

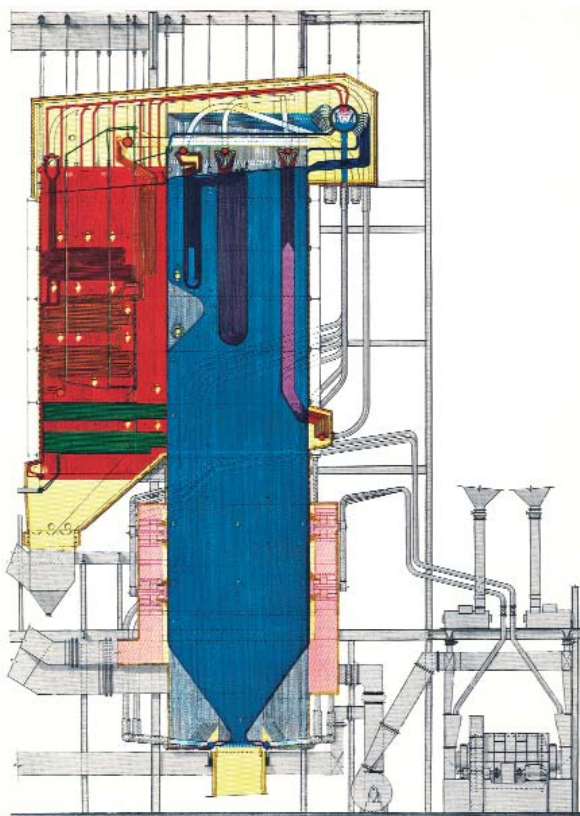
# Retrofit Helps Reduce NO<sub>x</sub> While Saving Money

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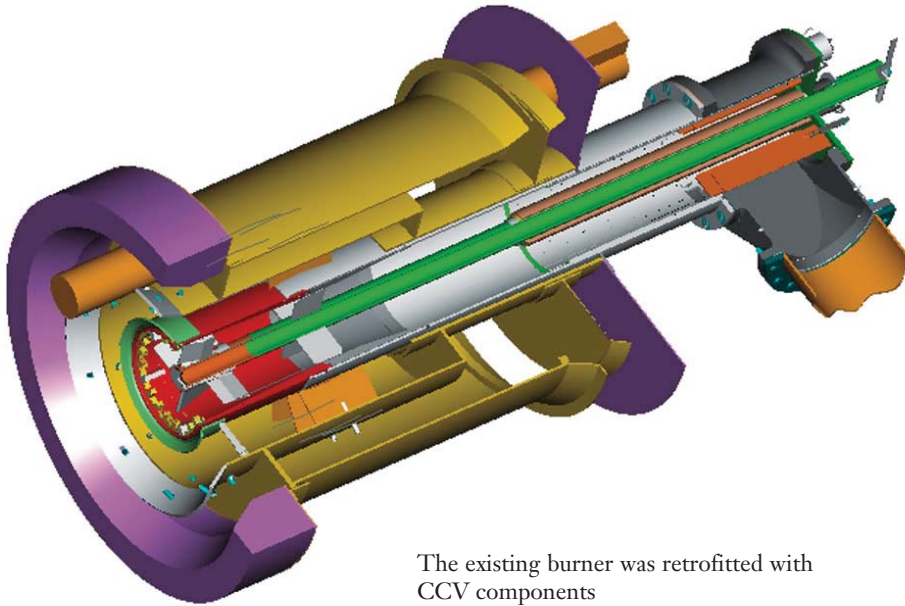
An Alabama Power generating plant faced the prospect of having to make substantial reductions in NO<sub>x</sub> emissions to meet new regulatory requirements. The company presumed that it would need to install new burners in order to achieve the required 30% reduction relative to the low NO<sub>x</sub> burners that had been installed in an earlier emissions upgrade. But engineers later determined a way to meet the emissions requirements through a series of modifications to their existing burners and installation of an overfire air (OFA) system. The modifications made it possible to achieve the required emissions levels at about half the cost of installing new burners and with much less impact on plant operating schedules. A key to the success of the modifications was the use of CFD to optimize the performance of the modified burner design while considering the constraints of the existing burner geometry.

Alabama Power, a Southern Company subsidiary, owns the Greene County generating facility located in Demopolis, Alabama. Unit 2 at this facility was designed in 1967 by Riley Power Inc. (RPI), a Babcock Power Inc. company, to generate 1,800,000 pounds/hour of steam at an operating pressure of 1650 psig and temperature of 1005°F. The unit was designed to burn eastern bituminous coal using 18 flare-type pulverized coal burners.

Alabama Power installed a low NO<sub>x</sub> combustion system in 1997 to meet the requirements of the Clean Air Act Amendment of 1990, replacing the original flare burners with Babcock &



The Alabama Power Greene County Unit 2



The existing burner was retrofitted with CCV components

Wilcox (B&W) XCL low NO<sub>x</sub> burners. In 2003, Alabama Power placed an inquiry bid with Riley Power to discuss options to further reduce NO<sub>x</sub> emissions as required by new regulations.

The initial thoughts on the project were to completely replace the existing burners with the latest low NO<sub>x</sub> burner technology and add an OFA system. Riley Power, however, proposed an innovative approach involving fewer hardware modifications and much lower installation costs. This solution involved retaining the existing burners, replacing critical components within the existing burner with Riley Power CCV (controlled combustion venturi) burner technology, and adding a new OFA system. By performing regression analysis on a database of historical installations, Riley Power engineers predicted that the more economical approach would meet Alabama Power's emissions requirements at about half the cost of installing new burners and an OFA

system.

Optimizing the design of the burner modifications was critical to actually accomplishing the project goals. The design objectives for the modifications to the combustion system included operability over a wide load range and optimization of furnace conditions with reduced emissions. The basic idea was to stage the combustion by reducing the amount of air supply in the burner zone and adding air back above the burner zone through the OFA system. Spreading out the combustion over a greater area reduces temperatures in the primary combustion zone, which lowers the thermal NO<sub>x</sub> without reducing efficiency. The NO<sub>x</sub> levels due to fuel-bound nitrogen are also reduced as a result of OFA since fuel nitrogen is released in a reducing environment.

This sophisticated design needed to be optimized to meet the specific characteristics for the burners onto which it would be retrofitted in order

to achieve optimal performance. The key to success was achieving just the right blend of primary, secondary, and tertiary airflow and generating strong recirculation zones in the primary airflow. While Riley Power's engineers have considerable experience in applying this design to burners of various types, the geometry and operating conditions of every burner are different and some of these differences can have a major impact on airflows.

Critical to the burner modifications was the design of the venturi coal nozzle and a flame stabilizer ring (FSR) that together provide precise control over the primary air / fuel ratio supplied to the burner. It would conceivably be possible to optimize the airflow by performing a series of physical tests on the burner but this would be extremely expensive both in terms of unit downtime and the need to build a series of different FSRs for testing purposes. Riley Power engineers overcame this challenge by using CFD to simulate the old burner with the new modifications installed. CFD allowed them to do parametric studies and significantly reduce the amount of hardware experimentation necessary to develop a prototype, thereby reducing design cycle times and costs.

The use of CFD made it possible to evaluate various alternative FSR designs and iterate to the best design. For each design, the engineers viewed the predicted airflow through the burner in the form of color-coded graphics that provided insight into why the design performed the way it did. This knowledge made it possible to move much more quickly to an optimized design than would have been possible with physical testing,



Alabama Power's Greene County Facility

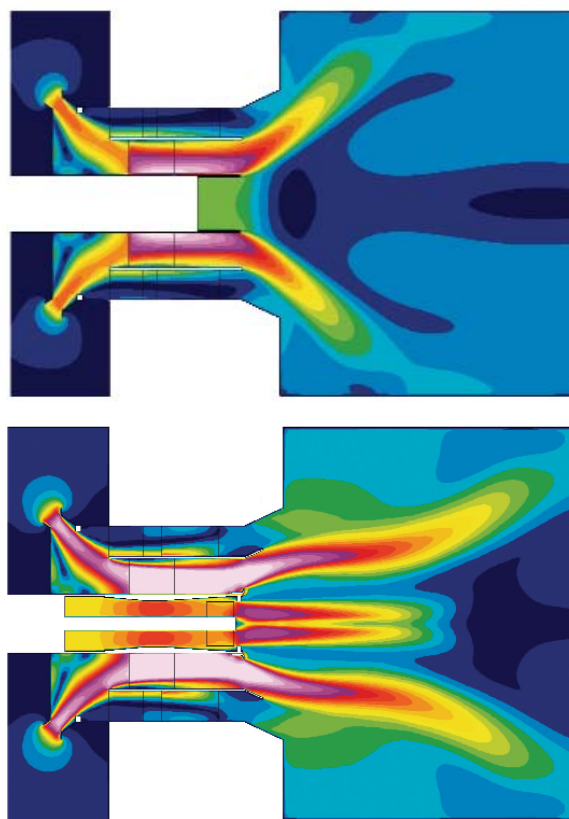
which provides far less airflow information at a much higher cost.

The burner components and OFA system were constructed at RPI's Erie, Pennsylvania manufacturing facility and installed by Southern Company Generation during a scheduled four-week outage. The lower cost burner modification approach significantly reduced the field installation scope and time. All modifications were completed from the furnace or burner deck.

After completion of the unit outage, Alabama Power, Southern Company Generation, and Riley Power began the start-up, commissioning, tuning, and testing. During the tests, Riley Power met all guarantees at three different boiler loads between full and low load conditions while maintaining NOx emissions below 0.320 lb/Mbtu. The CFD modeling conducted earlier in the project had determined the initial burner settings that would produce the best burner near-field flow patterns. Utilization of these settings during startup significantly reduced the commissioning time needed before conducting acceptance testing.

The new burner modifications and OFA system achieved NOx emissions of 0.288 lb/Mbtu at full load and below the guaranteed 0.320 lb/Mbtu

over the load range (40 - 100% MCR, or Maximum Continuous Rating) of the unit, reducing NOx emissions 30% compared to the previous low NOx burner. Testing results showed that the burner modifications alone resulted in a NOx reduction exceeding 12% without any optimization. The CO levels obtained during testing were less than 150 ppm. In addition the 90% reduction in superheat spray flow and the 2% reduction in reheat spray flow resulted in improved heating surface absorption. All in all, this project demonstrates that modifications to existing low NOx burners can often achieve the low NOx burner performance of new equipment at a much lower cost when state-of-the-art technology is properly applied. ■



Airflow patterns before (top) and after (bottom) the implementation of the modifications