POWER Engineering®

Field Notes

Teresa Hansen, Section Editor

Xcel Energy Implements an Alarm Management Strategy

By John Bass, Xcel Energy and Guillermo Abreu, Emerson Process Management

When it comes to alarms associated with power plant operations, the adage "it is possible to have too much of a good thing" certainly rings true. The operators at Xcel Energy's Pawnee Station would definitely agree.

Not too long ago, this 505-MW coal-fired generating station located in Brush, Colo., was commonly generating hundreds of alarms during an eight-hour shift. With roughly 39,000 possible alarm combinations, it was clear that something needed to be done to bring this alarming situation under control. That "something" is an ongoing, dedicated alarm management program supported by management and operators alike.

Pawnee Station's experience mirrors what's happening inside control rooms throughout the power industry. A proliferation of alarms is overwhelming operators, which can, in turn, affect the safety of plant personnel and the efficiency of plant operations. In fact, alarms have been determined to be the root cause of several abnormal situations during plant operations. So it's no surprise that alarm management has become a hot topic among utilities.

At first glance, it seems logical that adding alarms would promote plant safety by quickly bringing potential issues to the attention of operators. This was not feasible when plants utilized hardwired controls, primarily due to the cost associated with wiring each alarm point. With today's distributed control systems, however, it is possible to quickly and cost-effectively add alarms that previously would not have been practical.

Not too long ago, Pawnee Station, a 505 MW, coal-fired generating station located in Brush, Colo., was commonly generating hundreds of alarms per shift. Photo courtesy Xcel Energy.

It's easy to see how alarms can quickly multiply. For example, alarm limits are often specified during control system design, but are rarely revisited for validity during actual plant operating conditions. Additionally, alarms tend to be constantly added but rarely deleted. In fact, the mindset "if it costs nothing, why not alarm it?" becomes an easy trap to fall into. The situation is often further exacerbated by inadequate operator training and poorly designed operator displays.

So while suppliers and power generators have understandably embraced alarm capabilities of control systems, if left unchecked and without a plant-wide alarm philosophy in place, the ease with which alarms can be added can become a double-edged sword.

How many alarms are too many? According to the Engineering Equipment and Materials Users Association (EEMUA), the average rate should not exceed six alarms an hour under normal conditions based on a 12-hour shift. During a transient condition or an engineered protection trip, the rate should not exceed 24 alarms per hour.

There are a number of other indicators, one or more of which should serve as a red flag that alarm management should become a priority. They include:

- Significant operating upsets generate an unmanageable number of alarms
- Minor operating upsets, as well as seemingly routine operations, generate a significant number of alarms
- Active alarms do not really require operator attention
- Some alarms remain active for significant periods of time
- When alarms activate, the operator is not sure of what to do about them, and
- When nothing is wrong active alarms occur.

Sounding the Alarm

Xcel Energy's Pawnee Station began commercial operation in 1981 using a combination of Westinghouse 7300 combustion controls, a Control Data Corp. data acquisition system, a Westinghouse boiler interlock and interposing relay system and a Forney burner management system. From 1991 to 1994 Xcel Energy replaced these controls, including much of the balance of plant, with an Emerson WDPF system. Changes to environmental regulations and plant operating conditions required another upgrade to further improve plant performance and, consequently, the company implemented a program that migrated its existing WDPF equipment to Emerson's Ovation expert control system.

Pawnee Station's control system modernizations enhanced plant operations and provided greater insight into equipment and processes. The installation of advanced control technologies also expanded the plant's ability to alarm equipment and processes. Operators would typically face 300 to 400 alarms during an eight-hour shift, which they would routinely acknowledge and silence. However, with so many alarms just determining which alarms required action and which were merely incidental was extremely difficult.

Reprinted with revisions to format, from the November 2007 edition of **POWER ENGINEERING**

Long-time operators had institutional knowledge, accumulated from years of experience, which enabled them to better manage multiple alarms. For instance, an operator might understand that "when I start this pump I'll get 12 alarms, but they don't require any action." However, this type of "on the job" knowledge is becoming more scarce—not just at Xcel Energy but throughout the power industry—as the Baby Boom generation retires and hands over the reins to less-experienced personnel.

Xcel Energy understood the importance of effectively utilizing alarms to help assure plant reliability and therefore approached the situation proactively. Several people who championed the cause made the case to management, who agreed to launch an alarm management initiative.

Based on real-world experiences designing, implementing, operating and maintaining an alarm management program at the Pawnee Station, the alarm management team, in conjunction with Emerson, developed a set of best practices that can be adopted across Xcel Energy's fleet of plants and also serve as a model for other utilities seeking to better manage alarms. According to these best practices, several key components are required for the development and ongoing implementation of a successful alarm management program. These components are:

Philosophy

Philosophy, according to Xcel Energy, is where it all begins. The alarm management philosophy is a defined strategy of what will alarm; how alarms will be annunciated, viewed, acknowledged and recorded; and ensuring that alarms are cleared either operationally or through the maintenance system. The philosophy is the roadmap for effectively implementing a successful alarm management program.

Determine Alarm Regions and Priorities

As a next step, Xcel divided the plant into regions then reviewed and assigned each point to a specific region based on areas of the plant, processes or operator responsibility. For example, at Pawnee Station, operators control the boiler system, feedwater system, condensate system, air system and fuel system in the main control room. They control the water treatment facility from a separate control room. Operators control the ash systems from a third control room and the coal handling systems from a fourth. At each control location, operators should annunciate and acknowledge only the alarms pertaining to those systems. After determining the regions, operators should define priority schemes by reviewing and assigning the proper significance to each alarm point.

Dead-band Management

Dead-band management is the proper adjustment of resets for both analog and discrete alarms, as well as proper configuration of incremental alarms. Alarm dead-bands must not allow the point to continually alarm, or "chatter," on normal process variations. For example, if a drum-level-low alarm occurs at minus 10 inches and the normal drum level "swing" is plus or minus one inch, then the dead-band would need to be greater than one inch.

Another variation used by Xcel Energy is time delays on alarms such as an oil temperature alarm on the pulverizer oil system. At Pawnee Station, oil temperature is maintained through cooling water controlled in an on/off control configuration: the cooling water valve opens at 100 F and the high alarm activates at 105 F. Because the cooling process takes about five minutes, the temperature sometimes reaches 105 F before it decreases. In this scenario, a short-time delay on the alarm prevents unnecessary annunciation.

Tackling alarm dead-bands can significantly reduce alarms. At Pawnee Station, dead-band management resulted in considerable improvements—enough, in fact, to get buy-in from some operators who were skeptical about the tangible impact an alarm management program would have. Consequently, these operators have become part of the continuous improvement process for maintaining the alarm management program.

Alarm Rationalization–Suppression and Delays

Alarm rationalization uses logic to prevent alarms for equipment that is not in operation. For example, if an operator stops a boiler feed pump, all alarms that could occur and that are associated with this operator action should be suppressed. These might include:

- Boiler feed pump stopped
- Boiler feed pump discharge valve closed
- Boiler feed pump suction valve closed
- Boiler feed pump vibration alarm
- Boiler feed pump bearing

Pawnee Station's control system generated hundreds of alarms during an eight-hour shift; there were 39,000 possible alarm configurations. Photo courtesy Xcel Energy.

temperature alarm

Alarm suppression is also useful for certain routine events. For example, if each day the continuous emissions monitoring (CEM) system automatically calibrates, alarms associated with the CEM system should be suppressed when the "in calibration" signal is present.

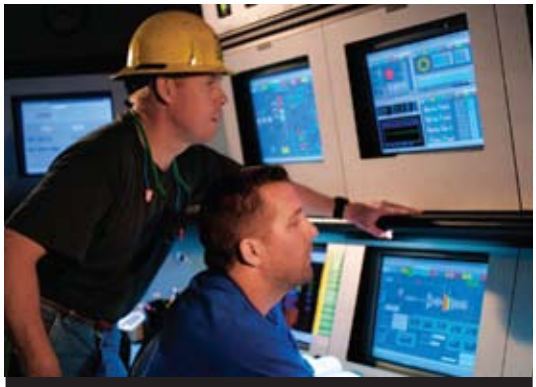
Operator Training

The experience at Pawnee Station demonstrated that for an alarm management initiative to be beneficial day in and day out, plant operators must understand the functions of each of the other key alarm management components: philosophy, dead-band management, alarm rationalization and more. What's more, operating procedures must be closely aligned with the alarm management program. This is accomplished through training that addresses the philosophy, the system's use and alarm response. To ensure operators are fully engaged, obtaining feedback throughout the alarm management program is an important aspect that should not be overlooked.

Power generators planning to implement an alarm management program should also use another valuable resource: the expertise of their control system supplier. For example, in addition to its work with Xcel Energy to define best practices, Emerson is rolling out a broad set of alarm management initiatives for customers who use its Ovation system. The tools—which allow plant personnel to analyze alarms, define and configure alarm strategies and further simplify alarm resolution—are designed specifically for its Ovation expert control system and are intended to be utilized as part of a utility's overall alarm management program.

Bottom Line: Don't Be Alarmed

So how do power plant personnel know if the alarm management program is working? A low alarm number is the best indicator of a good program. Today, Pawnee Station typically reports less than one alarm per hour or eight alarms per shift during normal operation—a dramatic drop from the hundred alarms it previously experienced and well below EEMUA guidelines. Moreover, the plant typically experiences fewer than 20 alarms per trip.



To ensure operators are fully engaged in an alarm management program, they must understand the importance in obtaining feedback from the alarms. Photo courtesy Xcel Energy.

Of course, these results did not happen overnight. A core team worked as many as 10 hours a week for approximately two years to thoroughly address each component. To ensure continued success, Xcel Energy treats alarm management as a continuous improvement process. For that reason, a member of the core implementation team spends an average of one or two hours a month reviewing alarms. The improvements have not gone unrecognized. The core alarm management team is sharing its expertise and lessons learned with other Xcel Energy power plants so that they, too, may benefit from the experiences at Pawnee Station.

While enhancing safety is a key benefit of an effective alarm management strategy, other important advantages exist, as well. Alarm management plays a role in reducing operator fatigue and stress, thereby contributing to increased productivity and job satisfaction. At Pawnee Station, for example, time spent by operators to respond to and silence numerous alarms can be applied toward other activities.

It's also important to note that operators are more confident. When an alarm does sound, they know something needs to be addressed and they can focus on the appropriate course of action.

Although alarm reductions don't show up on the balance sheet, per se, Xcel Energy realizes that a plant trip or equipment damage caused by the inability to appropriately respond to excessive alarms can have a real, negative economic impact. So from a financial perspective, by helping plants achieve higher levels of availability and reliability, an effective alarm management strategy does indeed contribute to bottom-line profitability.

Alarm management can be a vital component of a comprehensive strategy for achieving operational and financial improvement. Implementing an alarm management program can be a daunting challenge. However, instead of wondering, "Can we afford to dedicate the necessary resources toward this effort?" perhaps the better question for power generators to consider is, "Can we afford not to?" pe

EMERSON
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Emerson Process Management
Power & Water Solutions
200 Beta Drive
Pittsburgh, PA 15238
1-412-963-4000
1-800-445-9723
www.emersonprocess-powerwater.com