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Project Summary

Evaluation of Long-Term NO_x Reduction on Pulverized-Coal-Fired Steam Generators

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Long-term NO_x emission data from eight pulverized-coal-fired steam generators were analyzed for the purpose of quantifying the effectiveness of various combustion modifications. All boilers, but one, were modified to reduce NO_x emissions. These combustion modifications included changing both hardware and operating procedures. All boilers were subject to the NO_x provisions of the 1971 New Source Performance Standards (NSPS).

In several instances, when long-term emission data for the period before the modification were not available, the quantification of the NO_x reduction was based on the result of the performance test required by the 1971 NSPS. NO_x reductions of from 5.1 to 60 percent were determined without incurring significant adverse impacts on unit operation. NO_x emission levels, determined from the performance tests, were from 146 to 473 ng/J (0.34 to 1.10 lb/10^6 Btu) before control implementation and from 148 to 281 ng/J (0.34 to 0.65 lb/10^6 Btu) after combustion modifications were applied.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction and Summary

Previous work in this program identified pulverized-coal-fired steam generators that had been modified for the express purpose of reducing NO_x emissions. These modifications included changes of both hardware (e.g., burner substitution) and operating procedures (e.g., overfire air system adjustment).

The purpose of this work was to quantify the NO reduction achieved by comparing long-term (approximately 30 days) emission data obtained before and after the modification. Whenever possible, the effect of the modification on unit efficiency was also to be quantified. The emission data was to be obtained by certified NO and O_2 (or CO_2) analyzers. In addition, the unit load (in either gross MWe or steam flow) and coal analyses were requested from the participating organizations.

Table 1 summarizes the eight steam generators which were analyzed, the modification(s) implemented, and the NO_x reduction achieved at high load. Also shown are the post-modification levels. For several of these units, emission data before the modification were not available, in which case the NO_x reduction was referenced to the result of the performance test required by the 1971 New Source Performance Standards. (All units were subject to the 1971 NSPS.) The two NO_x reduction values shown for Gentleman Unit 1 are due to the utility's questioning of the initial performance test results.

Iowa Power and Light's Council Bluffs Unit 3 is an exception in that the excess air level was increased in an attempt to reduce slagging. However, the NO_x increase resulting from this operational change was also interpreted in a bilateral manner; i.e., as a NO_x decrease due to lower excess air when the high O_2 data was used as a "before" condition.

The NO_x reduction at other than high load was also quantified when long-term

Table 1. Data Base and High-Load NO_x Reduction

Utility	Station	Unit	Boiler Mfg.[a]	Coal Type[b]	Gross MWe	Modification[c]	NO_x Reduction, %	Post Mod. NO ng/J
Iowa Power & Light	Council Bluffs	3	B&W	Sub	720	LEA	5.1	148
Utah Power & Light	Hunter	2	CE	Bit	425	LNCFS, OFAA	39	155
Proprietary	-	A	RS	Bit	417	RB, UFA	40	269
Proprietary	-	B	RS	Bit	360	RB	40	279
Proprietary	-	C	RS	Bit	360	RB	41	245
Nebraska Public Power District	Gentleman	1	FW	Sub	680	OFAA, LEA	49, 60	188
Proprietary	-	D	B&W	Bit	81.9[d]	CO	15	281
		E	B&W	Bit	81.9[d]	CO	21	236

[a] B&W=Babcock & Wilcox
CE=Combustion Engineering
RS=Riley Stoker
FW=Foster Wheeler

[b] Sub=Subbituminous
Bit=Bituminous

[c] LEA=Lower excess air
LNCFS=Low-NO_x concentric firing system
OFAA=Overfire air adjustment
RB=Reburnering
UFA=Underfire air added
CO=CO-based control

[d] Rated steam flow, kg/s

emission data were available both before and after implementing combustion modification.

Discussion

The analysis is illustrated in Figures 1 and 2 for Iowa Power and Light, Council Bluffs Unit 3. Continuous emission monitor (CEM) and load data were supplied by the utility for two periods:

February 16 - May 29, 1981 low O_2 operation

May 30 - July 15, 1982 high O_2 operation

Figure 1 compares the NO vs. load characteristic for both periods. This characteristic was developed by sorting the hourly averaged NO into 10 equally spaced load increments (cells) which ranged from the minimum to the maximum loads. (Not shown in Figure 1 are the results for the two lowest load cells for which insufficient data were available to make a meaningful comparison.) The NO_x measured during the unit's performance test (as required by the 1971 NSPS) is also shown for reference.

An analysis was conducted to determine if the NO characteristics were statistically different with the results shown in Figure 2. In this instance, the higher O_2 during 1982 was used as a "before" condition in order to quantify the NO reduction resulting from lower excess air operation. As noted, the NO

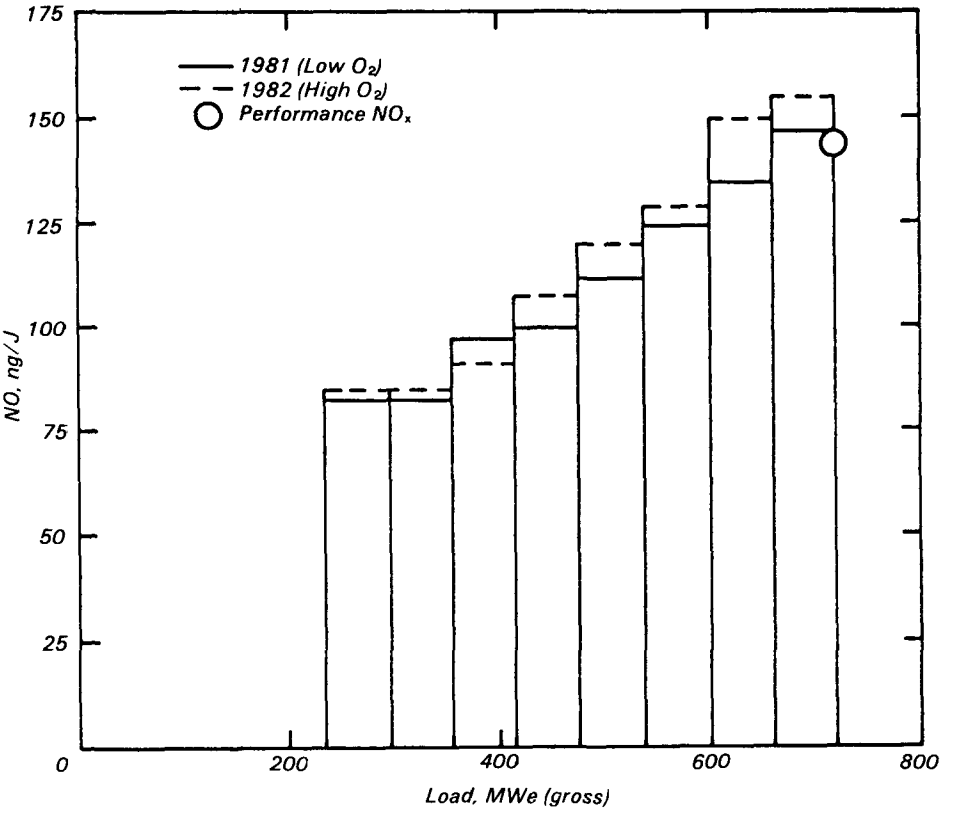

Figure 1. NO versus load comparison—Iowa Power and Light, Council Bluffs Unit 3.

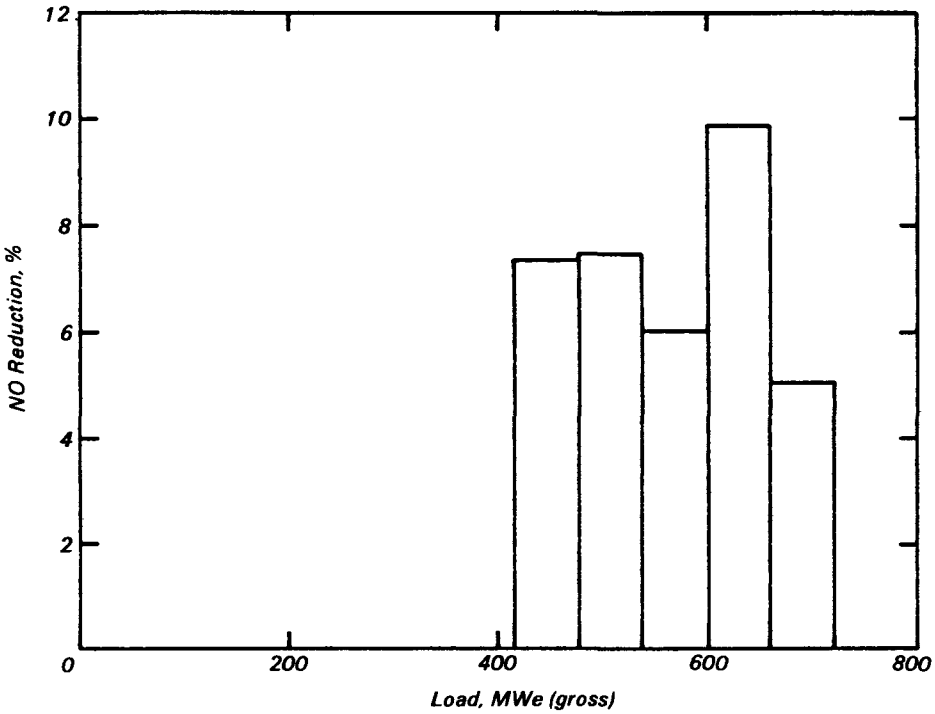

Figure 2. *NO reduction due to lower excess air—Iowa Power and Light, Council Bluffs Unit 3.*

reduction ranged from 5.1 to 9.9 percent with no statistical difference in the five lowest load cells.

Net heat rate data for Council Bluffs Unit 3 indicated that the higher O_2 operation during 1982 caused a 3.3 percent loss in efficiency, compared with the lower O_2 operation during 1981. This decrement was determined by integrating the heat rate across the normal load range. Conversely, lower O_2 operation would have improved efficiency by 3.2 percent.

Units D and E were originally equipped with O_2-based combustion air controls. These were subsequently replaced with CO-based systems operating at a CO set point of 150 ppm. It was determined that the CO systems, in addition to reducing NO_x, achieved overall efficiency gains of 0.92 and 2.1 percent, respectively. These efficiency gains were measured during short-duration tests conducted only at high-load conditions.

Conclusions

Eight pulverized-coal-fired steam generators, subject to the 1971 NSPS, were analyzed to determine the long-term effectiveness of various combustion modifications in reducing NO_x emissions Reductions ranged from 5.1 percent (lower excess air) to 60 percent (combined lower excess air and overfire air system adjustment).

Discussions with the participating organizations indicated that implementing these combustion modifications did not have any significant adverse effects on unit operation.

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The complete report, entitled "Evaluation of Long-Term NO_x Reduction on Pulverized-Coal-Fired Steam Generators," (Order No. PB 84-226 885; Cost: $14.50, subject to change) will be available only from:
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