GUIDELINES THAT SAVE MONEY

EPRI RESOURCE CAN HELP OPERATORS BEFORE, DURING AND AFTER OUTAGES

ALAN GRUNSKY
ELECTRIC POWER RESEARCH INSTITUTE

In the fall of 2008, a scheduled maintenance was under way on unit 2 at AmerenEnergy's E. D. Edwards Plant, a 744 MW coal-fired facility in Bartonville, IL. During the Low Pressure (LP) inspection, the maintenance crew discovered erosion on L-1 blades. A quick determination had to be made whether the blades could continue in operation or needed to be repaired or replaced.

In the past, like most utilities, Ameren's pre-planning for the inspection would have involved checking to see if a Finite Element Analysis (FEA) for the inspected blades was on hand or available from a third-party vendor, which would allow engineers to calculate blade stresses, if damage was discovered.

Without an FEA, however, the decision would be a judgment call. "Given the time constraints, it's pretty hard during an outage to create an FEA and do the actual modeling and analysis to understand the stresses on the blade," says Tom Kordick, Manager, Plant Support Services at Ameren. "You usually end up looking at the history of the blade and the amount of erosion on a previous inspection, and calculating the erosion rate over time. But it's a judgment on whether the blade is suitable for continued operation."

In this case, though, Ameren had more information. The utility used "Guidelines for Reducing the Time and Cost of Turbine-Generator Maintenance Overhauls and Inspections," a tool developed by the Electric Power Research Institute (EPRI; Palo Alto, CA).

The Guidelines are a seven-volume set of specifications and procedures necessary for planning and performing a maintenance outage on a fossil or nuclear steam turbine-generator. The information in the Guidelines has been collected under the direction of a Technical Advisory Group comprising utility members of EPRI.

In Volume 7 of the Guidelines, Ameren found modeling of the L-1 blade in question (Figure 2). "We were able to take that FEA, compare it to the eroded locations and determine that they were low-stress areas with little likelihood of failure," says Kordick. "It allowed us to document the erosion and put the unit back in service with the recommendation to replace the blade in the next inspection."

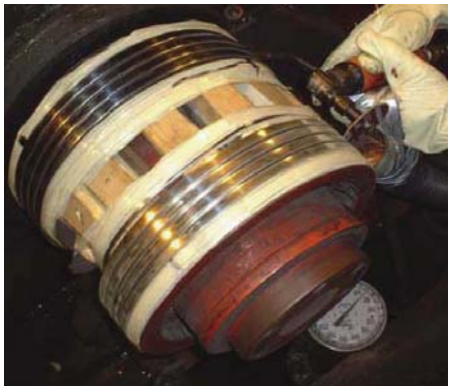

Figure 1: Recutting a worn-out helical groove (top)

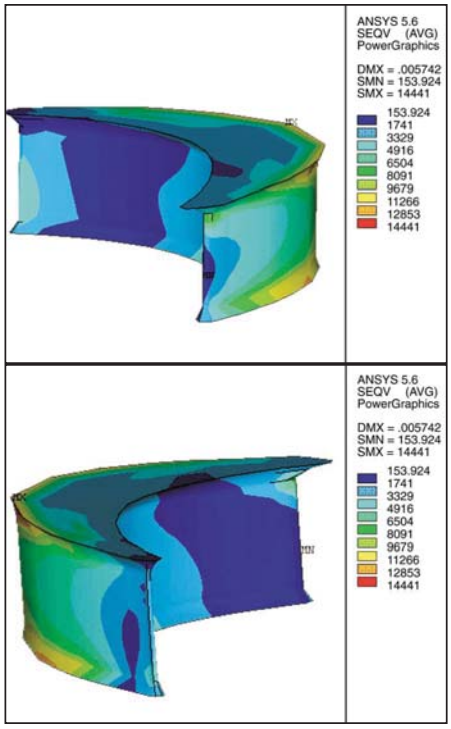

Figure 2: Distribution of steady stress on airfoil leading and trailing edges (right)

The experience at the Edwards plant is a common one. Up to 70% of outages planned for steam power plants involve work on the turbine, and, in many cases, the generator (Figure 1). The challenge for plant engineers is to efficiently use the outage to improve equipment performance and extend reliability while limiting downtime costs. A one-day reduction in outage time can save $200,000 to $500,000 for a typical 500 MW fossil unit.

A do-it-yourself manual

Many power producers are looking for accurate sources of information on maintenance outages and ways to shorten the learning curve for inexperienced employees, while at the same time properly managing their corporate risk relative to type and frequency of maintenance work on this equipment. EPRI's Guidelines meet this need by providing a compendium of successful utility practices.

Originally published more than seven years ago, the Guidelines have been annually updated and expanded to incorporate new information. The complete set now encompasses some 2,000 pages and is used by 45 utilities.

Included in the Guidelines is practical information, including common pre- and post-planning procedures for maintenance outages, specific component repair procedures, high- and low-speed rotor-balancing procedures, an alignment and balancing primer, major component purchase specifications, and blade-disc design audit and inspection procedures.

The procedures and practices represent a consensus of what has worked, including simple, practical tools — inspection procedures, engineering models, and guidelines for working with vendors, particularly on work scope definition and inspection of final product received. For instance, the Tennessee Valley Authority (TVA) has used Volume 3 of the Guidelines, "Balancing and Alignment Specifications," to develop specifications for high-speed balancing of rotors at five units at TVA's coal-fired Widows Creek, Bull Run, and Paradise Plants.

"Having those specifications allows us to get a better product after the testing is done," says TVA's Jerry Best, Manager of Steam Cycle and Generator Systems. "We are able to return the unit to service without having to do trim shots on the unit or perform as much online balancing as we would normally have to do. We probably saved at least one start-up on each unit by not having to do field-balancing on the rotors."

TVA is using Volume 4, "Blade and Rotor Procurement Specifications," to develop specifications for new equipment as part of the utility's future procurements, which is aimed at improving turbine efficiency.

For Ameren, the Guidelines also provide a reference library. "There is a tremendous amount of information in

A SEVEN-VOLUME SET OF GUIDELINES

- Volume 1: General Practices describes fundamental maintenance activities typically performed during an outage: Turbine-generator condition assessment (in-service), pre-outage planning and bidding, unit shutdown procedures, disassembly and recording clearances, foreign material exclusion process information, turbine-generator condition assessment (off-line), oil flushing, rotor alignment and balancing, pre-start up checks, and post-outage activities.
- Volume 2: Repair Procedures provides details to guide the pre-bid, inspection, disassembly, and repair of critical turbine and generator components.
- Volume 3: Balancing and Alignment Specifications includes comprehensive alignment and balancing primers and high- and low-speed balancing procedures for turbines, generators, and exciters.
- Volume 4: Blade and Rotor Procurement Specifications provides details for the procurement of turbine buckets, to include blade frequency testing and tuning guidance, high-pressure/intermediate-pressure/low-pressure (HP/IP/LP) fossil rotors, HP/LP nuclear rotors, generator rotor rewind, a new generator rotor, generator stator rewind, new generator stator, generator excitation system, turbine insulation, complete turbine outage services, and turbine bolting.
- Volume 5: Turbine Directory and Database of large (>75 MW electric) turbines that operate with last-stage buckets of 23 inches (58 centimeters) or longer.
- Volume 6: HP/IP Blade/Disk Design and Inspection Specifications includes blade/disk design audit and inspection procedures for a specific group of HP and IP steam turbine blades/disks.
- Volume 7: LP Blade/Disk Design and Inspection Specifications presents blade/disk design audit and inspection procedures for a specific group of LP blades/disks.

Generation companies and nuclear utilities that are members of specific EPRI programs are eligible to receive the guidelines. Non-members can purchase the guidelines by calling EPRI Customer Assistance Center at 800-313-3774 and asking for report number 1014134.

these documents," says Kordick. "As a standard practice, we use them to help in pre-planning to make sure we cover all the bases. It is particularly useful for entry-level engineers when they are planning for an outage. They can use them like an auto repair manual that goes step by step on what you need to do when you are taking the components apart, what checks you need to take, how to record the information, and so on."

Another application is as a reinforcement for in-house maintenance manuals. "When we take components apart in something like a stop valve inspection," says Kordick, "we have our internal guidelines and a two-way checklist to make sure we are looking at everything that needs to be looked at and taking the critical dimensions." TI

Author

Alan Grunsky is manager of EPRI's Steam Turbines, Generators and Balance of Plant Program. He may be reached at 704-595-2056 or agrunsky@epri.com.