LEHIGH ENERGY UPDATE

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USING THE ERC TO SOLVE POWER PLANT PROBLEMS

Steve Marbaise, an engineer at PSE&G's Hudson Station, needed help in determining boiler control settings to use at Unit 2 to achieve lower NO_x emissions. Greg Schmidt of PPL Generation had an upcoming maintenance outage and needed to determine what vertical sag to expect in the tube supports of an economizer during installation of the new tube bundle. Kal Merimets of Ontario Power Generation was considering removal of a steam air heater at Nanticoke Station and needed to know the impact on air preheater fouling. Brian Warnaka of FirstEnergy had to solve a boiler tube wastage problem, possibly brought about by cofiring petroleum coke with coal, and needed to determine if the petroleum coke was a contributing factor. Alex Huhmann of PSE&G asked for a critical assessment of the issues related to cofiring biomass in pulverized coal boilers. His company wanted to learn more about performance impacts, necessary plant modifications and conversion costs. Larry Kielasa of Detroit Edison needed information on recommended practices for on-line cleaning of Selective Catalytic Reduction (SCR) catalyst beds. CONECTIV was experiencing weld cracking in one of its Heat Recovery Steam Generators (HRSG) and Steve Reid of CONECTIV wanted to know the magnitude of the transient stresses in those weld during cold start-up conditions. All seven engineers turned to Lehigh's Energy Research Center for assistance.

(a) Research Scientist Arlan Benscoter (left) examines a failed boiler tube for an Energy Liaison Program member company.

(b) ERC researcher conducts field evaluation of air preheater cold end fouling.

According to John Sale, "The Energy Research Center has been helping industry with its problems for more than 20 years. Our people are specialists in disciplines such as mechanical engineering, chemical engineering, metallurgy, and civil engineering; and the work they perform for our industrial clients includes laboratory investigations, field studies, computer simulations, theoretical analyses, and state-of-the-art assessments."

"For example, both the CONECTIV HRSG study and the PPL Generation economizer tube bundle study required finite element stress analyses. ERC personnel performed combustion optimization tests at Hudson Station to determine how NO_x, CO and opacity respond to different boiler control settings. They then used software we'd developed to determine the optimal control settings. The steam air heater study at Nanticoke involved predictions of dew point conditions within the air preheater. The SCR catalyst bed investigation was performed by contacting catalyst vendors, consultants and power plant engineering staff on the cleaning options and on the advantages and disadvantages of each. The biomass cofiring assessment involved a review of

technical papers and reports, and discussions with specialists in biomass cofiring. The petroleum coke evaluation involved laboratory analyses of the pet coke used by FirstEnergy and a literature review and a utility survey on industry experience on operational problems with pet coke cofiring."

Although experienced researchers are the key to the ERC's success, its success is also due in no small part to Lehigh's unique collection of research equipment that can be applied to practical problem solving. The Center maintains laboratories in several buildings on campus, with

PROBLEM-SOLVING AT THE ENERGY RESEARCH CENTER

Listed below are examples of areas in which ERC staff provide problem-solving assistance. Typical investigations include state-of-the-art assessments, field tests, laboratory studies, theoretical analyses, and/or computer simulations.

! NO_x CONTROL AND HEAT RATE IMPROVEMENT THROUGH COMBUSTION OPTIMIZATION

The Center staff performs field tests to determine the effects of boiler control settings on heat rate and emissions. The results are used to identify the combustion control settings which meet the station's NO_x and heat rate goals. The results are provided to the operators in the form of a new set of control curves.

! DIAGNOSING THE CAUSES OF OPACITY EXCURSIONS

Center staff conduct field tests to identify the causes of opacity excursions. The test results are used to develop new operating strategies for minimizing opacity problems.

! FURNACE SLAGGING CONTROL

Laboratory analyses and field tests are performed to identify factors contributing to severe boiler slagging episodes. Recommendations typically involve some combination of new instrumentation, changes to furnace operating conditions, and changes to furnace sootblowing practice.

! SOOTBLOWING OPTIMIZATION

Field tests and analyses are performed to develop plant-specific solutions to optimized sootblowing. The results can be implemented as written instructions for the operators or can be used as input to automatic sootblowing systems.

! SNCR SYSTEM OPTIMIZATION

Field tests and computer analyses are performed to identify boiler control settings and SNCR reagent injection patterns which minimize reagent consumption and reduce by-product emissions.

! COAL PIPE BALANCING

Computer analyses are performed to determine orifice sizes needed to achieve balanced primary air (dirty air) flows in coal pipes, and recommendations are made on techniques for obtaining more accurate coal flow measurements.

! AIR PREHEATER PERFORMANCE IMPROVEMENTS/COLD END FOULING

Analyses are performed to diagnose reasons for heat transfer performance problems with regenerative air preheaters. Field tests and analyses are performed to determine how air preheater cold end fouling rate varies with boiler and air preheater operating conditions and with SCR and SNCR operations.

! CEM FLOW MEASUREMENT ACCURACY ISSUES

Field tests and analyses are performed to determine the magnitude of the CEM flow bias and identify the factors which contribute to the error. The results are used to develop the best strategy for reducing bias error.

! COMPONENT FAILURE ANALYSES

Laboratory analyses and computer simulations are performed to determine the cause(s) of mechanical failures of power plant components. Recommendations for corrective action are provided.

! COMPONENT LIFE PREDICTIONS

Computer simulations are performed to determine the remaining life in components subject to high temperature creep, creep-fatigue, or low-cycle fatigue damage.

! EQUIPMENT DESIGN IMPROVEMENTS

Analyses are performed to develop improved designs of power plant components. Design changes often include a modified configuration, change in materials of construction and/or modified welding procedures. The design improvements are typically carried out to increase component life, reduce pressure drop, reduce emissions or improve heat rate.

access to the latest and most sophisticated instruments and computers.

"Sometimes utilities seek assistance at Lehigh because other consultants haven't helped," Sale says. "We have the experts and equipment to do what many others can't." Sale adds, "One thing in our favor is our ability to see things that others don't because of our broad experience and research expertise. Coupling this experience and expertise with cutting edge research equipment gives the Center a broad spectrum of tools to draw on to solve our customers' day-to-day equipment problems."

Arnold Marder, a Professor in Materials Science and Engineering who has been closely affiliated with the Center since the mid 1980's, believes that much of the success of the Center also comes from a team approach in dealing with problems. Marder recalls, "Just before a holiday we received a call from an ELP member company at a nearby plant which had a critical problem with a pressure vessel which was thinning to the point where it might not sustain a load. The company had to report immediately on what it intended to do about the problem to avoid complete failure. The engineer called on the ERC to find out what options there were."

"Despite the pending holiday, three of us—a stress analyst, a welding engineer, and a corrosion specialist—dropped everything to discuss possible approaches to the problem. Among us, we were able to identify what stresses the vessel could sustain, what welding repair could be done, and where there might be potential sources of corrosion," Marder says. "This gave the company a total engineering approach to present as a solution."

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