EPRI *Leadership in Science and Technology*

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Technical Brief

GENERATION AND STORAGE DIVISION

Condenser Leak Detection by Using SF_6 as a Tracer Gas

Condenser problems in large power plants cause a considerable loss in plant availability—an average 3.8% annual loss, according to an early EPRI study (CS-2378). As a result, utilities frequently target main condensers and associated components within the vacuum boundary for availability and performance improvements.

Leakage of air or water into the condenser can adversely affect both plant efficiency and equipment life. High rates of air in-leakage can contribute to turbine disk cracking and may create high levels of dissolved oxygen in the feedwater; high oxygen levels accelerate deterioration of the boiler and feed systems. Extremely high in-leakage rates can reduce condenser vacuum and increase turbine back pressure, leading to an overall loss of efficiency. Condenser tube leakage also allows contaminants in the circulating cooling water to transfer into the highly purified water of the steam cycle. This results in degradation of boiler components through corrosion or fouling or in decreased lifetime of condensate demineralizer resin beds, if they are present.

Leak Detection With Helium as Tracer

The use of gaseous tracers in testing for and locating condenser leakage has become a widely accepted practice. Several different tracers, including halogenated compounds (chlorinated and fluorinated hydrocarbons), helium, and perfluorocarbons have been investigated. Since the initial use of such tracers for power-plant leak detection more than 10 years ago, helium and helium mass spectrometers have been the most widely used means of testing.

The most commmonly used method to detect air and water in-leakage in condensers relies on the EPRI-developed helium leak detection technology (EPRI report NP-912). In this method, testing for air in-leakage is by sampling the condenser off-gas. Leakage is identified when helium migrates through the leak into the condenser, is expelled from the condenser steam space with other noncondensables in the off-gas, and is detected by a mass spectrometer.

Typically, condenser tube leakage testing begins by isolating and draining a suspected circulating water train. In effect, this transforms the water leak into an air leak. The helium is released through a distribution plenum into a specific group of tubes. Once leakage is indicated, an isolation procedure helps identify a single leaking tube. However, one problem emerged: suspected tube bundles often proved to be leak-free, yet their removal from service for testing nonetheless caused operation at reduced power. As a result, utilities needed a more sensitive detection technique, one which would allow testing on-line.

New SF_6 Tracer Gas Technology

Recently developed hardware and techniques that use sulfur hexafluoride (SF_6) as a tracer gas provide a solution to the problem. SF_6 offers lower ambient background concentration and lower cost per unit test than any other tracer. Using pure

Figure 1. Plant technician using SF_6 tracer gas release device.

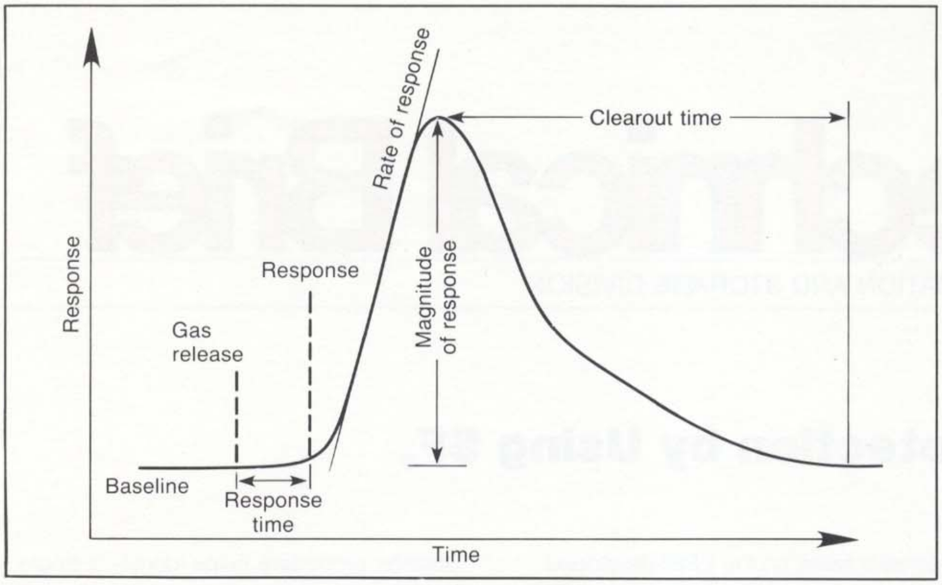

Figure 2. Recording of a typical leak response.

SF_6, detection accuracies can be 40 times greater than those obtained with helium. Commercial SF_6-analyzing equipment, which provides greater sensitivity and has lower maintenance requirements than any other tracer system, can detect one part SF_6 in 10 billion parts air.

With the new system, SF_6 can be released directly into water circulating through a particular water box while the condenser is still in service and the plant is operating at full power. If a condenser is leaking as little as one gallon per day, SF_6 will travel with the cooling water through the leak and into the condenser steam space. After the leaking tube bundle is identified, plant personnel can take it out of service, apply an isolation procedure, and identify any leaking tubes.

Although helium is sensitive enough for effective air in-leakage testing, there are several advantages to using SF_6 instead. A commercially available SF_6 release mechanism (Figure 1) is extremely portable (users do not have to cart a 115-pound bottle of helium throughout the plant), has an extended operating duration, and can be tuned to release the tracer in various concentrations, thus allowing sensitivity adjustments.

Dilution of SF_6 with air to a nominal concentration of 1000 ppm ensures that excessive amounts of SF_6 are not released into the condenser steam space. The low concentrations of SF_6 necessary for detection, the low solubility of SF_6 in water, and the high efficiency (>99%) of air removal systems on noncondensible gases reduce the probability that measurable amounts of tracer will carry over into the feedwater. Consequently, the possibility of fluoride contamination of the stainless steel components and the potential for high conductivity in the feedwater are minimal.

Leak-Detection Guidelines Available

On the basis of previous experience with either SF_6 or helium, an EPRI project team developed leak-detection procedures. The team demonstrated them at the Baltimore Gas & Electric Co. Wagner Station, and the team then developed guidelines that were reviewed by the EPRI Condenser Advisory Group and published in CS-6014.

If the system is not used properly, the high sensitivity of SF_6 tracer gas measurements can result in operational difficulties such as false indications and other problems associated with contamination of the background by SF_6. Accordingly, it is important that plant personnel read and understand all sections of CS-6014, which contains operating instructions for avoiding SF_6 contamination of the background, before attempting to use the SF_6 technique in field tests. The report provides users of the SF_6 gaseous tracer leak-detection method with the necessary information to realize the benefits of the equipment and methods.

EPRI's guidelines outline procedures for condenser air and water in-leakage detection that are quite specific yet practical for use at a variety of plants. To assist plant personnel in developing plant-specific procedures, several different plant configurations are discussed, and an air in-leakage checklist developed at one utility unit is provided.

The successful employment of gaseous tracer leak detection in a power plant is an acquired skill. It must be practiced for mastery. At its simplest level, a gas is released during the leak search, and a signal is displayed when a leak is detected. However, there are techniques in the gas release and signal interpretation that require experience and careful attention to detail. One section of CS-6014 discusses the principles of SF_6 leak detection, the choice of a search pattern, and differentiation among leakage paths in close proximity by interpreting signal magnitude, signal response time, signal slope, and signal clear-out (Figure 2). The guidelines also describe the SF_6 analyzer, the tracer gas release mechanism, and other required equipment, in addition to information on how to install system equipment and how the principal components function together to achieve optimum leak-detection capability.

For further information, contact EPRI project manager John Tsou, (415) 855-2220.

References

CS-6014, *Condenser Leak-Detection Guidelines Using Sulfur Hexafluoride as a Tracer Gas,* Final Report, September 1988.

NP-2597, *Condenser In-leakage Monitoring System Development,* Final Report, September 1982.

CS-2378, *Failure Cause Analysis—Condenser and Associated Systems,* Final Report, June 1982.

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