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Photos by David Sanders/TEP.

Builds Award-Winning Predictive Maintenance

by Gary Gardner

In 2012, the predictive maintenance team at the Tucson Electric Power Springerville Generating Station (SGS) helped the company avoid more than $1 million in maintenance and replacement costs. In the first three quarters of 2013, predictive maintenance efforts at SGS saved more than $750,000. This documented return on investment is one of the factors that led Emerson Process Management to recognize Tucson Electric Power (TEP) with the Reliability Program of the Year Award for 2013, an honor for which 64 programs around the world were nominated.

What sets our five-member predictive maintenance team apart from other reliability teams is our commitment to customer service. You can see that reflected in our mission: *"to provide condition monitoring services with the goal of early equipment failure detection and a reliability maintenance strategy which will improve safety, planning and scheduling, operation and maintenance cost savings, and equipment availability. This is accomplished through effective application of the latest predictive maintenance technologies, specialized training, and communication with our customers."*

SGS, located in Springerville, Arizona, has four coal-fired generating units. TEP, which operates the plant, currently receives all of the output from Springerville Unit 1 through a 14 percent ownership and leases for the remainder. TEP also owns and receives all of the output from Unit 2. The two units represent slightly over a third of the company's owned generating capacity, approximately 800 megawatts (MW).

Springerville Unit 3 is owned by Tri-State Generation and Transmission Association and Unit 4 is owned by Salt River Project.

TEP leadership strongly supports our reliability program and emphasizes good planning and execution to minimize downtime. Good planning requires good prediction and coordination with other departments. We've built a relationship of trust with our work planning department. When our predictive maintenance department gives the planning group advance warning that a motor is starting to deteriorate, they have adequate time to plan for appropriate staff, parts and tools to complete the work.

In fact, the planning group brings our team in to test high cost or critical equipment before it's even shipped to our facility. This way, TEP avoids incurring the expense of shipping and commissioning equipment that isn't working properly.

Keep Asset Criticality Up-To-Date

At SGS, we're responsible for monitoring an incredible, complex variety of equipment – conveyors, gear boxes, pumps, turbines, blowers, compressors, pulverizers, fans and mills. To ensure we're monitoring the most essential assets, we validate equipment criticality on a regular basis. Considerations used to determine criticality include safety, regulatory issues, envi-

Figure 1: Members of the TEP predictive maintenance group at the generating station in Springerville. From left; Latigo Pate, Troy Burk, Gary Gardner, and Kevin Lee

ronmental compliance, load reduction and single point of failure. We use criticality ranking and run-to-failure statistics to inform the frequency of predictive monitoring for every one of our critical assets. We also monitor critical, redundant equipment. Based on trends we identify in our assets, we're continuously revising our maintenance strategy.

Rely on High-Performing Technology

TEP relies on technology with high resolution, accurate data collection and advanced diagnostics capabilities. Our primary tools include vibration analysis, oil analysis, electrical motor testing, infrared thermography, ultrasonic testing and partial discharges testing.

One of the systems we've recently installed is an automated, wired monitoring system used to determine machinery health. One of the most valuable characteristics is its wide range of coverage, specifically its ability to collect high frequency, high resolution vibration data from equipment that rotates at more than 10,000 rotations per minute.

In 2013, TEP also installed wireless vibration transmitters throughout the coal yard. We now have the largest wireless vibration network of any power plant in the world. The transmitters automatically gather vibration data on equipment while it's running and wirelessly send it back for analysis, ensuring safe, accurate data collection. For example, we now receive predictive diagnostic information on the railcar positioner and dumper asset, which pulls an entire trainload of coal, then rotates and dumps out the coal one car at a time. If this equipment shuts down unexpectedly, we don't dump any coal, resulting in additional labor expense and delays in plant operations. With five motors tied to five gearboxes, the asset is expensive. Due to the nature of its function, it's not safe for someone to be on the equipment while it's moving. Now, with wireless vibration monitoring, we can collect data and use predictive maintenance to help us identify deterioration before the asset fails.

Make Training a Priority

To get the full benefit from its technology and maintenance processes, TEP has made training a high priority. Team members participate in up to three training sessions per year. The entire team has minimum certification in all predictive technologies. This use of cross-training enables the group to offer consistent service if a member is absent. With the breadth of training and tools available, the predictive maintenance team can leverage multiple tools for diagnosis. However, each member has additional areas of specialty. For example, if there is a problem with a motor, we can use vibration, infrared thermography and ultrasonic testing to pinpoint the problem. This approach cuts down on time for troubleshooting and yields more robust results.

Provide Clear, Detailed Reporting

At most companies, a problem, such as a motor bearing which needs replacement, is identified and then a maintenance work order is generated. At TEP, after a problem has been identified, we write a work order and then develop a report for our management team. The report describes the problem, adds context with trends and specific data points, and provides recommendations for resolution. In the motor bearing example, we would show the increase in amplitude and provide details about the frequencies that bearing is producing. After repairs are made, we write a follow-up report with an analysis of failed components, including pictures, and an estimate of how much production availability and money we would have lost had there been a failure. This detailed communication gives our leadership the opportunity to experience the demonstrated value of the work we do in real time.

Recently, we identified an issue with a gearbox that had been rebuilt within the last 18 months. Vibration data indicated looseness in the input bearings. The gearbox was removed for repair before functional failure occurred, which prevented unplanned downtime and secondary equipment damage. During our analysis of the components, we identified fretting corrosion due to the loose bearings, as well as abnormal wear on
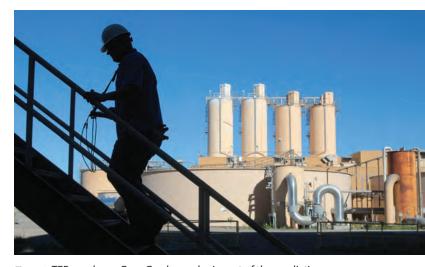

Figure 2: TEP employee Gary Gardner, who is part of the predictive maintenance group, walks throughout the generating station in Springerville, collecting data where he measures ultrasonic, vibration analysis, infrared thermography and electrical motor testing, analyzing equipment to predict when it will need replacing.

the gear teeth. Based on our findings, we were able to have the $250,000 gearbox replaced without cost as part of our warranty.

Expand the Program

Within the last several years, our reliability program has expanded to include lubrication. To combat the threat of cross-contamination, TEP has purchased several climate controlled lubrication buildings that will house large containers of oil. When these buildings are put in place, each type of oil will be stored in its own tank, with its own pump. Storage tanks and canisters, as well as the equipment the oil will be used for, will be color-coded and labeled to prevent contamination. And desiccant breathers will be used to prevent dirt from entering the tanks. By eliminating the threat of contamination through proper storage, handling and application, we anticipate extending equipment life.

In addition, we'll continue to focus on building our predictive maintenance capabilities for equipment that is difficult to access, runs intermittently, or varies in load. We'll do this by expanding our wireless vibration network, both inside and outside the coal yard. We'll also be increasing the number of permanently mounted accelerometers on hard to reach equipment. Used in combination with a machinery health analyzer, the accelerometers enable us to safely collect data at higher frequencies.

Our predictive maintenance team is honored to receive international recognition for our program. Just as importantly, we're proud of the work we've done for our internal customers. We're monitoring more critical assets than ever before. We've put documented proof of the value of predictive maintenance in the hands of our leaders. We've made a difference in TEP's ability to prevent unplanned shutdowns and to more effectively plan maintenance work. With the predictive maintenance foundation we have in place, we're excited to contribute to TEP's success.

Gary Gardner is a Predictive Maintenance Coordinator II for Tucson Electric Power. Gary has more than 12 years of experience in the preventive and predictive maintenance field, with more than 10 of those years spent in the mining industry. He specializes in vibration analysis and holds certifications in a number of other predictive technologies, including machinery lubrication, infrared technology and electrical motor testing.