The Susquehanna plant has two boiling water reactors, rated at 1235 and 1182 MWe, at a site near Berwick, Pa. (Photos: PPL Susquehanna)

Getting results with preventive maintenance feedback

BY KENNETH HART

PPL Susquehanna's feedback process ensures that the thousands of hours employees spend on preventive maintenance are spent wisely.

NO ONE WILL deny that nuclear power plant workers want to do the right preventive maintenance (PM) at the right time to support the safe and reliable operation of the plant. The problem is to identify the right PM and avoid doing excessive work—which not only can waste staff resources but can have an impact on equipment reliability by inducing early failures.

Given that nuclear plants have several hundred thousand pieces of equipment, determining what type of PM is needed and on which components is a daunting task. Although every U.S. nuclear power plant has a program that lists tens of thousands of PM activities, there's always room for improvement.

To determine what work needs to be done, many nuclear plant staffs set up a Preventive Maintenance Optimization (PMO) project. Such an effort can last for several years, frequently getting bogged down from "paralysis of analysis," and in the end could generate more maintenance work than the station can handle. This, in turn, can lead to another effort to re-review the results of the PMO.

Although there is value in the occasional performance of a large PMO project, it sometimes leads plant personnel to overlook more direct and useful approaches. PPL Susquehanna, which operates two boiling water reactors (rated at 1235 and 1182 MWe) near Berwick, Pa., uses a proactive feedback process that allows employees to ensure that the thousands of hours they spend doing PM are spent wisely.

Getting and using feedback

PM is simply the performance of regular maintenance—such as lubricating or replacing components—to keep equipment in good working order. A PM program identifies which equipment is critical for the safe and reliable operation of the plant and lists the type and frequency of the work to be performed. The Susquehanna PM program seeks feedback from the personnel who come in di-

Kenneth Hart (<kahart@pplweb.com>) is a Senior Engineer at PPL Susquehanna. This article is based on a presentation he made at the 2008 Utility Working Conference.

Ken Hart (right), senior engineer in charge of Susquehanna's preventive maintenance program (and author of this article), discusses with Jeff Crone, mechanical foreman, the maintenance to improve performance of the check valve internal hinge that Crone is holding.

rect contact with the equipment to help in making decisions about the type of work required and how frequently it needs to be done.

Two important pieces of feedback the PM program continually seeks are the "as-found" condition of equipment being worked on and the recommendations of the experienced craft workers who perform the work. Engineers use this information to evaluate the frequency and type of activities that need to be performed, and also to decide whether some equipment should be replaced with similar components made of higher-quality materials in order to minimize the demands placed on the PM program.

The Institute of Nuclear Power Operations (INPO) oversees several efforts across the entire U.S. nuclear industry to develop advanced processes. One such ongoing

Check valve parts with the condition code "E," for "extremely degraded"

effort—the Equipment Reliability Process, designated AP-913 by INPO—clearly identifies PM feedback as an integral part of the overall process. Many nuclear plants, however, gain few if any benefits from such feedback, and instead rely more on the automatic data filtering of the codes used to describe a component's as-found condition. That reliance requires that a PM process be reviewed only if several problems have occurred on the equipment or system undergoing maintenance and leads to overly general guidance regarding the activities that need to be performed.

By interviewing maintenance workers directly, engineers can better grasp the true nature of the condition code documented in the database and refine the PM activities. An additional benefit of the personal interviews is that maintenance workers better understand how their feedback is used and see that their expertise is valued. As a result, the feedback documented in the database is of high quality, and for the plant as a whole, the capability factors are higher, nuclear safety is improved, and fewer hours are spent on PM activities.

A check valve with improved material used on the hinge and fasteners

What feedback has done

A few examples of how feedback has improved the PM process at Susquehanna are as follows:

Extended time between PM work on fan belts—Susquehanna employees documented in a database the condition of numerous fan belts over a period of several years. By reviewing the condition codes, along with actual samples of old fan belts, employees were able to identify the key factors, such as belt size and fan speed, that lead to accelerated wear. Using that information,

employees were able to replace these fan belts with longer-lasting ones. This significantly extended the time between routine belt replacements.

Improved reliability of check valves—Reviewing the condition codes of check valves allowed employees to identify material that was prone to excessive corrosion. By reviewing the information provided by mechanics about the internal condition and clearance of the valves, the plant gradually replaced the internals of some of the valves with materials less prone to corrosion. The plant is able to tailor the timing of activities on specific valves. Those with less durable materials will undergo more frequent inspections, and those with more durable materials will be inspected less frequently.

Preventing unplanned battery charger failures—Although extending the length of time between PM activities is preferred, the constant feedback also allows plant employees to identify when more frequent PM is needed. During routine circuit board inspections, which occur every two years, Susquehanna workers found evidence of heat stress on several boards in battery chargers. That led them to add scope to an eight-year PM to replace the boards.

Identified correctable trend with lockout relays—Feedback from PPL's Relay and Test group led Susquehanna engineers to realize that what were initially thought to be random failures of lockout relays were actually a trend. They thwarted this trend with periodic lubrication and tightening of the relays that previously had not been done.

An engineering student (right) assigned to Susquehanna in a cooperative education program accompanies a plant worker in a maintenance activity. Students also conduct many of the feedback interviews.

Who finds the feedback?

Susquehanna's proactive approach to PM is fostered by the following:

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■ Strongly valuing maintenance craft expertise and the information provided from the equipment's as-found condition.
■ Maximizing face-to-face communication between the PM coordinator, often an engineer, and maintenance craft workers to encourage a continuing team effort, as well as providing a prompt reply to workers' suggested improvements.
■ Establishing an expedited process for reviewing and approving changes to the PM program that minimizes delays.
■ Developing performance indicators that measure the actual desired results of the program, rather than merely reporting a percentage of as-found conditions or numerical analysis of as-found codes.

Input from the Maintenance Department to define the equipment's as-found condition is only the start of the process. The use of simple condition codes—to represent Superior (like-new), Normal, Degraded, and Extremely Degraded—works effectively when combined with brief comments. The need to provide this level of detail does not place an undue burden on Maintenance.

Granted, face-to-face interactions take time, which becomes scarce during the few short weeks of scheduled outages, when more than half of the year's PM activities are performed. Over the past several years, Susquehanna has successfully tapped the talents of college interns (assigned to the plant as part of cooperative education) to help add substance to the program. With nominal training, the interns are able to supplement the information documented in the program by interviewing more craft workers than full-time personnel alone could have done. Interns are encouraged not only to dig into equipment history, but also to go into the field with workers and observe the work being performed. The interns then apply their engineering training to evaluate the PM task and provide recommendations. The interns reported that they found the work much more challenging and rewarding than the busywork they are often assigned.

The face-to-face discussions not only provide crucial information but also foster expanded communications, understanding, appreciation, and teamwork between the Engineering and Maintenance organizations as a whole. Maintenance feels that their expertise and knowledge are valued, and Engineering is better able to ensure that the right work is done at the right time.

Susquehanna has saved between 2000 and 3000 staff-hours of maintenance resources annually over the past five years without sacrificing safety or reliability. Of equal importance, about 20 significant equipment reliability improvements have been identified every year. Without the feedback process, most likely they would never have been found. NN