

Tests Show Value of Flexible-Eddy Current Array Probe for Detecting Cracks in HRSG Weld Joints

Southern Company hosted plant demonstrations of a new nondestructive evaluation (NDE) technology for conducting plant inspections. The technology—a wearable, flexible-eddy current array probe—was shown to be effective for detecting the presence of cracks in the tube-to-header weld joints of heat recovery steam generators (HRSGs) in natural gas combined-cycle power plants and potentially other complex structures such as natural gas turbine buckets and valve components.

The demonstrations, which were conducted at Southern Company subsidiary Southern Power's Plant Rowan and Plant Harris, gave the utility an early look at and firsthand experience with the probe, and allowed EPRI to document performance of the new technology.

Crack Detection

HRSGs contain numerous steel tubes welded to headers. The geometry of the weld area is complex and is characterized by weld beads located at the intersection of a large-diameter cylindrical header with a small-diameter cylindrical tube. Over time, these welds are susceptible to cracking.

Eddy current probes are typically used to inspect welds for cracking, but the surfaces of the HRSG tube-to-header welds are difficult to inspect due to the complex weld intersection and irregularities of the weld surface. Liquid penetrant examination can also be used to locate cracks, but this method can be cumbersome and messy for crews, and many of the tubes are inaccessible for liquid penetrant examination.

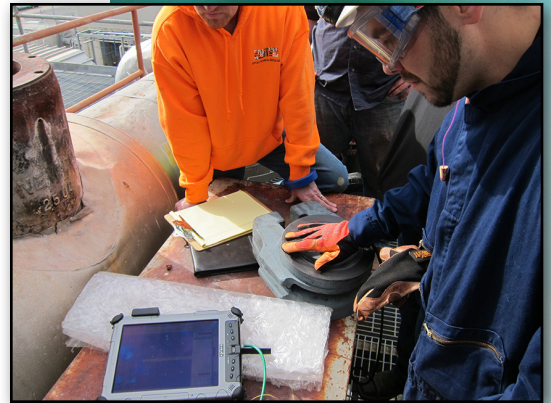
Flexible-Eddy Current Array Probe

Southwest Research Institute (SwRI®) developed the flexible-eddy current array probe as part of a project in EPRI's Combined-Cycle HRSG and Balance of Plant Program.

The probes are based on printed circuit-board (PCB) technology. The PCB array of coils is attached to a flexible backing material. Because the material is flexible, the array can conform to complex geometries such as those on the tube-to-header welds, and potentially can be used to manually inspect an entire weld region in a single circumferential scan.

The advantages of this approach are that 1) scanning and probe alignment requirements are simplified, 2) probes are easily produced using conventional PCB technology, and 3) probe components that are subject to wear are low cost.

The latest version of the probe is incorporated into a glove worn by an inspector. Finger pressure allows the probe to conform to the weld surface as it is scanned. Laboratory testing on welded mockups supplied by EPRI demonstrated detection of implanted cracks in the welds. Cracks ranged in size from 0.150 inches (3.8 millimeters) long by 0.045 inches (1.1 millimeters) deep to 0.362 inches (9.2 millimeters) long by 0.125 inches (3.2 millimeters) deep.



Flexible-eddy current probe being used to find a surface crack in the valve-gate facing.

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~ Charles Boohaker
Principal Engineer,
Southern Company

Tubes in the mock ups were from different types of steel; however, no significant difference in response from the different materials was observed.

The glove probe was evaluated in the HRSGs at four different power plants. Improvements were made to the probe based on feedback from the field testing.

Plant Rowan and Plant Harris Demonstration

The site of the first Southern Company demonstration was Southern Power's Plant Rowan, a 925-megawatt (MW) simple-cycle and combined-cycle natural gas turbine facility near Salisbury, North Carolina. EPRI and SwRI® representatives were on site at the plant with the flexible-eddy current probe and attached glove for 2½ days. Southern Company NDE staff and NDE contractors witnessed demonstrations and were able to use the gloved probe firsthand.

Participants confirmed that the probe was a significant improvement over certain NDE methods and offered a number of suggestions for further improvements. The eddy current probe was also demonstrated on natural gas turbine buckets and on a valve seat and its associated valve gate. Visible cracks in the valve seat were detected with the probe. Two cracks, including one not visible to the naked eye, were detected with the probe on the face of the valve gate. A follow-up liquid penetrant examination confirmed the probe findings on the valve gate and revealed no additional cracking. Southern Company personnel also observed and used the probe to examine several buckets of the combustion turbine, several of its compressor blades and portions of the natural gas turbine rotor.

Arrangements were also made to have the probe demonstrated at Southern Power's Plant Harris, a 1,254-MW combined-cycle facility near Autaugaville, Alabama. The applicability of the probe to in-situ natural gas turbine examination was tested on first- and second-stage compressor rotor and stator blades.

"During these demonstrations, our primary goal was to put the technology in the hands of our NDE field technicians who will ultimately be the end users," said Charles Boohaker, Southern Company principal engineer. "NDE sensor development, including miniaturization, is a vital link in the chain for advancement of inspection technology automation."

Related EPRI Work

Examination of Tube-to-Header Welds with Flexible Eddy Current Array Probes. EPRI. Palo Alto, CA: May 2014. 3002003390.

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

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