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BY: BRYAN C. MCCARTY, ENTERGY CORPORATION
AND BILL LANG, LENOX INSTRUMENT COMPANY

FURNACE CAMERAS ASSIST IN NO_X REDUCTION

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In a time when environmental responsibility is increasingly important, reducing the NO_x emissions of gas-fired boilers is becoming a priority for many electric utilities. As the sixth largest producer of electricity in the country, Entergy Corporation has set aggressive goals to improve its environmental performance, including the reduction NO_x emissions. These goals have helped Entergy to reduce its overall air emissions rate to the second lowest of the ten largest U.S. electric power generators.

Furnace cameras are one tool Entergy is using in the fight to reduce emissions. Entergy recently installed a camera manufactured by Lenox Instrument Company on the Unit 2 boiler at the company's Sabine plant, Bridge City, Texas. Entergy has found that using the camera has not only helped them reduce NO_x emissions, but it has also aided in combustion tuning and monitoring the operation of other NO_x reduction equipment.

Based on the success of the initial installation on Unit 2, high temperature video systems were installed on all five units at Sabine. These video systems have benefited the operation and start-up of these boilers. By reducing the amount of time to bring the units on line the cameras have allowed greater flexibility for the plant to respond to changes in demand. Reducing the start-up time of the boilers has also decreased the costs associated with bringing the units online. Use of the cameras has allowed Entergy to achieve two seemingly conflicting goals: improved environmental performance and more profitable operations.

Furnace cameras are not new. In fact, they have been installed as part of some original boiler equipment packages for almost half a century. However, because the older cameras generally provided low-quality images, and required regular maintenance, many utilities simply abandoned the cameras.

Fixed FireSight camera systems used at the Sabine plant have an air-cooled quartz lens that can withstand temperatures up to 3,500 F, which is 1,000 F to 1,200 F greater than glass optics. With solid-state electronics tied into an independent digital control system, and an adjustable light volume control, the system provides an extremely clear, color image from inside the furnace. This technology was pioneered 12 years ago with the introduction of CCD cameras which resulted in better reliability, improved picture quality, color viewing and better light control.

PROJECT CHARACTERISTICS

The Sabine power plant has five natural gas fired units with an overall maximum capacity of 1,900 MW. The NO_x reduction strategy at the Sabine plant requires the utilization of several different techniques. These include low excess air (LEA), burners out of service (BOOS), separated over-fire air (SOFA) and induced flue gas re-circulation (IFGR). However, many of these techniques have significant potential to negatively impact boiler operation and equipment reliability if they are not properly controlled. Thus, it is critical to closely monitor combustion equipment changes on the boilers.

The color furnace cameras installed at Sabine provide a "real-time" image of what is actually happening inside the furnace, thereby allowing the operators to view problems instantly such as flame instability, incomplete combustion and poor flame distribution.

Sabine's furnace control panel

Entergy's Sabine Plant.

Sabine installed the first high-temperature furnace camera system on the 230 MW Unit 2. The unit, a Combustion Engineering (CE) tangential-fired, divided-furnace, "upside-down" boiler, has a capacity of 1.584 MMlb/hr MCR. Because the boiler has a divided furnace it requires the installation of one camera on each side of the furnace division wall and two-video displays in the control room above the bench board. The cameras and associated equipment were installed during a planned maintenance outage in the fall of 2000.

REDUCES NO_X EMISSIONS

The initial objective for installing the furnace cameras was to aid in combustion tuning for NO_x emission reduction. According to Steve Wood, President of ETEC, LP and a consultant for Entergy, balancing the combustion process can reduce emissions by as much as 20 percent. On Unit 2, LEA and BOOS have been utilized to reduce the 30-day rolling average for NO_x emissions by more than 30 percent.

Operating under these conditions, however, has required increased precision in the control of furnace fuel/air ratios and continuous monitoring of combustion characteristics in the furnace. Furnace cameras have aided combustion monitoring by visually showing the operators the flame distribution. Using this information the operators are able to monitor the impacts of combustion changes and establish more uniform combustion.

Once the furnace camera system was installed, the plant's operators quickly realized that the cameras provided several additional benefits including:

- *Faster boiler start-up and troubleshooting – Cameras provide visual confirmation of burner and igniter flames, which enable operators to quickly identify faulty flame scanner indications. This has shortened start-up time on the unit by several hours, resulting in significant cost reductions.*
- *Increased safety – Cameras provide a verification of stable combustion and are a valuable accessory to existing fuel safety systems. By revealing loss of flame, the cameras help to prevent boiler "puffs" or explosions.*
- *Greater reliability – The cameras also indicate flame impingement and other localized overheating problems that can cause waterwall tube failures. In the tangentially fired Unit 2 boiler, flame impingement is avoided by using the cameras to center the fireball away from the waterwall tubes in each furnace, helping prevent costly forced outages during peak periods.*

THE END RESULT

The high-temperature furnace camera system provides a vivid image of flame quality and distribution. As a result, the operators can monitor and tune the combustion process to achieve peak performance. Likewise, unit start-up time has been consistently reduced by several hours. The system also provides added safety benefits, troubleshooting assistance and reliability improvement by allowing the operators to detect unsafe or unstable combustion conditions and identify faulty flame scanners

The plant operators have found the furnace camera system to be an invaluable tool for reducing NO_x emissions and decreasing the start-up response time. Control room supervisors describe the new furnace cameras as "the best improvement we have made in a long time." PE

Authors—
Bryan McCarty, a plant engineer at Entergy's Sabine plant, supports routine maintenance and planned outage projects for Units 1-5. He joined Entergy in 1998 as a design engineering intern at the River Bend Nuclear station. McCarty hold has a BS degree in mechanical engineering from Louisiana Tech University.

Bill Lang is Director of Marketing and one of the owners of Lenox Instrument Company (Trevose, PA), manufacturer of the FireSight high-temperature video camera system, along with a full line of other remote visual inspection equipment. Bill has more than 35 years of application engineering experience in the field. A graduate of LaSalle College, he began his career in the Lenox shop fabricating high-temperature lenses and optics, and he later pioneered the use of the portable FireSight camera system, used initially for demonstration purposes in fossil-fuel fired power plants.