Meeting compliance and profit goals takes ingenuity, fortitude

Predicting compliance mandates and their time-lines. much less meeting them, greatly complicates powerplant management. Each plant will have to customize a solution—fuels, emissions control technologies, buying and selling SO_2 allowances and NO_x credits—that does not sacrifice operating flexibility

By Cate Jones, *Contributing Editor*

Let's face it—the US Environmental Protection Agency (EPA) is not going to wake up one morning and decide that the air is sufficiently clean, it has done its job well, and now it is time to settle back and just maintain. Thus, the ongoing struggle between rule "developers" and rule "detractors" will continue. But the bottom line remains: More rules, standards, and monitoring requirements will continue to be added to EPA's already burgeoning list of regulatory "dos and don'ts."

The challenge for each generating company is to develop a control strategy that anticipates future emissions standards and time lines and is compatible with deregulation and profit-making. One result of this "predictive thinking" is the trickle down effect it has on every aspect of the emissions control business. For example, studies indicate that the EPA's National Ambient Air Quality Standard for fine particulate matter (PM2.5) could force the installation of scrubbers on a significant number of coal-fired units. This, in turn, could greatly increase the quantity of available SO_2 allowances.

Electric Utility Week, a publication of The McGraw-Hill Companies, reported recently that in the last allowance auction, the prices paid in the seven-year advance auction were well below the prices paid in the spot auction. Uncertainty about the regulatory climate has resulted in a reluctance to acquire vintage allowances for the 2008-2010 time frame. And that reluctance has gradually spread to 2007 and now 2006. Both the number of bidders and the number of allowances bid for in the spot auction declined compared with 1998. In the seven-year advance auction, the number of bidders was the same as in 1998, but the total number of allowances being bid for dropped by half.

1. A 60-ft-diameter absorber tower at Big Bend station will be one of the largest in the world

Logic suggests that if the number of advance allowances being bid for are down, then SO_2 emissions control strategies must be on the rise. Certainly, the continued increase in consumption of low-sulfur Powder River Basin (PRB) coal indicates that fuel switching and/or blending is on the rise. And the number of scrubber projects that have been awarded is on a slight upswing recently.

As at least partial evidence supporting this logic, owners of several large coal-fired units announced recently that they will add scrubbers to provide system-wide benefits for their owners:

■ Virginia Power, Richmond, Va, awarded Marsulex Environmental Technologies, Lebanon, Pa, a contract to supply two flue-gas desulfurization (FGD) units on the 550-MW Units 1 and 2 at Mt Storm. The FGD systems will remove 95% of SO_2 emissions and are being installed as part of Virginia Power's Phase II compliance strategy. Commercial operation is scheduled for February 2002.

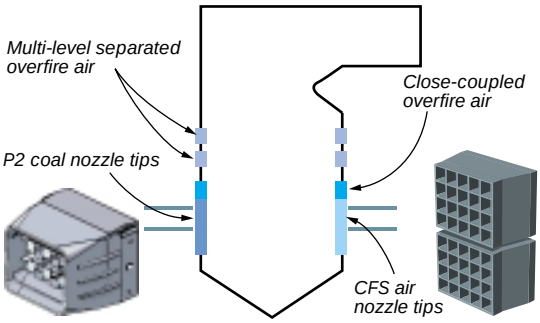
■ PacifiCorp, Portland, Ore, has awarded a consortium of ABB Environmental Systems (ABB ES), Knoxville, Tenn, and Stone & Webster Engineering Corp, Boston, Mass, a contract to design, build, and install two wet FGD systems for the 1340-MW Centralia powerplant in Lewis County, Wash. The FGD systems will remove 90% of the SO_2 emissions and are scheduled for completion in 2002.

■ Edison Mission Energy, Rosemead, Calif, will install an ABB ES wet FGD unit on the 650-MW Unit 3 at its 1884-MW Homer City power station, recently acquired from Pennsylvania Electric Co. The installation is expected to ultimately reduce operating costs by allowing flexibility to burn a wider variety of local coals. Under the agreement, ABB ES also will install selective catalytic reduction (SCR) system on Units 1, 2, and 3.

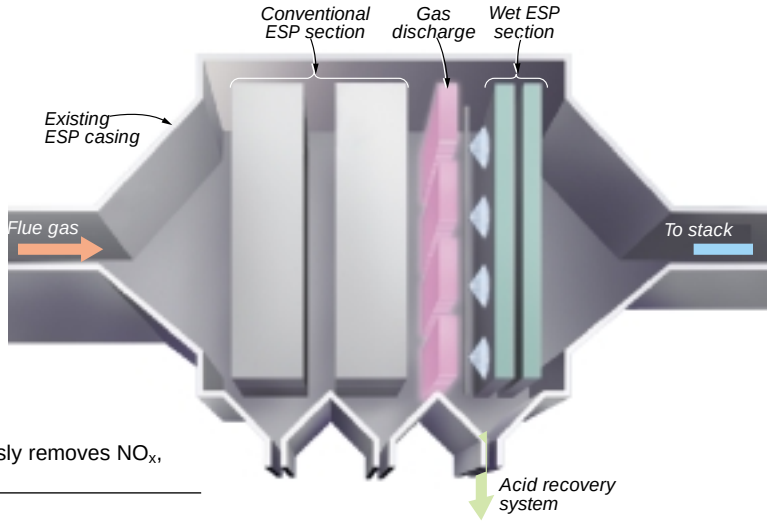
■ Tampa Electric Co (TEC) is installing an FGD system at Big Bend Units 1 and 2, rated at 440 MW each. The FGD unit is being designed, built, and installed by Wheelabrator Air Pollution Control Inc, Pittsburgh, Pa.

Covergent creativity

Another result of the convergence of



2. *Aggressive* in-furnace NO_x control technology reportedly can meet 0.15 lb/million Btu NO_x emissions limits



3. *Retrofit* into an existing ESP, this system simultaneously removes NO_x, SO_2, PM 2.5, and mercury

deregulation and environmental regulatory uncertainty has been the resurgence of creative problem-solving. This has fostered a new attitude of working smarter, not just harder. (POWER, May/June 1999, p 4) Thinking "outside the box" historically has not been a hallmark of the power industry, yet some decisions and practices now surfacing indicate this attitude is changing.

The steady increase in the number of alliances forming among power producers and equipment suppliers attests to this change. Fuel flexibility, operating costs, maintenance considerations, capital costs, reliability and availability issues, emissions, renewable energy portfolios, operating duty, life-cycle impacts, etc, all come into play in any solution matrix. The numerous examples of elegant engineering solutions that are emerging illustrate the results of balancing these increasingly complex objectives.

Bigger, better absorbers

TEC was required to reduce SO_2 emissions for Phase I by 100,000 tons/yr, and 180,000 tons/yr to meet Phase II compliance. Bulk of these reductions were required at the Big Bend station.

TEC evaluated numerous fuel switching, dispatching, repowering, load reduction, allowance purchase, and FGD system options during its Phase I compliance planning efforts. These compliance options then were re-evaluated as part of its planning for Phase II.

An FGD retrofit of Units 1 and 2 at Big Bend proved to be the best approach. Plant operators chose a limestone forced-oxidation FGD system, with dibasic acid (DBA) additive, that has four two-loop absorber towers to reduce SO_2 emissions from the 460-MW Unit 3 and the 490-MW Unit 4.

By contrast, the new FGD system for Units 1 and 2 will use only one absorber tower. Scrubbing 880 MW makes it one of the largest single FGD absorbers in the world, and the largest in the US.

Units 1 and 2 will burn a fuel blend of 85% coal and 15% petroleum coke. The high-velocity absorber reportedly will provide the most economical scrubbing technology. A dual-flow tray absorber using limestone forced-oxidation chemistry with DBA will be used. At full load, the FGD system will be able to remove 95% of the SO_2 from Units 1 and 2 (Fig 1).

The absorber vessel, inlet transition section, and outlet elbow are constructed of carbon steel clad with alloy C276. The floor plate of the absorber is solid alloy C276. The treated effluent stream from the absorber will produce commercial-grade gypsum, which is contracted for sale to the wallboard industry. The cost of the system is $100/kW which compares favorably to the average of cost of $233/kW for all Phase I FGD systems in the US. The FGD system is scheduled to begin operation in January 2000.

Furnace mods rival SCR

Deep in the heart of Texas, Reliant Energy, Houston, Tex, and ABB C-E Services Inc, Windsor, Conn, are boldly taking furnace modifications where they've never gone before—to a NO_x emissions rate of 0.15 lb/million Btu. Details of this project were presented at *Electric Power '99*, sponsored by POWER magazine/McGraw Hill Energy and the TradeFair Group Inc. The project captured a great deal of interest.

The unit undergoing the modifications is the W A Parish station Unit 7—a 590-MW tangentially fired boiler. The unit, which came on line in 1980, is fired with Powder River Basin (PRB) coal and equipped with a fabric filter for particulate control. The unit does not have an FGD system.

Prior to January, the NO_x emissions levels for Unit 7 averaged approximately 0.40 lb/million Btu. Plant engineers selected the TFS 2000 R system to meet the new limit (Fig 2). Four major elements are integrated to lower NO_x emissions levels, reportedly with minimal effect on boiler performance: precise furnace stoichiometry control, pulverized-coal fineness control, initial combustion process control, and concentric firing.

For units firing PRB coal, the existing pulverizer fineness sufficiently maintains low levels of unburned carbon in the ash. Multiple levels of overfire air (OFA) provide precise furnace stoichiometry. Two levels of separated overfire air, plus close-coupled overfire air, achieve precise "stoichiometry history" control that is crucial for minimizing NO_x emissions, while minimizing increases in CO emissions and unburned carbon (UBC) in flyash.

The OFA compartments are designed with manual yaw adjustments, which are set during the tuning phase and remain in place once the optimum settings are obtained. Flame-front nozzle tips control the early devolatilization phase of coal particle combustion.

Concentric firing creates an oxidizing atmosphere along the furnace waterwall and changes the furnace dynamics. This combination has decreased the propensity for slagging by creating changes in the ash composition at the wall while avoiding problems associated with operating under reduced burner-zone stoichiometric ratios. The air nozzle tips provide offset air. The tips are manually adjusted during startup and set in place. The system was installed early this year. Preliminary results indicate no impact on slagging and minimal impact on UBC.

The system is currently in the tuning phase, reports Roger Hoh, project engineer at Parish. He indicates that NO_x emissions have been averaging about 0.15 lb/million Btu. "Depending on which mill is out service, we are either right at, a little above, or a little below 0.15. CO emissions are also scattered," says Hoh.

The goal is to get NO_x below 0.15 lb/million Btu regardless of which mill is out of service. The plant has six mills, and five out of the six are typically in operation at any time. According to Hoh, plans call for installing the system on another tangential-fired unit next year.

Niche solution

Not long ago, sophisticated control systems designed to simultaneously remove NO_x, SO_2, and sometimes other pollutants were at the forefront of industry R&D. While often proving their efficacy, they were also not usually cost-effective. Parasitic power consumption, capital costs, site requirements, operating costs, etc, were some of the barriers to market entry. A new technology that is currently being pilot-tested may prove to be the exception.

First Energy's (Akron, Ohio) R E Burger plant is now testing an innovative, patented process to simultaneously remove NO_x, SO_2, fine PM, and mercury from flue gas. The system, developed by Zero Emissions Technology (ZET), New Durham, NH, is called Electro-Catalytic Oxidation (ECO). The process reportedly can remove up to 80% of the NO_x, 50% of the SO_2, and 90% of the mercury and PM2.5 within the envelope of a standard electrostatic precipitator (ESP). The system uses a dielectric barrier discharge—similar to those used in large, industrial ozonators—to convert SO_2 and NO_x to acids and elemental mercury (Hg) to mercuric oxide (HgO).

A condensing wet ESP collects the resulting acid mists and fine particles, including HgO. The system is designed to be retrofit into the last fields of an existing ESP (Fig 3). It consumes about 5% of the unit's power output, and produces marketable acids as byproducts.

The pilot program is scheduled to be complete this summer. Results to date have been encouraging—the system has reduced NO_x emissions by 70 to 80% at inlet NO_x levels of 320 ppm, and SO_2 emissions by 40 to 50% with inlet SO_2 levels about 1200 ppm. The next step: A commercialization program scheduled for fall 2000.

ECO developers indicate that the system is ideally suited for older units under 300 MW. They estimate that capital costs for a 150-MW ECO system would be about 30% less than an SCR system, with operating costs about 50% less.

Maturing relationships

As utilities face profit-enhancing pressures, alliances formed with vendors are growing. Wisconsin Electric Power Co (Wepco), Milwaukee, Wis, has a developing relationship with Environmental Elements Corp (EEC), Baltimore, Md. Initially, the alliance allowed EEC to maintain Wepco's particulate control devices system-wide.

Last spring, Wepco installed the first full-scale Fine Particulate Agglomerator (FPA)—a new, patented technology developed by EEC—at the Presque Isle facility. The FPA uses laminar flow in a single field of an ESP to promote agglomeration of fine submicron particles with larger particles. These agglomerates reportedly are easily removed in the remaining part of the ESP.

The relationship recently expanded when Wepco entered into an agreement with EEC and DB Riley Consolidated Inc, Worcester, Mass, to reduce emissions, improve performance, and maintain capacity and reliability of its fossil-fired powerplants. Under the partnership, the three companies will jointly evaluate how to meet EPA's new smog-controlling rules, which limit NO_x emissions. DB Riley and EEC will jointly manage, design, engineer, procure, fabricate, supply, and install boiler technology, particulate control technology, and NO_x control equipment. A Wepco representative estimates a $250-$300-million budget for the project, which includes the installation of emissions controls at Pleasant Prairie, Oak Creek, Valley, and Presque Isle stations.

Novel NO_x approaches

Meeting NO_x emissions limits is currently the hot environmental topic. SCR systems are being planned and installed on many units (POWER, May/June 1999, p 80). But there are other innovative tactics being taken to reduce incremental NO_x emissions:

■ TU Electric, Dallas, Tex, plans to use a new furnace water cannon technology to reduce NO_x emissions at its Martin Lake plant by 3000 tons annually. Water cannons will reportedly keep the walls clean, thus providing more efficient burning. TU Electric engineers tested the technology last year and report that they are confident that NO_x emissions will be reduced by at least 10%.

■ Southern Illinois Power Cooperative, Marion, Ill, plans to demonstrate a commercial-scale staged combustion process for the reduction of NO_x emissions from a Cyclone-fired boiler. Construction will begin on the 33-MW Unit 3 boiler during a scheduled fall outage. ClearStack, Bradenton, Fla, will install the system, and has already begun to model the boiler, finalize engineering, and conduct lab studies. Modeling has shown that the process will reduce NO_x emissions to levels at or below 0.15 lb/million Btu.

■ Public Service Electric & Gas Co, Newark, NJ, is installing a commercial Amine Enhanced Fuel Lean Gas Reburn (AEFLGR) system at its Mercer station. The utility began testing the technology last year on the 320-MW wall-fired, wet-bottom boiler at Unit 2. Mercer commercially retrofitted its units in 1994 with a selective noncatalytic reduction system from Nalco Fuel Tech, Naperville, Ill. Nalco is installing the AEFLGR system, which is licensed exclusively from the Gas Research Institute, Chicago, Ill. The contract for the new technology guarantees a 60% NO_x reduction for both units. ■