Portable leak detection instrument improves heat rate at electric power plant.
By Terrence O'Hanlon, CMRP
Reliabilityweb.com

By using a ruggedized portable ultrasonic leak detector, Mr. Brian Thorp, PdM Technician for Seminole Electric has been able to provide quick leak detection and repair on an aging steam condenser, allowing the utility to provide maximum power during high demand periods.

Seminole Electric is a generation and transmission cooperative headquartered in Tampa, Florida. It provides bulk supplies of electricity and wholesale energy services to 10 cooperatives located throughout peninsular Florida. More than 1.5 million individuals and businesses in 45 counties rely on Seminole and its members for electric service. Seminole's primary generating facility is located on the St. Johns River in Putnam County, Florida, about 50 miles south of Jacksonville. This 1,300 megawatt (MW) station has two 650 MW generating units. (Guidelines vary, but one megawatt of capacity can power approximately 660 homes that each use about 1,000 kilowatt hours of energy per month.) You can see the plant's water hyperbolic cooling towers (450' tall and 400' across) and 675' stack from many miles away. This plant generates electric energy from coal. Its output is distributed across transmission lines to Seminole's member distribution systems that in turn, deliver electricity to individuals and business - about 1.5 million people and business, or 10% of Florida's population, through about 750,000 meters (2002).

In today's competitive electric power generation market attention must be given to improving the condensers operating efficiency. Steam turbines cannot attain their specified performance without an efficient condenser. Tube leaks that affect condenser performance are critical. Most condenser tubes are designed to last at least 30 years before replacement is required. Unfortunately, normal plant operation, changes in water chemistry and other unforeseen circumstances often create a much shorter life for tubes. Most condensers are overbuilt to allow for a certain percentage of tubes to be plugged when a leak is detected.

When high sodium levels occur in the condensate, the water leaving the condenser must be “polished” through resin exchange and a boiler blow down. When this happens, cost is increased and the output of the power plant is reduced.

In the past, Seminole Electric, like other utilities, used methods that included pasting wet newspapers against tube sheets, spraying thick foam or using saran wrap to locate condenser tube leaks. These methods were slow, required multiple experienced operators at inconveniencing hours (plants can typically be brought to a partial load only during the midnight shift) and worse, they were often ineffective.

Ultrasonic Technology

Ultrasonic Leak detectors work like simple microphones that are sensitive to high frequency sounds ranging from 20 kHz (a kHz or kilohertz is one thousand cycles per second) to 100 kHz. To put that in perspective, most humans can hear up to 17-19 kHz.

Using a sensitive piezoelectric crystal element as a sensor element, minute high frequency sound waves excite or “flex” the crystal creating an electrical pulse that is amplified and then heterodyned or translated into an audible frequency that the technician can hear through a pair of noise reduction headphones.

As a leak passes from a high pressure to a low pressure, it creates turbulence. The turbulence generates a high frequency sound component, which is detected by the sensitive piezoelectric element, allowing the technician to quickly guide the instrument to the loudest point in order to pinpoint the leak.

Several ultrasonic detectors use parabolic reflectors or elliptical reflectors to enhance and concentrate the leak signal, which can be useful when detecting small leaks or scanning at a great distance.

The effects of condenser tube leaks

The condenser is the largest heat exchanger in the condensate/feedwater network. It is located under the steam turbine generator. When the steam exits the turbine, it is passed over cool pipes that condense it back to liquid water. The purified water is pumped back

to the boiler to be heated to steam again. The same purified water is boiled and condensed over and over.

Keeping the condenser tubes in the condenser from leaking river water used for cooling into the steam or clean side of the condenser is a key to achieving optimum performance of the plant. Fresh water leaking into the purified system can wreak havoc by causing corrosion throughout the system and can significantly reduce operating life if not rapidly addressed.

The Seminole Electric plant condensers contain 44,000 one inch tubes per unit and feature a split design, with eight water boxes or two loops. This allows the plant to isolate one loop or four water boxes while running at a partial load. Isolating a section of the condenser allows Thorp to drain the cooling water and enter the water boxes while the plant is still operating. Because the turbine is still operating, a vacuum is present on the steam side of the condenser tube. This vacuum creates a pressure differential that "sucks" air into the tube leak site. As the air enters the leak site, it creates a minute turbulence, which generates a high frequency signal. The sensitive ultrasonic leak detector quickly detects and pinpoints leaking tubes allowing them to be plugged.

Operations know when a leak is severe enough to warrant attention by sensitive sodium parts per billion (ppb) counters in the condensate pump discharge system. The sodium counter display is checked by operators on their rounds.

Water boxes in operating power plants are not the most pleasant environments to work in, with an ambient temperature of 100º-105º F and a 99.99 relative humidity. It can be a

stressful experience and heat exhaustion is not uncommon. Using Ultrasonic leak detectors has allowed Seminole and the maintenance personnel to get into the waterbox, find the leak and get out quickly.

Seminole originally tried an older airborne ultrasound detector. The unit tested was not designed for the high humidity environment that is present in steam condensers. It soon ceased to function as moisture built up in the circuit, but not before they were able to hear what they thought might be a tube leak. Unable to complete the ultrasonic test at that time, the traditional and time consuming methods were used to solve the immediate problem; however the PdM department was convinced to learn more about high frequency ultrasonic detectors that were designed for harsh environments.

His research led him to SDT North America, who offered the SDT 170M with several features that convinced Thorp this unit could be a big help. The unit was sealed to IP65 and included a flexible extension wand to extend the reach of the leak detection sensor.

Thorp soon discovered that online steam condensers offer abundant ultrasonic signals to compete with the leak signal. His general method used is to hold the instrument a couple feet from the tube sheet and scan the entire area. If a noisy area is found it is noted. He then switches to an extended flexible sensor and scans tube to tube. If the sound signal on the digital dBvu meter or sound in the headset does not change from tube to tube, a leak is unlikely. This is particularly true of tubes located on the outer edges of the tube sheet as these tubes are more likely to have noisy steam flowing over their OD surfaces. If a significant signal change occurred, a leak is suspected. If the leak is within the tube the

difference will be heard at the tube opening. If the noise level is heard on the tube sheet he blocks the area to eliminate reflected noise. He then places a concentrator cone with an opening of one eight inch on the flexible extended sensor and holds it almost on the tube sheet surface and moves it around the tube to tube sheet fit or the plug previously installed in the tube. During this process the small area of the one inch tube that is leaking can be pinpointed and repaired.

After using the ultrasonic detector on his own for while, he recently attended a 2.5 day level 1 training course. He returned from that training confident that he would expand the use of his ultrasonic detector to detecting problems with coal conveyors, bearings, compressed air leaks and many other kinds of problems that commonly occur in a power generating station.

Seminole Electric realized several intangible savings from the ultrasonic leak detection project related to improvements in water cleanliness and reliability. Water chemical cleanings range in cost depending on unit specific requirements but the cost can be significant. A reduction in tube leakage also means less corrosion.

Thorp reports a quick return on investment for their ultrasonic detector and has attracted the attention and support of top company management based on the results to date.

His advice to other considering ultrasound is to use as many technologies as you have access to solve problems as no one technology can supply all the answers. He is confident that ultrasound will remain an important inspection tool for Seminole Electric.

Sidebar:

For a web based tutorial titled “Introduction to Airborne Ultrasound” visit www.rcm-1.com/ forms/sdt2_reg.htm. This 20 minute narrated course provides an overview of ultrasonic applications for beginners as well as detailed test procedures for this already using ultrasonic technology. Brief registration and a current media player are required.

Bio: Terrence O'Hanlon, CMRP is the Publisher of Reliabilityweb.com. He is a Certified Maintenance & Reliability Professional and has assisted hundreds of industrial plants over 20 year experience in the design and application of airborne ultrasound.

Background and corporate photos are available from
http://www.seminole-electric.com
bthorpe@seminole-electric.com