LG&E and KU Use EPRI Guidelines to Design First HRSG

In 2011, LG&E and KU began designing its first natural gas combined-cycle (NGCC) unit with heat recovery steam generators (HRSGs). The 640-MW plant, known as Cane Run Unit 7, was to be built on the site of a retired coal-fired plant near Louisville, Kentucky.

As the company did not have any HRSGs within its fleet, it consulted companies and/or organizations with experience in the technology. In particular, LG&E and KU looked to EPRI for its extensive background in HRSG design, including research initiatives, technical guidelines, training materials, experienced program managers and technical support staff.

By utilizing EPRI's background, LG&E and KU aimed to develop a HRSG design that would improve water chemistry and minimize the risk of major damage and failure mechanisms. Goals included:

- No HRSG tube failures due to cycle chemistry and reduced deposition
- No steam turbine problems influenced by cycle chemistry
- Optimized feedwater treatment
- Operational guidelines
- Reliable chemistry instrumentation and control
- Optimized procedures for unit shutdown and layup
- Reduced frequency and optimized chemical cleans
- Optimal managerial approach and support of cycle chemistry
- Cost-effective cycle chemistry program
- Procurement specification for HRSG components, including properly designed drains and attemperation sprays

Based on these goals, LG&E and KU incorporated a number of changes and enhancements in the design of the Cane Run Unit 7 HRSG.

Material Upgrade

Due to EPRI's identification of flow-accelerated corrosion (FAC) as a main corrosion mechanism affecting HRSG metallurgy and causing a safety concern, LG&E and KU upgraded sections of the low-pressure and kettle boiler from carbon steel to P11 (1.25% Cr). EPRI's *Comprehensive Cycle Chemistry Guidelines for Combined Cycle/Heat Recovery Steam Generators* report indicated this upgrade would significantly reduce FAC exposure. P11 has a 34 times lower rate of metal loss than carbon steel.

Furthermore, through EPRI's Life Assessment of Creep Strength Enhanced Ferritic Steels project, LG&E-KU utilized the 2011 *Guidelines and Specifications for High-Reliability Fossil Power Plants: Best Practice Guideline for Manufacturing and Construction of Grade 91 Steel Components* (1023199). This guideline was used to specify certain trace elements and a nitrogen-to-

A view of the Cane Run Unit 7 HRSGs and steam turbine building from one of the fast-start clarifiers.

"LG&E and KU believe that by utilizing EPRI's technical reports, as well as its program managers/technical staff, Cane Run Unit 7 has been designed to minimize the risks associated with serious corrosion and deposition problems (chemistry-influenced HP evaporator tube failures, turbine corrosion, deposition, and flow-accelerated corrosion) that have been experienced at other combined-cycle power plants. Furthermore, LG&E and KU believe that these changes in materials will allow for better reliability."

~ Michael Rupinen, Generation Engineering, LG&E and KU Services Company

aluminum ratio during mill fabrication of the Grade 91 piping and tubing. EPRI testing demonstrated that these changes provide long-term reliable operation of components. The LG&E and KU project team also met with EPRI staff to review the *Heat Recovery Steam Generator Procurement Specification* (3002001315) to ensure proper design of the superheat and reheat drain lines and steam attemperation sprays.

Nitrogen Blanketing

EPRI's *Comprehensive Cycle Chemistry Guidelines for Combined Cycle/Heat Recovery Steam Generators* also raised the issue of pitting and corrosion in the HRSG tubing during off-line conditions. Based on this, the decision was made to include nitrogen blanketing for both the HRSGs and the demineralized water tank. Use of nitrogen blanketing minimizes oxygen ingress to the makeup water and protects the unit during shutdown. This system was utilized during the pre-op chemical cleaning of the units.

EPRI Core and Diagnostic Parameters

EPRI's *Comprehensive Cycle Chemistry Guidelines for Combined Cycle/Heat Recovery Steam Generators* recommends core parameters as the minimum essential chemistry parameters for preventing damage and failure due to corrosion/deposition. Additionally, EPRI recommends diagnostic parameters for identifying the root cause from specification conditions. Based on EPRI's recommendations and research, both the core and diagnostic parameters were included in Cane Run Unit 7. This was the first time LG&E and KU incorporated on-line chloride analyzers, integrated corrosion product monitors, a demineralized water flush, as well as a diagnostic panel for verifying instruments and identifying cycle contamination.

Powdered Resin Condensate Polisher

Cane Run Unit 7 was originally projected to cycle (start and stop daily). EPRI research has shown that the highest levels of corrosion product transport are seen during startups. Based on EPRI's *Comprehensive Cycle Chemistry Guidelines for Combined Cycle/Heat Recovery Steam Generators*, the decision was made to equip the unit with a powdered resin condensate polisher that can remove the suspended corrosion products in the condensate. This polisher will enable the unit to have cleaner, faster startups and increase the interval between chemical cleans. With the cost of chemical cleaning units doubling over the next year, due to the inability to evaporate chemical cleaning solutions, this technology will reduce future chemical cleanings and reduce costs.

Cooling Tower Metallurgy and Ball Cleaning System

Cane Run Unit 7's makeup water is from the Ohio River, which has fluctuating levels of manganese, posing risks to stainless steel tubing. Based on EPRI's research, LG&E and KU decided to utilize titanium tubing for the condenser and to include a ball cleaning system for off-line conditions. These two system changes have the potential to help minimize the risk of manganese deposition and pitting.

Related EPRI Work

Comprehensive Cycle Chemistry Guidelines for Combined Cycle/Heat Recovery Steam Generators (HRSGs). EPRI. Palo Alto, CA. December 2013. 3002001381.

Heat Recovery Steam Generator Procurement Specification. EPRI. Palo Alto, CA. December 2013. 3002001315.

Guidelines and Specifications for High-Reliability Fossil Power Plants, First Edition: Best Practice Guideline for Manufacturing and Construction of Grade 91 Steel Components. EPRI. Palo Alto, CA. December 2011. 1023199.

Guidelines for Makeup Water Treatment: Conventional Fossil and Heat Recovery Steam Generator Water/Steam Cycle Makeup. EPRI. Palo Alto, CA. December 2010. 1019635.

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com)

CONTACTS

Steve Shulder, *Senior Technical Leader*
704.595.2953, sshulder@epri.com
Mike Caravaggio, *Program Manager*
704.595.2589, mcaravaggio@epri.com
Bill Carson, *Program Manager*
704.595.2698, bcarson@epri.com

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Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com