



Project Summary

Analysis of Low NO_x Operation of Two Pulverized- Coal-Fired Utility Boilers

S.S. Cherry

The operation of two pulverized-coal-fired utility boilers subject to the 1971 New Source Performance Standard was reviewed to determine if other boilers could adopt a similar mode of operation to reduce nitrogen oxide (NO_x) emissions. These two boilers had been identified, during a previous study, as low NO_x emission sources.

It was determined that reburning, burner modification, or optimizing the overfire air system of existing Foster Wheeler boilers offered the potential to reduce NO_x significantly. It was also determined that existing Babcock & Wilcox boilers would probably not respond to further combustion modifications.

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

It was determined that the NO_x emissions from two boilers (Unit 1 of Public Service Co. of New Mexico's San Juan Station, and Unit 3 of Iowa Power and Light's Council Bluffs Station) were lower than other pulverized coal-fired utility boilers analyzed during a previous study. The purpose of the program was to determine if other boilers manufactured by Foster Wheeler (San Juan Unit 1) and Babcock & Wilcox (Council Bluffs Unit 3) could achieve a lower NO emission rate.

It was determined that Foster Wheeler boilers with the single-register Intervane burner and operating with overfire air (OFA) could, potentially, reduce emissions by one of the following:

1. Burner modification: including coal splitters in the annular coal nozzle.
2. Burner replacement: substituting the newer dual-register controlled-flow/split-flame variable-velocity (CF/SV) burner for the Intervane burner.
3. Overfire air: increasing the amount of OFA or optimizing the OFA damper settings.

The approach selected must be unit-specific.

It was determined that the newer Babcock & Wilcox boilers would probably not be able to achieve a significantly lower NO_x emission rate using these techniques. All new boilers have dual-register burners and compartmented windboxes (for closer control of burner air flow).

Discussion

The NO_x measured during the performance test conducted on Foster Wheeler boilers subject to the 1971 New Source Performance Standard (NSPS) is summarized in Table 1.* Note that most of these units have the single-register, high-turbulence Intervane (IV) burner and are operating with OFA.

*San Juan Unit 1 was designed to comply with the State of New Mexico NO_x limitation of 0.45 lb/10⁶ Btu (194 ng/J) and not the 1971 NSPS. However, it is included in this study of other Foster Wheeler units subject to the 1971 NSPS

Table 1. Summary of Foster Wheeler Pulverized-Coal-Fired NSPS Utility Boilers

Test	Utility	Station	Unit	Gross MWe	Firing Mode ^a	No. of Burners	Burner Type ^b	Overfire Air	Coal Type ^c	Performance lb/10 ⁶ Btu	NO _x ng/J
1A.	Public Service Co. New Mexico	San Juan	1	360	1	16	IV	No	Sub.	1.05	452
1B.							IV	Yes		0.63	271
1C.							CF/SV	No		0.35	151
2.	Omaha Public Power District	Nebraska City	1	575	2	28	IV	Yes ^d	Sub.	0.479	206
3.	Proprietary	--	--	114	1	8	IV	Yes	Sub.	0.699	301
4.	Portland General Electric	Boardman	1	530	2	32	CF/SV	Yes	Sub.	0.57 ^e	245
5.	Nebraska Public Power District	Gentlemen	1	650	2	32	IV	Yes	Sub.	0.354	152
6.	Proprietary	--	--	500	2	24	IV	Yes	Sub.	0.518	223
7.	Proprietary	--	--	534	2	24	CF	Yes	Sub.	0.465 ^e	200
8.	Northern Indiana Public Service	Schahfer	15	511	2	24	IV	Yes	Sub.	0.45	194
9.	Iowa Public Service	Neal	4	630	2	28	IV	Yes	Sub.	0.345	148
10.	Allegheny Power Service	Pleasants	1	660	2	24	IV	Yes	Bit.	0.61	262
11.	Allegheny Power Service	Pleasants	2	660	2	24	IV	Yes	Bit.	0.61	262
12.	Proprietary	--	--	770	2	48	IV	Yes	Bit.	0.63	271
13.	Proprietary	--	--	860	2	32	IV	Yes	Bit.	0.66	284
14.	Proprietary	--	--	736 ^f	2	40	IV	Yes	Bit.	0.43	185

^a 1 = Front-wall
^a 2 = Opposed-wall
^b IV = Intervane
 CF/SV = Controlled-flow/split-flame variable velocity
 CF = Controlled flow
^c Sub. = Subbituminous
 Bit. = Bituminous
^d Interstage air
^e Overfire air closed
^f Two boilers supplying one steam turbine.

Figure 1 is a plot of these data in terms of the gross MWe per firing wall. * Also shown in this figure is a linear regression of these data (except Tests 3,5, and 9) which shows a high degree of correlation ($r^2 = 0.80$) of NO_x in terms of MWe/wall. Linear regressions of data obtained on pre-NSPS boilers are also highly correlated in terms of this parameter ($r^2 = 0.81$ for baseline, $r^2 = 0.85$ for staged combustion).

Results from San Juan Unit 1 with the dual-register controlled-flow/split-flame variable-velocity burner (Figure 2) indicate a NO_x reduction of 32 to 44 percent with respect to the IV burner operating with OFA. However, results from Boardman Unit 1 (Test 4, Table 1) are not consistent with San Juan Unit 1; i.e., it was anticipated that the emissions for the CF/SV burner-equipped Boardman Unit 1 should have been lower.

Adding coal splitters to the IV burner (operating without OFA) has been demonstrated to significantly reduce NO_x emissions from pre-NSPS units. However, these results have also been shown to be highly unit-specific.

It was determined that the low emissions for Tests 5 and 9 (Table 1) were due to a modification of the OFA system to increase OFA flow. These modifications

*The performance NO_x is that measured during the performance test required by the 1971 NSPS using EPA Method 7

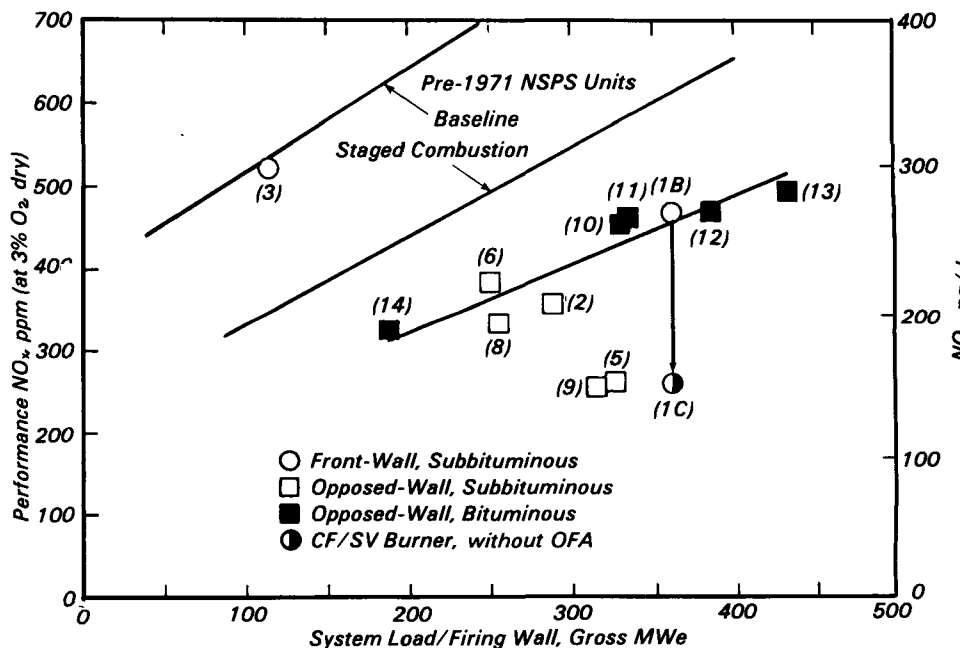


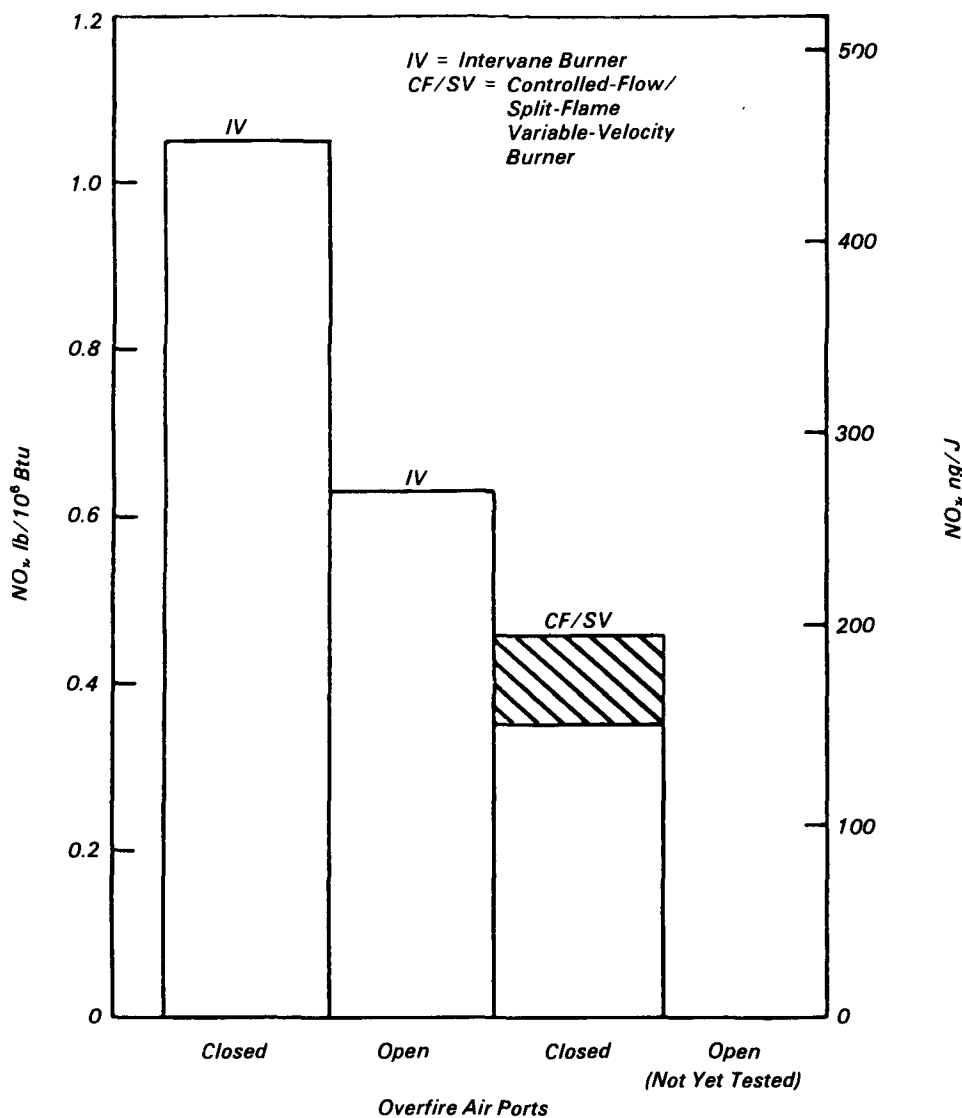
Figure 1. Foster Wheeler NSPS units, Intervane burners with OFA.

were apparently responsible for achieving a NO_x level lower than the correlation based on other Foster Wheeler boilers (Figure 1).

An analysis of Babcock & Wilcox NSPS boilers operating with subbituminous coal (Figure 3) indicated that Council Bluffs Unit 3 was not a particularly low

NO_x emission source when compared with other B&W 1971 NSPS units. These data demonstrate that the performance test NO_x for Council Bluffs Unit 3 is no different than the sample mean.

This result implies that B&W NSPS units operating with subbituminous coal would probably not be able to achieve



flame variable velocity configuration) offers the potential to reduce NO_x emission on Foster Wheeler 1971 NSPS boilers. Quantification of the effectiveness of these approaches is uncertain due to an apparent unit specific nature of the results. The effectiveness of burner replacement should become more firmly established as new units with the CF/SV burner are performance tested. Optimizing the OFA system would probably be most applicable to units with a low windbox-to-furnace pressure differential.

Figure 2. Low NO_x burner comparison.

significantly lower NO_x. (All such units have dual-register burners and compartmented windboxes.)

Conclusions

(Note: The objective of this effort was to assess the potential NO_x reduction for 1971 NSPS boilers manufactured by Babcock & Wilcox and Foster Wheeler, based on the operation of Council Bluffs Unit 3 (B&W) and San Juan Unit 1 (F.W.)

It was concluded that:

1. B&W 1971 NSPS units would not significantly benefit from the adoption of Council Bluffs Unit 3's mode of operation.
2. Foster Wheeler 1971 NSPS units would benefit from a burner modification,

burner replacement, or optimization of the overfire air system. The degree of potential NO_x reduction is uncertain.

The first conclusion is based on a comparison between Council Bluffs Unit 3 and other subbituminous-coal-fired B&W boilers, which showed no statistical difference in NO_x emission levels measured during the performance test. Thus, the initial perception that Council Bluffs Unit 3 was a significantly low NO_x source is not warranted when compared to other B&W 1971 NSPS units.

Burner modification (adding primary air/coal stream splitters to single register burners) or burner replacement (replacing Intervane burner with controlled flow/split

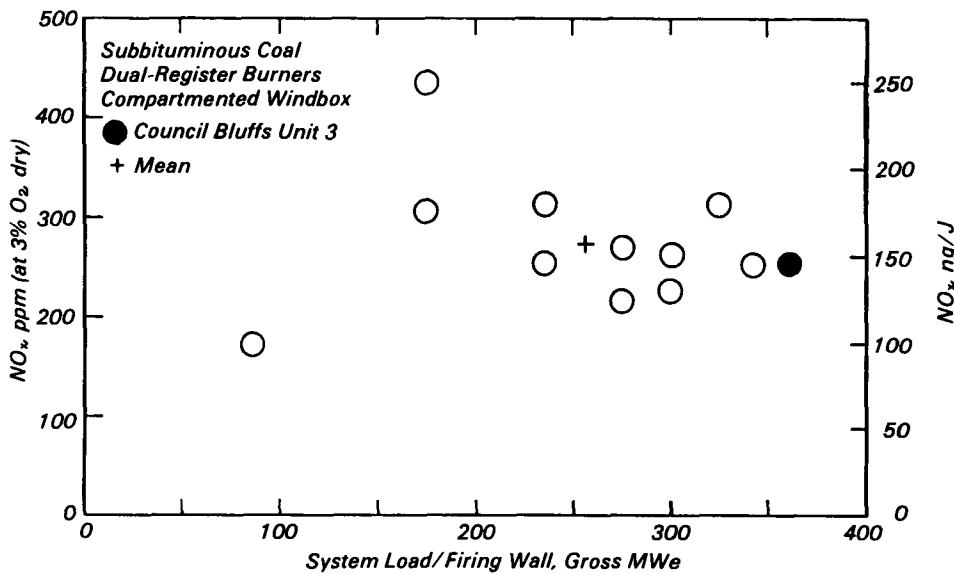


Figure 3. Babcock & Wilcox 1971 NSPS boilers.

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 The complete report, entitled "Analysis of Low NO_x Operation of Two Pulverized-Coal-Fired Utility Boilers," (Order No. PB 84-118 918; Cost: \$8.50, subject to change) will be available only from:
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