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THE EFFECT OF BOILER FIRING PRACTICES ON POTENTIAL FIRESIDE CORROSION WITH LOW NO_x BURNERS

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Abstract

Fireside corrosion of boiler tube walls in the lower furnace region has become a serious concern on large high heat release rate supercritical boilers operating in low NO_x firing configurations. Some utilities have seen water wall wastage rates increase by a factor of two or more after installing low NO_x burners and/or overfire air. Occasionally, these high corrosion areas occur in unpredictable areas where one side or end wall of the furnace experiences much higher corrosion rates than another. Although fuel rich corrosive furnace wall atmospheres (high CO and significant H_2S) are known to be a factor in accelerated fireside corrosion, a need exists to quickly identify low NO_x firing configurations that produce these conditions so that they can be minimized.

This paper outlines some combustion diagnostic testing conducted on a 750 MW coal-fired supercritical low NO_x cell burner unit that was experiencing high furnace wall corrosion. The use of a real time multipoint combustion diagnostic analyzer at the economizer exit test grid in combination with direct measurement of CO and H_2S led to the identification of two boiler firing configurations that generated corrosive furnace wall atmospheres. More importantly, two alternative firing configurations were identified where corrosive furnace wall atmospheres were minimal. Surprisingly, the firing conditions of greatest concern existed at 90 percent of full load with one pulverizer out-of-service rather than at full load with all pulverizers in service.

Overview

Combustion diagnostic testing was conducted on a 750 MW (net) unit firing a blend of mid-sulfur and low-sulfur Eastern bituminous and Western subbituminous (PRB) coals. The boiler was originally equipped with cell burners which were subsequently converted to low-NO_x firing. This was achieved by converting one of the burner throats to overfire air while the other burner throat passed all of the fuel in a local "staged" combustion operating mode. Fireside corrosion and water wall wastage have been serious concerns at this unit, particularly since conversion to low NO_x firing modes. The areas of corrosion in the lower furnace differ considerably between the various side and end walls requiring weld overlay and metal flame spraying to inhibit tube wastage. One area in particular requiring extensive weld overlay and metal spraying was the center of the east water wall of the unit tested. There were no obvious reasons for the higher corrosion rates in this region but fuel rich corrosive furnace wall atmospheres containing CO and H_2S, produced during low-NO_x staged combustion, were suspected.

Synopsis of Test Results

The combustion diagnostic testing provided the opportunity to evaluate the effect of different boiler firing configurations (load, O_2 level, firing pattern, etc.) on combustion uniformity and local furnace wall atmospheres. Non-uniform combustion in the burner zone, due to uneven fuel or air distribution to the burners, could result in pockets of fuel rich combustion, high CO and H_2S along the furnace walls. Combustion uniformity was evaluated using a real-time multipoint combustion diagnostic analyzer (MCDA) connected to a grid of 24 sample probes at the economizer exit (12 in each duct). The premise of this testing was that firing configurations that resulted in local pockets of high CO and low NO_x along the walls at the economizer exit most likely had much higher CO and potentially corrosive combustion conditions along the furnace walls. This was subsequently confirmed with gas measurements in the lower furnace region.

Surprisingly, the most adverse combustion conditions, measured at the economizer exit with the MCDA, occurred at 680 MW with Mill 4 out-of-service rather than at full load (750 MW) with all mills in service. The highest regions of CO (in excess of 1000 ppm) were measured at the bottom of the duct (Figure 1), an area corresponding to the east wall of the furnace where high corrosion rates were noted. By contrast, other 680 MW firing configurations, such as Mill 2 out-of-service (Figure 2), had no CO at the economizer exit and much more uniform O_2 profiles. Full load data is shown in Figure 3. These results suggested that the MCDA held considerable promise as an effective method of identifying both favorable and unfavorable boiler firing configurations in terms of potentially corrosive furnace wall atmospheres.

A series of direct measurement of furnace corrosion gas concentrations was made with a water cooled probe through sample ports immediately above the burner zone as shown in Figure 4 and Table 1. These measurements confirmed that the regions of highest corrosion potential were at 680 MW with Mill 4 out-of-service rather than at full load (750 MW) with all mills in service. Furthermore, the highest CO and H_2S readings were measured along the east wall in a region where the CO was also highest using the multipoint combustion diagnostics analyzer at the economizer exit. This corresponded to an area of high tube wastage in the lower furnace. It is quite possible that much higher CO and H_2S readings may exist lower in the furnace but additional measurements would be necessary to confirm this speculation.

Conclusions

Many utilities operating high heat release rate supercritical boilers with low NO_x burners have a need for quickly identifying potentially adverse firing conditions that are conducive to accelerated furnace waterwall wastage. Once these firing conditions are identified, they can either be avoided or investigated in more detail using conventional furnace corrosive atmosphere measurements. Preliminary results with the multipoint combustion diagnostic analyzer indicate that it has considerable promise in screening and identifying potentially corrosive boiler combustion conditions.

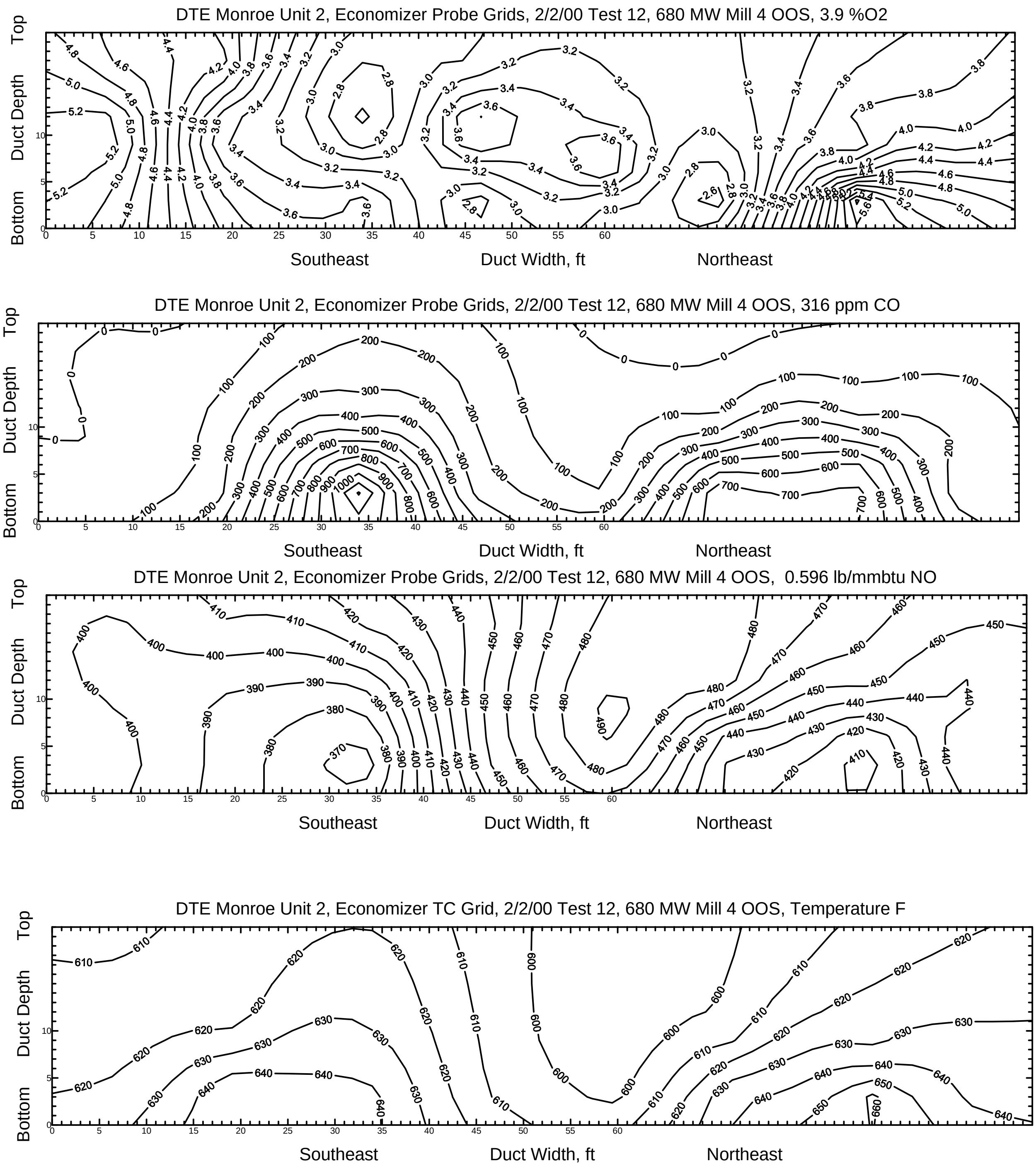

Figure 1. 680 MW (90% Load) Mill 4 OOS Economizer Exit Profiles

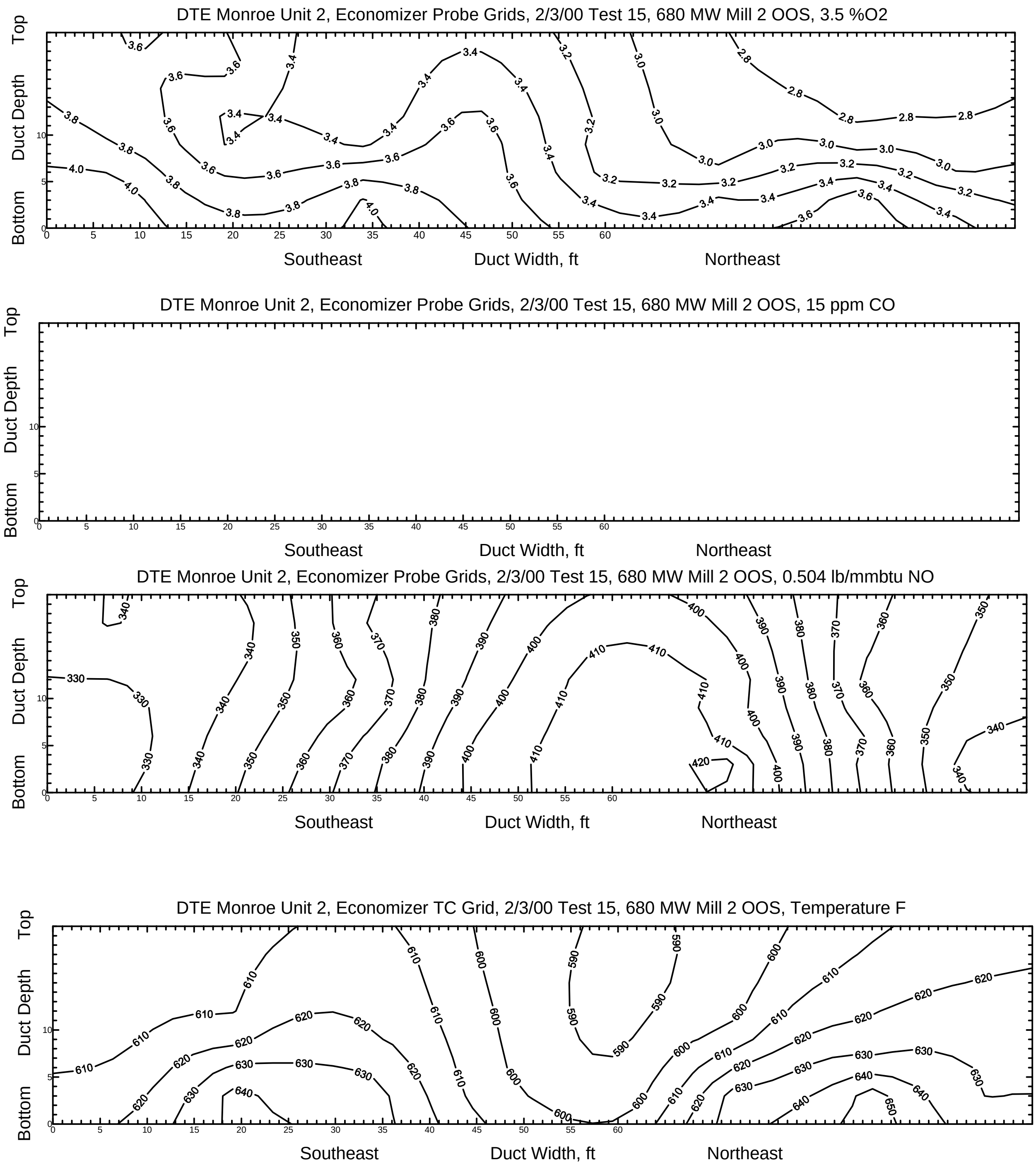

Figure 2. 680 MW (90% Load) Mill 2 OOS Economizer Exit Profiles

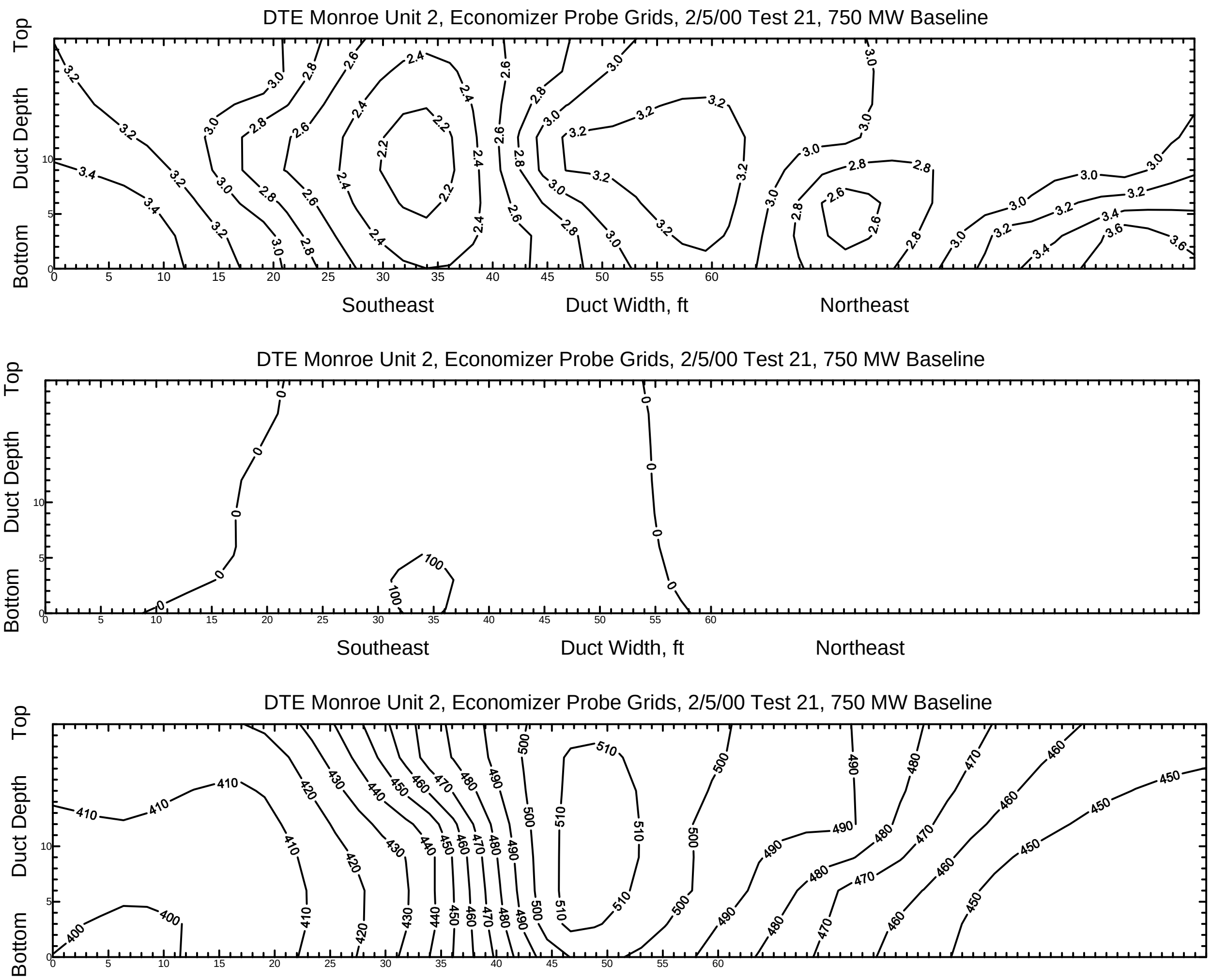

Figure 3. 750 MW (100% Load) Seven Mill Operation Economizer Exit Profiles

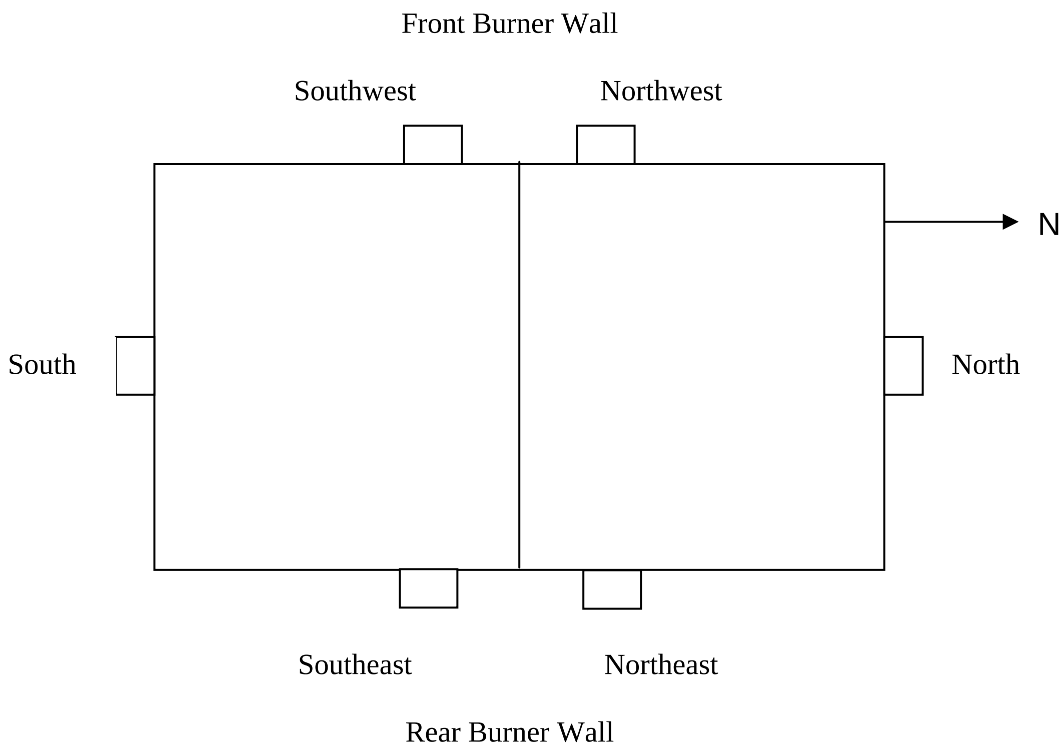

Figure 4. Furnace Corrosion Test Sample Ports

Table 1. Summary of Corrosion Gas Measurements

	CO, %		H_2S, ppm	
	750 MW	680 MW	750 MW	680 MW
Port	All Mills	Mil 4 Out	All Mills	Mill 4 Out
Average Measurements (over 4 ft. probe insertion depth)				
North	0.2	0.3	4	
Northeast	4.3	6.7	26	60
Southeast	4.4	6.4	29	83
South	0.1	0.2	3	
Northwest	0.7	0.2	8	
Concentrations 1 foot from wall				
North	0.1	0.1	4	
Northeast	5.0	6.8	41	108
Southeast	5.5	7.5	68	91
South	0.1	0.1	2	
Northwest	0.5	0.2	0	