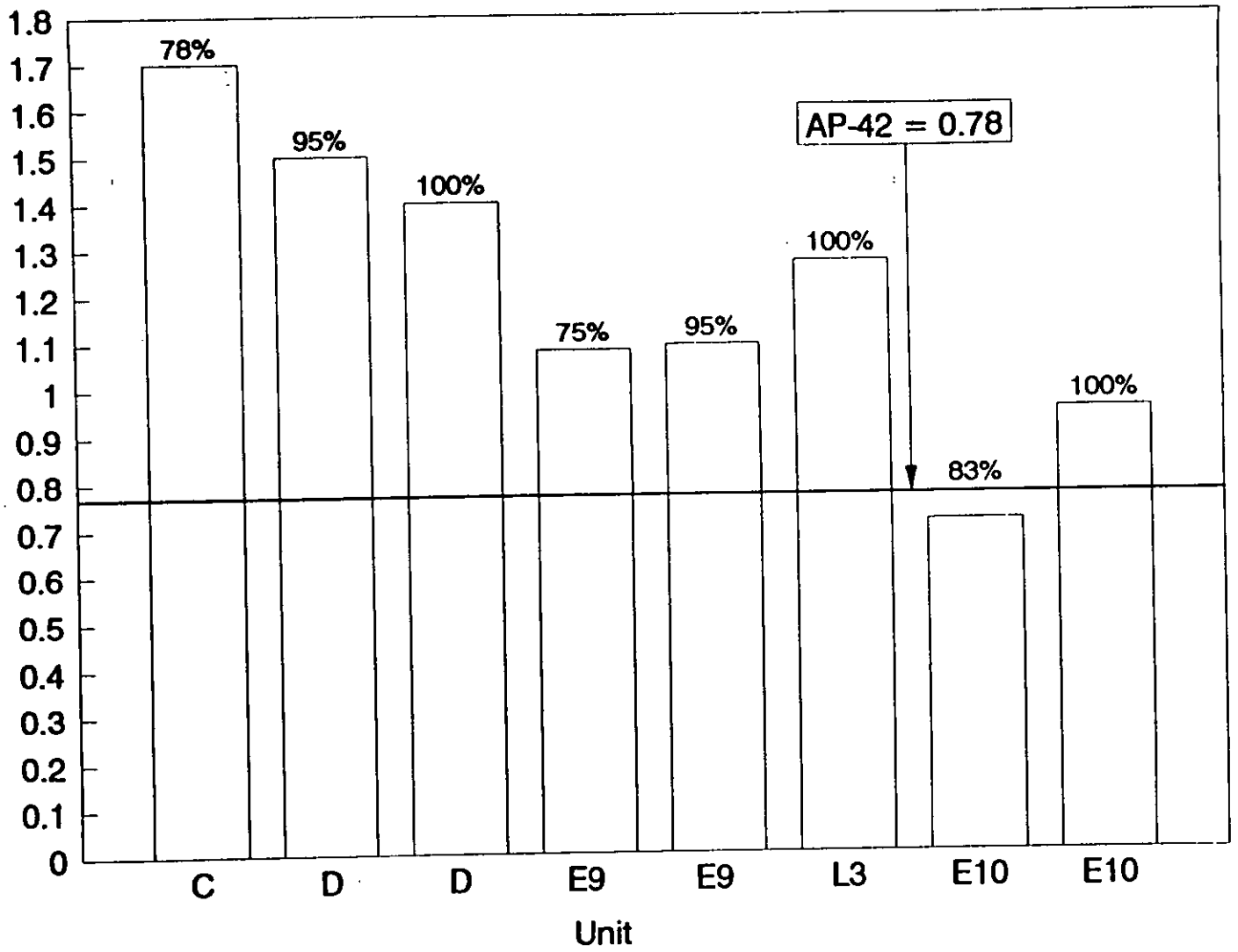

Figure 3. NOx emissions, cell-burner wall-fired units.

TABLE 4. BOILER POPULATION FROM CURRENT AP-42 REFERENCE LIST AND LITERATURE SEARCH

ID[a]	Plant	Unit No.	Boiler Mfgr.	Capacity MW	AP-42 Major Category	Subclass	Coal Type	Reference
E1	Unidentified	1	B&W	206	Cyclone	N/A	Unknown	3
E2	Unidentified	2	B&W	Unknown	Cyclone	N/A	Unknown	3
E3	Unidentified	3	B&W	200	Cyclone	N/A	Unknown	3
E4	Unidentified	4	B&W	Unknown	Cyclone	N/A	Unknown	3
E5	Unidentified	5	B&W	240	Cyclone	N/A	Unknown	3
E6	Unidentified	6	B&W	704	Cyclone	N/A	Unknown	3
E7	Unidentified	7	B&W	Unknown	Cyclone	N/A	Unknown	3
E8	Unidentified	8	B&W	300	Cyclone	N/A	Unknown	3
L1	Niles	1	B&W	108	Cyclone	N/A	Bituminous	4
L2	Nelson Dewey	2	B&W	100	Cyclone	N/A	Bituminous	5
E9	Four Corners[b]	4	B&W	800	Wall	Cell	Subbituminous	6
L3	Four Corners[b]	4	B&W	800	Wall	Cell	Subbituminous	7
E10	Harlee Branch	3	B&W	480	Wall	Cell	Bituminous	6
L4	Crist	7	FW	500	Wall	Opposed	Bituminous	8
L5	Hammond	4	FW	500	Wall	Opposed	Bituminous	9
E11	Widows Creek[c]	5	B&W	125	Wall	Single	Bituminous	6
E12	Widows Creek[c]	6	B&W	125	Wall	Single	Bituminous	6
E13	Crist	6	FW	320	Wall	Single	Bituminous	6

(Continued)

TABLE 4. BOILER POPULATION FROM CURRENT AP-42 REFERENCE LIST AND LITERATURE SEARCH (CONTINUED)

ID[a]	Plant	Unit No.	Boiler Mfgr.	Capacity MW	AP-42 Major Category	Subclass	Coal Type	Reference
E14	E.D. Edwards	2	RS	256	Wall	Single	Bituminous	6
E15	Dave Johnson	2	B&W	105	Wall	Single	Subbituminous	6
L6	Edgewater	4	B&W	105	Wall	Single	Bituminous	10
E16	Comanche[d]	1	CE	350	Tangential	Single Furnace	Subbituminous	6
E17	Naughton	3	CE	330	Tangential	Single Furnace	Subbituminous	6
E18	Barry[d]	2	CE	130	Tangential	Single Furnace	Bituminous	6
E19	Barry	4	CE	350	Tangential	Single Furnace	Bituminous	6
E20	Dave Johnson	4	CE	340	Tangential	Single Furnace	Subbituminous	6
L7	Smith	2	CE	180	Tangential	Single Furnace	Bituminous	11
L8	Hunter	2	CE	400	Tangential	Single Furnace	Bituminous	12
L9	Lawrence	5	CE	400	Tangential	Single Furnace	Bituminous	13
L10	Cherokee	4	CE	350	Tangential	Single Furnace	Bituminous	14
L11	Valmont	5	CE	165	Tangential	Single Furnace	Bituminous	14
E21	Barry	3	CE	250	Tangential	Twin Furnace	Bituminous	6
E22	Navajo[d]	2	CE	800	Tangential	Twin Furnace	Subbituminous	6
L12	Kingston	6	CE	200	Tangential	Twin Furnace	Bituminous	15

[a]E = units identified through AP-42 references, L = units identified through the literature search.
[b]Identified in both the AP-42 reference list and in the literature search.
[c]TVA boiler.
[d]Unit is equipped with overfire air ports for NO_x control. Data from baseline operation (i.e., normal firing with overfire air ports closed) were used in the analysis.

SECTION 7

REFERENCES

1. Office of Air Quality Planning and Standards, Compilation of Air Pollution Emission Factors, Volume 1: Stationary Point and Area Sources, AP-42, Fourth Edition (GPO 055-000-00251-7). U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. September 1985 [supplemented October 1986 (GPO 055-000-00265-7) and September 1988 (GPO 055-000-00278-9)], pp 1.1-1 - 1.1-17.

2. U.S. Environmental Protection Agency. Code of Federal Regulations. Part 60, Appendix A, Methods 3A and 7E, 7-1-89 Edition.

3. Ctvrtnicek, T.E., and S.J. Rusek. Applicability of NO_x Combustion Modifications to Cyclone Boilers (Furnaces). EPA-600/7-77-006 (NTIS PB263-960), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, January 1977.

4. Booth, R.C., R.E. Hall, R.A. Lott, A. Kokkinos, D.F. Gyorke, S. Durrani, H.J. Johnson, J.J., Kienle, R.W. Borio, R.D. Lewis, and M.B. Keough. Reburn Technology for NO_x Control on a Cyclone-Fired Boiler. In Proceedings: 1991 Joint Symposium on Stationary Combustion NO_x Control, EPRI GS-7447, Volume I.

5. Yagiela, A.S., G.J. Maringo, R.J. Newell, and H. Farzan. Update on Coal Reburning Technology for Reducing NO_x in Cyclone Boilers. In Proceedings: 1991 Joint Symposium on Stationary Combustion NO_x Control, EPRI GS-7447, Volume I.

6. Crawford, A.R., E.H. Manny, and W. Bartok. Control of Utility Boiler and Gas Turbine Pollutant Emissions by Combustion Modification - Phase I. EPA-600/7-78-036a (NTIS PB281-078), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. March 1978. Four Corners 4 Harlee Branch 3

7. Vatsky, J., and T.W. Sweeney. Development of an Ultra-Low NO_x Pulverized Coal Burner. In Proceedings: 1991 Joint Symposium on Stationary Combustion NO_x Control, EPRI GS-7447, Volume I. Four Corners 4

8. Sawyer, J.W., and E.B. Higginbotham. Combustion Modification NO_x Controls for Utility Boilers. Volume II: Pulverized-Coal Wall-Fired Unit Field Test, EPA-600/7-81-124b (NTIS PB82-227273), July 1981.

9. Wilson, S.M., J.N. Sorge, L.L. Smith, and L.L. Larsen. Demonstration of Low NO_x Combustion Control Technologies on a 500 MWe Coal Fired Utility Boiler. In Proceedings: 1991 Joint Symposium on Stationary Combustion NO_x Control, EPRI GS-7447, Volume I.

10. LaRue, A.D. The XCL Burner - Latest Developments and Operating Experience. In Proceedings: 1989 Joint Symposium on Stationary Combustion NO_x Control, Volume I, EPA-600/9-89/062a (NTIS PB89-220529), June 1989.

11. Hardman, R.R., S.M. Wilson, and J.D. McDonald. Advanced Tangentially-Fired Combustion Techniques for the Reduction of Nitrogen Oxide (NO_x) Emissions from Coal-Fired Boilers. Presented at the Eighth Annual International Pittsburgh Coal Conference, Pittsburgh, Pennsylvania, October 14-18, 1991.

12. Kokkinos, A., and R.D. Lewis. Field Evaluation of a Low-NO_x Firing System for Tangentially Coal-Fired Utility Boilers. EPA-600/7-85-018 (NTIS PB85-201093), May 1985.

13. Thompson, R.E., G.H. Shiomoto, D.E. Shore, M.D. McDannel, and D. Eskinazi. NO_x Emissions Results for a Low-NO_x PM Burner Retrofit. In Proceedings: 1989 Joint Symposium on Stationary Combustion NO_x Control, Volume 1, EPA-600/9-89/062a (NTIS PB89-220529), June 1989.

14. Hunt, T.G., R.R. Hawley, R.C. Booth, and B.P. Breen. Retrofit Experience Using LNCFS on 350 MW and 165 MW Coal-Fired Tangential Boilers. In Proceedings: 1991 Joint Symposium on Stationary Combustion NO_x Control, EPRI GS-7447, Volume I.

15. Higginbotham, E.B., and P.M. Goldberg. Combustion Modification NO_x Controls for Utility Boilers: Volume 1. Tangential Coal-Fired Unit Field Test. EPA-600/7-81-124a (NTIS PB82-227265), July 1981.

16. How Fuel Quality Affects NO_x Formation - and CAA Compliance. Power Magazine, July 1991, Volume No. 135, No. 7, p. 54-56, 81.

RESULTS

The results of the testing are as follows:

UNIT 1
7/6/89

TIME PERIOD	LOAD	BOILER O2	VAN %O2 DRY	VAN NO,PPM 3% O2	VAN NO LB/MBTU	CEM %O2 DRY	CEM NO,PPM DRY	CEM NO LB/MBTU
1200-1215	1020	6.3	8.0	1156	1.7	8.1	855	1.2
1215-1230	1016	6.6	8.2	1157	1.7	7.3	848	1.2
1230-1245	1015	6.4	8.3	1152	1.7	8.1	833	1.2
1245-1300	1015	6.5	8.3	1145	1.7	7.3	805	1.2
1300-1315	1015	6.5	8.2	1125	1.6	8.1	855	1.3
1315-1330	1030	6.7	8.3	1124	1.6	8.1	900	1.3
1330-1345	1015	6.5	8.4	1133	1.6	8.1	809	1.2
1345-1400	1010	6.7	8.4	1120	1.6	8.1	855	1.2
AVERAGE	1015	6.5	8.3	1140	1.7	7.9	845	1.2

UNIT 2
6/27/89

TIME PERIOD	LOAD	BOILER O2	VAN %O2 DRY	VAN NO,PPM 3% O2	VAN NO LB/MBTU	CEM %O2 DRY	CEM NO,PPM 3% O2	CEM NO LB/MBTU
1200-1215	1223	4.2	6.7	1012	1.4	6.1	935	1.3
1215-1230			6.6	1003	1.4			
1245-1300			6.6	1106	1.5			
1300-1315	1235	4.2	6.5	1055	1.5	6.1	935	1.3
1315-1330			6.5	1030	1.5			
1345-1400			6.7	1055	1.5			
1400-1415	1235	4.2	6.7	1064	1.5	6.5	961	1.4
1415-1430			6.8	1066	1.5			
1430-1445	1236	4.0	6.9	1065	1.5	6.5	921	1.3
AVERAGE	1230	4.2	6.7	1050	1.5	6.3	938	1.3

UNIT 2
6/29/89

TIME PERIOD	LOAD	BOILER O2	VAN %O2 DRY	VAN NO,PPM 3% O2	VAN NO LB/MBTU	CEM %O2 DRY	CEM NO,PPM 3% O2	CEM NO LB/MBTU
945-1000	1285	4.4	6.7	1021	1.5	6.7	894	1.3
1000-1015	1290	4.4	6.7	1003	1.4	6.5	921	1.3
1015-1030	1294	4.3	6.5	972	1.4	6.5	921	1.3
1100-1115	1292	4.1	6.4	1052	1.5	6.2	902	1.3
1115-1130	1292	4.1	6.3	1019	1.5	6.2	941	1.3
1245-1300	1294	3.7	5.7	989	1.4	6.2	941	1.3
1300-1315	1293	3.6	5.7	1011	1.4	6.2	902	1.3
1315-1330	1298	3.4	5.7	1009	1.4	6.2	902	1.3
1330-1345	1294	3.6	5.6	996	1.4	6.2	902	1.3
1345-1400	1298	3.4	5.5	989	1.4			
1415-1430	1309	4.1	6.0	1014	1.4	6.5	1001	1.5
1430-1445	1302	4.0	6.2	1016	1.5	6.5	974	1.4
1445-1500	1293	4.2	6.1	1004	1.4	6.7	974	1.4
1500-1515	1293	4.0	6.1	995	1.4	6.7	934	1.3
1515-1530	1293	4.2	6.1	987	1.4	6.7	934	1.3
1530-1545	1281	4.7	6.6	980	1.5	6.7	934	1.3
AVERAGES	1295	4.0	6.1	1005	1.4	6.5	932	1.3

CONCLUSIONS:

The conclusions from the NOx testing are as follows:

1. CEM and Van correlated well for Unit 2; however, CEM reads approximately 0.5 lb/mbtu lower than the Van for Unit 1.

2. At reduced load (1240 MW) on Unit 2, NOx emissions were slightly higher than at full load. This is probably due to the higher boiler O2 levels at reduced load.

3. At reduced load (1015 MW) on Unit 1, NOx emissions were high. Again, this is probably due to the extremely high boiler O2 levels.

4. Reducing boiler O2 on Unit 2 from 4.4 to 3.6 % showed slight reduction of NOx. However, on a unit of this size with so many other operational factors to be considered, it may be difficult to see a significant reduction in NOx when boiler O2 is reduced.

August 14, 1989

CUMBERLAND UNITS 1 AND 2

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER
STOCK EMISSION TEST - CUMBERLAND FOSSIL PLANT

Sample Identity	Unit 2 PL-351-BuS 2nd Shift	Unit 2 PL-352-BuS 3rd Shift	Unit 1 PL-360 2nd Shift
Date Sampled	6/30/89	6/30/89	7/7/89
Laboratory No.	89-3317	89-3318	89-3319
Air Dry Moisture			
Residual Moisture	2.8	3.5	3.4
Total Moisture			
Proximate Analysis			
% Volatile Matter	40.8	39.8	40.2
% Ash	9.6	9.9	9.8
% Fixed Carbon	49.6	50.3	50.0
% Total Sulfur	3.27	3.06	3.17
Btu/lb			
As Received			
Dry	13,095	13,056	13,064
A and MF	14,480	14,498	14,489
Ultimate Analysis			
% Carbon	73.0	73.1	73.1
% Hydrogen	5.2	5.2	5.1
% Nitrogen	1.6	1.6	1.6
% Oxygen	7.33	7.14	7.23
Forms of S			
% Sulfate			
% Pyritic			
% Organic			
% Total			
Grindability Index			
% Chlorine	.12	.12	.12

NOTE: All results are on dry basis unless stated otherwise.

Date: August 14, 1989

CUMBERLAND UNIT 2

REPORT OF ANALYSIS - COAL ANALYSIS REPORT
TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES - CHATTANOOGA POWER SERVICE CENTER
STOCK EMISSION TEST - CUMBERLAND FOSSIL PLANT

Sample Identity	Unit 2 PL-344-BuS 2nd Shift	Unit 2 PL-345-BuS 2nd Shift	Unit 2 PL-346-BuS 3rd Shift	Unit 2 PL-348-BuS 2nd Shift	Unit 2 PL-349-BuS 3rd Shift
Date Sampled	6/27/89	6/28/89	6/28/89	6/29/89	6/29/89
Laboratory No.	89-3312	89-3313	89-3314	89-3315	89-3316
Air Dry Moisture					
Residual Moisture	2.4	2.3	2.3	2.6	2.5
Total Moisture					
Proximate Analysis					
% Volatile Matter	40.6	40.9	40.7	40.5	40.6
% Ash	9.4	9.2	9.2	10.0	9.8
% Fixed Carbon	50.0	49.9	50.1	49.5	49.6
% Total Sulfur	3.17	3.10	3.14	3.25	3.25
Btu/lb					
As Received					
Dry	13,016	13,190	13,187	13,089	13,037
A and MF	14,469	14,529	14,525	14,537	14,461
Ultimate Analysis					
% Carbon	73.3	73.5	73.7	73.0	72.7
% Hydrogen	5.2	5.3	5.3	5.2	5.2
% Nitrogen	1.6	1.6	1.6	1.6	1.6
% Oxygen	7.33	7.30	7.06	6.95	7.45
Forms of S					
% Sulfate					
% Pyritic					
% Organic					
% Total					
Grindability Index					
% Chlorine	.12	.11	.11	.12	.12

NOTE: All results are on dry basis unless stated otherwise.

Analyzed by: Billie Hudson/Robert Brannan (3593C)