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Executive summary

Industry best practices call for pipeline operators to define a clear alarm management plan that helps avoid controller overload and ensures alarms are accurate and support safe pipeline operation. Review of controller workload is key in this program, as it can provide the most critical information on how to improve the performance of an alarm system and the controllers monitoring it. Controller performance can be impaired when deluged with too many SCADA alarms, a significant increase in the number of points being monitored and alarms related to communications, which all add to other attention-demanding activities not directly related to alarms.

Developing a program to analyze and continually improve the alarm system includes identification of the operator’s Alarm Philosophy: identifying what constitutes an alarm, who manages it, how it is managed and how training and change of management are carried out. Other best practices of an alarm management program include benchmark and performance audits; rationalization to determine which SCADA alarms warrant response; and implementation, in an auditable manner, of actions defined.

When implementing an alarm management improvement program, the highest benefit is realized through strategies that involve little advanced technology. These high benefit strategies include alarm storm reviews, tuning alarm settings on nuisance alarms and fixing known issues; adjusting deadbands of repeating alarms; and eliminating alarms with no defined response. Strategies of medium benefit include suppression of alarms from ‘out of service’ stations; replacing absolute alarms with deviation alarms; and filtering, de-bouncing, or suppressing repeater alarms. Other advanced alarm improvement strategies that can provide additional benefit after initial strategies have been implemented include use of dynamic alarm thresholds, operator-set alarms and operational mode suppression. Tracking improvement in the alarm program after modifications are made is important, especially as operations bring in larger point counts.

Schneider Electric actively participates in industry alarm management programs to assure its advanced-technology Control Room Management solution targets best practices and meets new regulations for improved alarm management in the pipeline sector and other control implementations.
Supervisory control and data acquisition (SCADA) system alarms are a key tool for managing pipeline operations and maintaining safe operations. However, the number of alarms generated can be excessive, overloading controllers and creating a significant safety hazard, making proper alarm management a necessity.

The definition of alarm management centers around two major components — managing the notifications generated by the SCADA system and developing a program to analyze and continually improve the alarm system. In other words, reducing the number of false alarms and improving the management of actual alarms to reduce controller load.

In building an alarm management program, pipeline operators have both industry best practices and regulatory requirements to guide them. The following addresses these guidelines: how to implement them, and the technical solutions available to create an effective program and ensure compliance with all rules and regulations.

**U.S. Regulatory Framework**

The United States serves as an excellent model for the regulations operators face due to its clearly defined standards and statutes. The U.S. Department of Transportation’s Pipeline Hazardous Materials Safety Association (DOT-PHMSA) issued its control room management Human Factors Rule on February 2, 2010. All regulated gas and hazardous liquid pipelines that have at least one SCADA system or Distributed Control System (DCS) controller and control room are affected by this rule.

The primary goal of this rule is to assure that operators are providing the necessary training, tools, procedures, management support, and environment to allow the controller to effectively support safe operation. This includes key features of control room management such as clear and accurate SCADA displays, a manual operating plan, backup SCADA system testing, shift turnover protocols, controller fatigue prevention, and an alarm management plan.
Safer control rooms through best practices in alarm management
Control room management best practices today

A wave of recent pipeline incidents has many countries evaluating the way they oversee pipeline operations. Recent regulation changes affecting major gas producers and pipeline oil and gas transmission companies internationally call for the review and rationalization of operator processes for control room management (CRM). This has raised interest in the state of equivalent regulations and best practices as they apply across the world. This includes the United States, who passed new control room management regulations in 2010, adding a new emphasis on alarm management and increasing agency oversight. While pipeline operators benefit from proper alarm management through increases in operational efficiencies and performance, keeping pace with regulatory compliance is mandatory.

Alarm management requirements

While every country differs, many require, and industry best practices dictate that pipeline operators define a clear alarm management plan with the primary goals of avoiding controller overload and ensuring alarms are accurate and support safe pipeline operation. Operators should have a written plan that includes the following:

• A review of SCADA safety-related alarm operations.

• Once a month, identify points that have been taken off scan, had alarms inhibited, generated false alarms, or have needed maintenance.

• Verify alarm values and descriptions once a year.

• Annual plan review to determine its effectiveness.

• Annual review of controller load.

• Address any deficiencies identified.

While each of these components provides essential value, it is the review of controller load that often provides the most critical information on how to increase the performance of an alarm system and the controllers monitoring it.
What affects controller workload?

**Too many SCADA alarms**
Adding alarms in SCADA is relatively inexpensive and easy. SCADA systems make it easy to make configuration changes at the host without necessarily requiring any form of field intervention.

The ability to easily change configurations and add points is a tremendous benefit to the end user. However, with the ability to create up to ten alarms at each of the thousands of points in the pipeline system, alarm proliferation is all too easy and can overload the controller.

**Significant increase in number of points monitored**
It is common to see the addition of more points, through organic growth, mergers and acquisitions, or bringing in a new pipeline from another operator with alarm limits that were not based on your original philosophy.

Adding more alarm points with new configurations alters the balance of an existing alarm management philosophy. As this type of increase in points occurs, it is critical that operators go back and properly rationalize these new points as well as manage the increased load for operators.

**Communications related alarms**
One of the more challenging aspects of SCADA and alarm management is communications. Interruptions to the communications network can create little alarm “bursts” when the communications are restored and in some cases cause the re-generation of alarms.

This increase in alarm activity can distract operators from safety-related alarms. To counter this, operators need to work on ways to improve communication infrastructure where possible to reduce SCADA specific communication alarms.

**Alarm load is only one measurement of controller activity**
In addition to alarm load, it is important to look at full controller load, including phone calls, interruptions, shift change and all the other tasks associated with the control room. These can contribute significantly to overloading the controller with information and distractions.
Building an alarm management program

There are several steps to building a successful and compliant alarm management program that pipeline operators should follow. Developing best practices for operation of any specific pipeline is a continuously repeating process of evaluation and audit that considers:

- **Alarm Philosophy**
- Measurement, through benchmarking, and performance audit
- Rationalization (rules of engagement), including identification of the ‘bad actor’ and cleanup of repeat offender
- Dynamic and state-based alarming, including parent/child suppression
- Implementation
- Continuous improvement
- Management of change

**Alarm Philosophy**

An Alarm Philosophy shapes and guides an alarm management program. It is a performance-based written plan that describes your executive mission statement for your program, the owners of the program, and owners and responsibilities for the actual alarm program.

A philosophy would include:

- **Purpose**—why do you have an alarm management program and what do you expect from it?
- **Definition**—what do you consider an “alarm”? Does it signal an event that requires action, or does it merely signal development of a deviation from normal?
- **Executive mission statement**—important for executive buy-in because of the costs associated with alarm management.
- **Ownership**—who is responsible for alarm management? Clear roles and responsibilities must be laid out.

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Operator plans should reflect industry best practices

Operator plans should reflect the industry standards and guidelines ‘recognized as good engineering practice’ (RAGEP):

- **International Standards Association (ISA) SP 18**—industry standards
- **API RP 1167**—pending publication
- **American Gas Association (AGA) recommended practices issued by its Gas Control Committee**
- **Various industry publications**:
  - **EEMUA 191**
  - **“Alarm Management of Process Control” by Douglas H. Rothenberg**
Building an alarm management program (continued)

- Alarm documentation and rationalization—includes process, methodology, preparation, alarm priorities, alarm set-points and information storage (master alarm database).

- Alarm audits and performance monitoring—how are audits to be conducted, by whom, and what indicators are considered?

- Management of change—documentation of how notification and training are conducted.

Operators can refer to pipeline industry associations and alarm management experts and published reference material for recommended practices and assistance in defining and documenting an individual Alarm Philosophy. Three examples of alarm management reference and guidance documents include EEMUA 191, API RP 1167 and ISA SP 18.

**Benchmark and performance audit**

Operators want to see continuous improvement in their alarm management program. To do that, benchmark alarm activity levels need to be measured and referenced against current levels over time. By creating dashboards in the SCADA system that monitor these values, operators can compare current alarm levels with historic performance (e.g., this shift versus last shift, this week versus last week, etc.) for a continual performance audit.

**Rationalization**

A primary function of alarm management is to determine which alarms need responses and which are repetitive or “bad actors.” A common control industry for an alarm is a notification that requires a response. The rationalization process is a point-by-point review of the pipeline system to determine which SCADA alarms do, in fact, require a response and developing a prioritization level for them. As well as documenting the appropriate response to the alarm once it has been verified.

It is during this review that operators begin to develop a clear picture of the alarm system. Rationalization provides the information needed to begin the implementation phase of the alarm management plan.
Building an alarm management program (continued)

Implementation
As the rationalization process takes place, the most egregious “bad actors” will be identified relatively quickly and operators can take immediate steps to address them. After dealing with this “low hanging fruit,” alarm levels will drop off and allow operators to begin looking for more subtle alarm issues. This is an ongoing process and can be dependent on the guidelines used in crafting the Alarm Philosophy.

All of this needs to happen within an audited program, so that when you need to make a change to an alarm limit, you can prove that any changes to the operating procedures were communicated to the controllers and well documented.

Alarm management improvement strategies

As operators enter the implementation phase, there are a variety of resources available to guide the process. When working with customers, Schneider Electric follows guidelines such as what is published by the Engineering Equipment and Materials Users’ Association (EEMUA 191). In an effort to prioritize the strategies based upon the resulting improvements to system performance, the EEMUA recommends applying first basic, then advanced techniques to achieve the necessary improvements.

Based upon this process, the following strategies should be considered in approaching an alarm management improvement process—

Highest Benefit
These strategies, while providing the highest value, involve little advanced technology, having more to do with reviewing alarms and adjusting alarm settings properly:

• Review alarm storms to determine noise vs. value—a true system upset can generate a storm of alarms, not all of which are valuable to addressing the area of concern.

• Tune alarm settings on nuisance alarms, fix known issues—many times, operators and controllers have identified chattering alarms or alarms resulting from broken field equipment and just ignore them. These are easily identifiable fixes.
Alarm management improvement strategies (continued)

- Adjust deadbands of repeating alarms—adjusting or adding a deadband to reduce noise.

- Eliminate alarms with no defined response—as stated before, an alarm is defined as an event with a defined response. Identified alarms with no defined response should be given a low priority setting. These alarms can also be changed to alerts.

- Ensure alarm priorities are correctly assigned

- Introduce Alarm Shelving—rather than turning off alarms, lower priority alarms can be shelved, marking the controller as acknowledging the alarm but being held for later action so as to clear alarm noise.

- Introduce single line annunciation of repeating alarms—rather than generating repeating notifications from the same alarm, one alarm is generated with a counter showing the number of times it has been triggered.

Medium Benefit

- Suppress alarms from “out of service” stations—stations that are offline, during calibration for instance, may generate many nuisance alarms. These alarms can be grouped and suppressed on the display.

- Replace absolute alarms with deviation alarms—setting alarm triggers as a deviation from an acceptable range rather than a set point.

- Eclipsing—if one alarm goes from a lower priority to a higher priority, rather than leaving both alarms displayed the lower priority alarm is eclipsed.

- Apply filtering, de-bouncing, suppression on repeating alarms—alarms can be filtered into various classes that suppress repetition.

- Using logic to combine redundant sets of alarms—grouping similar alarms that require the same action or denote a pattern and eliminating all but the most critical.
Alarm management improvement strategies (continued)

**Additional Future Benefit**
There are additional advanced alarm improvement strategies that can be applied once the highest and medium benefit strategies have been implemented. They include using dynamic alarm thresholds, operator-set alarms, and operational mode suppression.

**Tracking improvement**
As these strategies are implemented and reviewed over time, operators should be able to see not only a reduced number of alarms but a general improvement in safety and performance of the alarm system, as well as more efficient control room operation overall. Schneider Electric customers that were skeptical at being able to achieve an alarm rate of six to ten alarms per hour just a few years ago, are now seeing significant drops in their alarm loads as they continue to refine their alarm management program. It is important that these performance measures are tracked carefully, especially as operations are scaled up into larger point counts.

**Schneider Electric solutions and expertise are always updating**
As a leading provider of oil and gas pipeline solutions, Schneider Electric is constantly working to improve its products and services to ensure the company continues to provide benefits valued by the end user and assist them in keeping up with the changing business and regulatory climate. Schneider Electric participates on industry alarm management committees to ensure its products are well positioned to meet any new regulations for improved alarm management in the pipeline sector as well as other control industries. In addition, Schneider Electric utilizes customer feedback to a high degree to ensure its products are responsive to customer needs.

As a result, Schneider Electric offers a control room management solution that helps operators implement not only the best practices critical to alarm management but also for other control room functions, supporting efficient, secure and compliant operations.
Effective alarm management in a nutshell:

SCADA alarms are necessary for effective and safe pipeline operations. Yet the industry advises that operators carefully assess how much alarm is too much for its particular infrastructure and operations. Excessive alarms can overload controllers and actually undermine safe operations.

Best practices in control room management and alarm management help the operator implement a program to analyze and continually improve the alarm system for better pipeline safety and operational efficiency.