

Performance Benchmarking and Alarm Philosophy Development



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Introduction

This white paper defines the scope of Benchmarking and Philosophy Development and how they integrate with the other ANSI/ISA 18.2 stages.

Performance Benchmarking is absolutely necessary for improving an existing alarm management system. Measuring the state of the current alarm system, and then comparing it with the objectives and goals established to enhance the system is called Gap Analysis, which identifies the actions required for alarm system improvement.

Information obtained in the Gap Analysis often uncovers areas in the existing alarm system that should be addressed when developing the Philosophy Document. It should be noted, however, that when implementing a new distributed control system (DCS), developing a Philosophy Document is often the initial step toward ISA 18.2 compliance.

As explained in the first white paper in this series, the common alarm management issues – alarm loads, nuisance alarms, bad actors, and redundant alarms – can be immediately and economically addressed through the Monitoring & Assessment entry point into ANSI/ISA 18.2. This first step provides credibility and inertia toward implementing a comprehensive alarm management system as resources and time permit.

This three-part white paper series will cover these areas in the 18.2 lifecycle stages:

1. **Monitoring & Assessment** – A limited, but effective, program of nuisance/bad actor alarm elimination.
2. **Performance Benchmarking and Philosophy** – Benchmarking includes alarm analysis, operator analysis, and gap analysis. The Philosophy stage results in a document that details the recommended approach to how a company addresses alarm management through all stages of the lifecycle.
3. **Rationalization and Implementation** – Rationalization is the process of reviewing and justifying alarms that meet criteria that are established in the Philosophy Document. Implementation includes all infrastructure changes to support a new alarm system or modifications to an existing alarm system.

Following the steps and guidelines included in this white paper helps ensure that the critical issues for alarm management improvement are identified during the Benchmarking stage. The Philosophy Document provides the steps for completing and documenting the remaining processes in the 18.2 lifecycle as addressed in the third white paper of this series..

Overview of ANSI/ISA 18.2 Lifecycle

The ANSI/ISA 18.2 standard was developed to help the process industries design, implement, operate, and maintain effective alarm management systems.

Figure 1 illustrates the 18.2 lifecycle. It provides workflow processes and common alarm management terminology. Like any other well-defined engineering process, the alarm management lifecycle requires a:

- Written philosophy that states alarm management goals and objectives
- Documented engineering process to determine alarms
- Continuous improvement environment by maintaining, auditing, monitoring, and assessing the alarm system

In all process industries, safety is paramount. Because a faulty alarm system can contribute to process accidents, using the 18.2 standard helps improve safety and incident prevention, reduce unplanned downtime, and improve regulatory and best practices compliance. Adhering to the standard helps achieve the following alarm management goals:

- All alarms are configured to require an operator response or there is a consequence
- A thorough process is developed to help ensure alarms are defined and prioritized
- Alarms must be presented at a rate to which operators can respond
- It must be clear when the alarm system is not performing as intended

The 18.2 standard was developed to help engineering and technical staff identify ways to improve alarm management systems. It excludes information about how to implement and/or improve these systems in the most effective and economic manner.

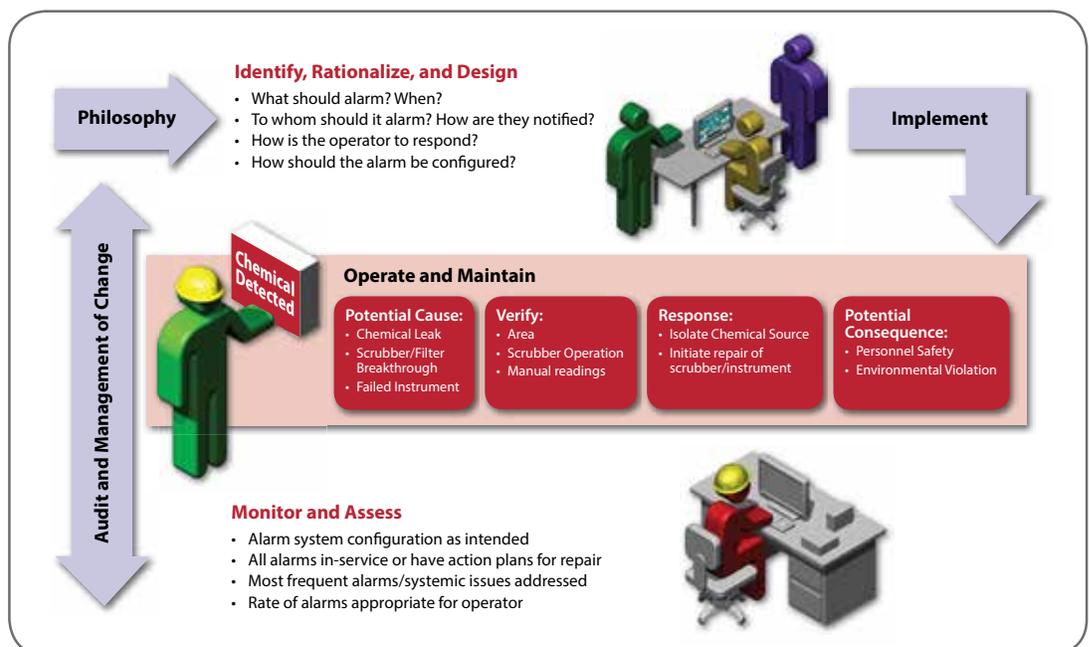


Figure 1

Benchmarking: Identify the Gaps Between Current System Performance and Requirements for ANSI/ISA

18.2 Compliance

Benchmarking and analysis are fundamental to improvement. It is impossible to improve an alarm system without thorough analysis and a comprehensive baseline report that benchmarks initial performance for ongoing comparison.

Effective benchmarking helps identify the alarm system's most pressing issues and systematic design problems. The leading causes of alarm management issues are poor design and incorrect configuration. To help ensure that benchmarking is successful, it is necessary to document the cause, potential consequence, and response time for each identified alarm. This helps highlight needed improvements that are most critical to operators.

The three steps to benchmarking are:

- Alarm Analysis
- Operator Interviews
- Gap Analysis

To establish an adequate baseline when benchmarking, at least 30 days of alarm system data should be gathered. Every operational plant area needs to be analyzed.

The goal is to evaluate key performance indicators (KPIs) and design a system that meets alarm system KPIs as established by the ANSI/ISA.2 standard.

An operator's response to an alarm is subject to various human factors. These include how the operator detects and silences an alarm, navigates the system to ascertain and verify the reason for the alarm, takes actions to address the situation, then monitors the system to ensure that the correct actions were taken. Operators are often inundated with alarms and sometimes, out of necessity, ignore some to them. That can lead to accidents.

How many alarms can an operator effectively handle per day? ISA 18.2 states that, ideally, one alarm per 10 minutes can be taken care of without sacrifice to the operator's other duties. Two alarms per 10 minutes are identified as manageable. (See Figure 2)

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The first white paper in this series addressed bad actors – such as chattering, fleeting, duplicate and stale alarms – to reduce the number of alarms in an overloaded alarm system. FactoryTalk® Vantage Point® software, from Rockwell Automation, was used as a case history example to illustrate how bad actors are identified and what steps were put in place to eliminate them. Benchmarking is the next level in the alarm analysis process.

Alarm Performance Metrics		
Based upon at least 30 days of data		
Metric	Target Value	
Annunciated Alarms per Time:	Very Likely Acceptable	Maximum Manageable
Annunciated Alarms per Day per Operating Position	150 alarms per day	300 alarms per day
Annunciated Alarms per Hour per Operating Position	6 (average)	12 (average)
Annunciated Alarms per 10 Minutes per Operating Position	1 (average)	2 (average)
Metric	Target Value	
Percentage of hours containing more than 30 alarms	<1%	
Percentage of 10-minute periods containing more than 10 alarms	<1%	
Maximum number of alarms in a 10 minute period	≤10	
Percentage of time the alarm system is in a flood condition	<1%	
Percent contribution top 10 most frequent alarms to overall alarm load	<1% to 5% maximum, with action plans to address deficiencies	
Quantity of chattering and fleeting alarms	Zero, action plans to correct any that occur	
Stale Alarms	Less than 5 present on any day, with action plans to address	
Annunciated Priority Distribution	3 priorities: 80% Low, 15% Medium, 5% High or 4 priorities: 80% Low, 15% Medium, 5% High, <1% "highest" Other special-purpose priorities excluded from the calculation	
Unauthorized Alarm Suppression	Zero alarms suppressed outside of controlled or approved methodologies	
Unauthorized Alarm Attribute Changes	Zero alarm attribute changes outside of approved methodologies or MOC	

Figure 2

Alarm Analysis

During an alarm analysis, the alarm rate to be measured is the operator alarm rate at each individual station. Using alarm analysis software to access and evaluate alarm history data is critical to identifying exact alarm metrics and issues so the most efficient solutions to alarm problems can be implemented.

The alarm performance targets shown in Figure 2 are ambitious, but necessary for making major improvements to an alarm management system.

The ISA 18.2 standard acknowledges that the target metrics are approximate and are affected by many factors, such as the process, operator experience, HMI design, degree of system automation, and the degree and significance of alarms produced. These 18.2 alarm performance metrics provide the foundation of the Benchmarking stage and the targets for achieving 18.2 compliance.

There are several ways to analyze how many alarms are sounding, the number of stale alarms, and frequently occurring alarms at each operating position during a specified period. Using standard alarm reports provided by most distributed control systems is a good first step. For example, the Rockwell Automation FactoryTalk VantagePoint reporting software cited above provides standard out-of-the-box, web-based Alarms and Events reports, including:

- Average Number of Alarms/Day (See Figure 3): The average number of alarms per day is the most efficient measurement for determining the overall status of an alarm system. ISA 18.2 recommends measuring and targeting "Very Likely Acceptable" (150 alarms) and "Maximum Manageable" (150) for each operator. A quantity more than this is too much for a single operator to handle.

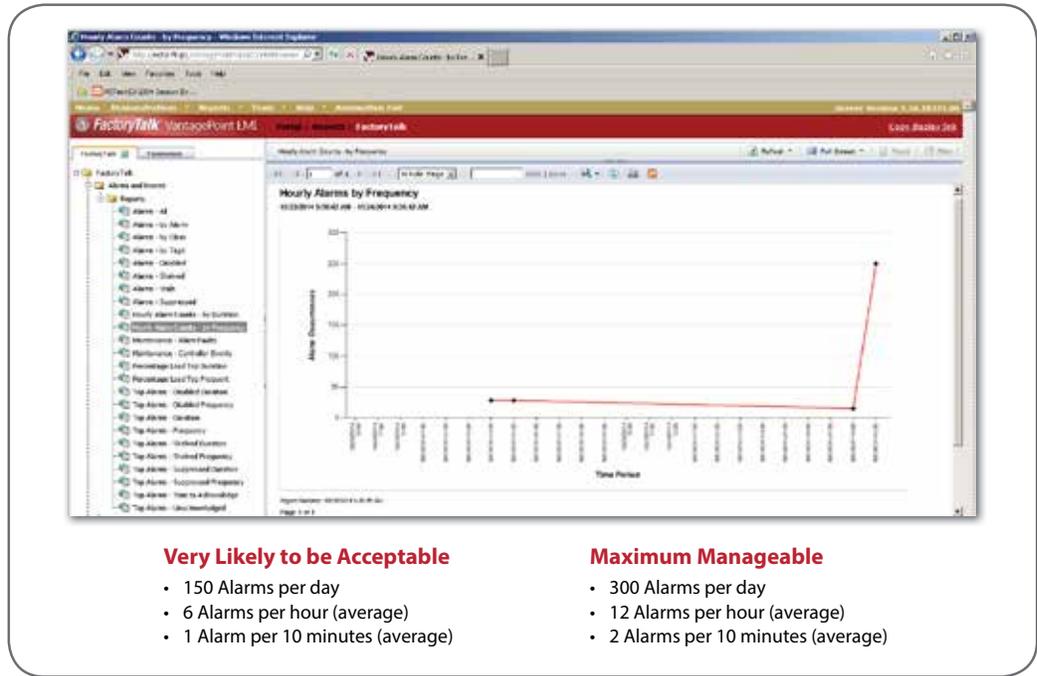


Figure 3

- Stale Alarms (See Figure 4): These alarms remain in the alarm state for an extended time. The target value per ISA 18.2 is five on any given day, with action plans to reduce this number. Stale alarms remain on HMI displays and impact an operator’s efficient response to legitimate alarms as they occur.

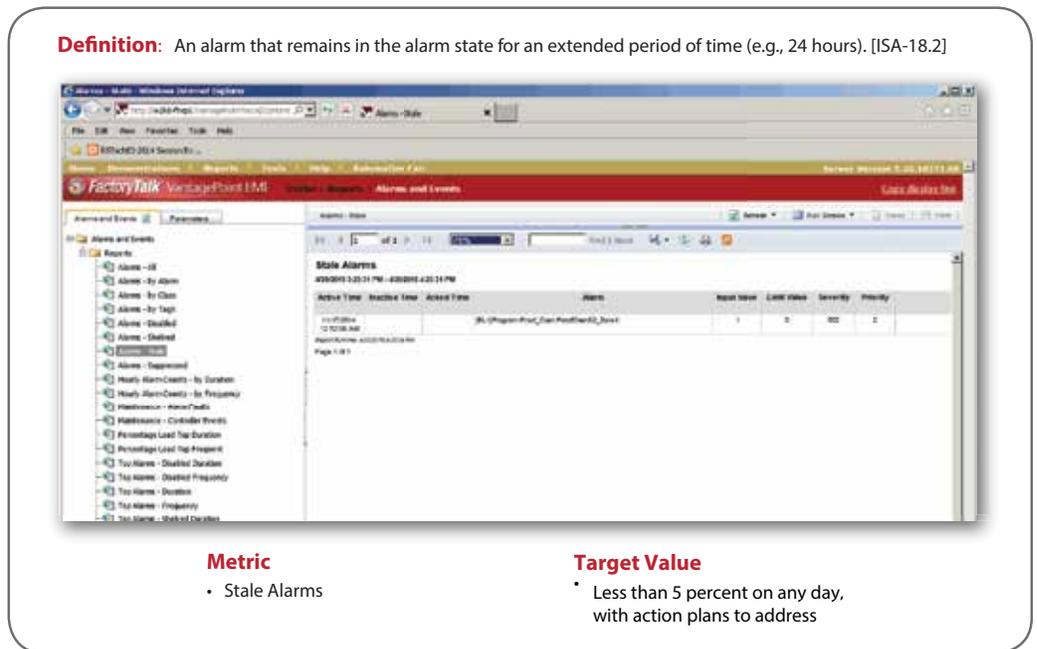


Figure 4

- Frequently Occurring Alarms (See Figure 5): As illustrated in the first white paper in this series, frequently occurring alarms account for the top ten most frequent alarms in a specified time period. The goal is to reduce these alarms to less than five percent of the total during a 30-day period.

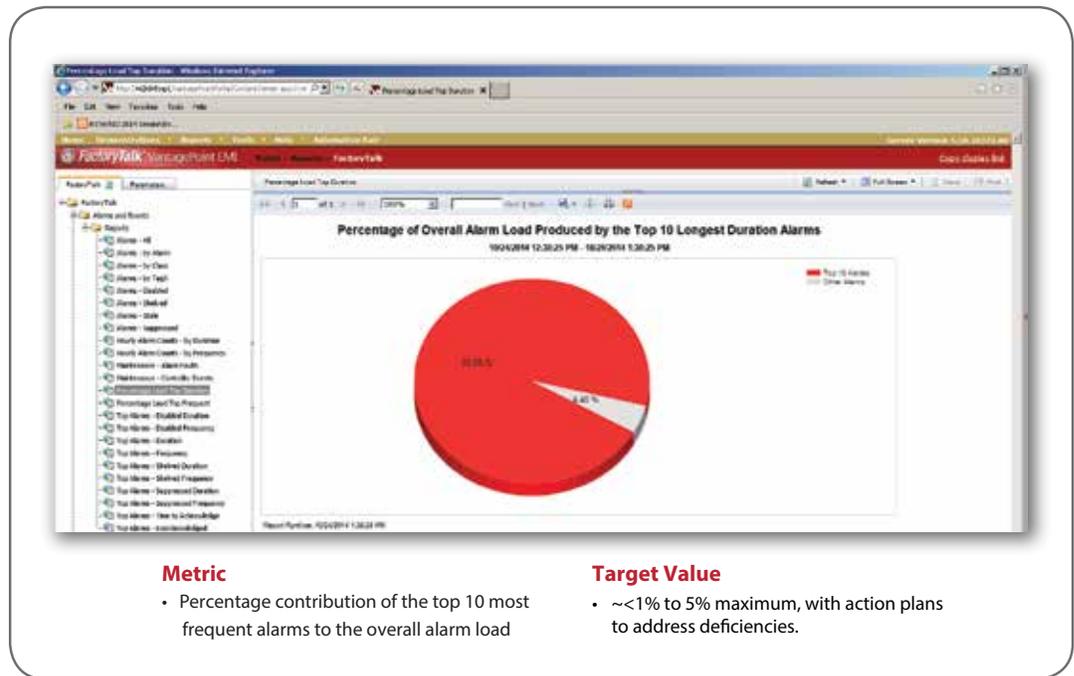


Figure 5

Operator Interviews

Operator surveys and follow-up interviews provide qualitative feedback from the actual users of the alarm system. Typical surveys include questions about:

- Operator experience
- Amount of DCS training
- Support provided by the alarm system during normal operation
- System performance during plant faults and trips
- Alarm system design
- Alarm management processes and procedures
- General questions requesting recommendations to improve the alarm management system

Asking multiple operators questions such as: “On average, how many alarms are displayed on the alarm summary list continuously for more than 24 hours?” will get numerous responses. In this example, operators responded from 15 to 200, and in one case, up to 1,000, indicating that stale alarms are a significant issue. The ISA 18.2 target is less than five on any given day. These operators were also asked: “What percentage of alarms are for information only (and do not require you to take action)?” Again, responses varied from a low of 20 percent to a high of 90 percent. The variety of answers illustrates one of the reasons benchmarking data must be gathered for every operator

workstation to help ensure comprehensive and accurate data.

Figure 6 provides a sample of operator survey topics and questions included in the Operator Survey developed by Exida, a nationally recognized provider of alarm management solutions for process automation systems, that partners with Rockwell Automation on PlantPAx Alarm Management Implementation projects.

Another source for viewing a complete sample Operator Survey is Appendix 3 of Alarm Management for Process Control by Douglas H. Rothenberg. [2]

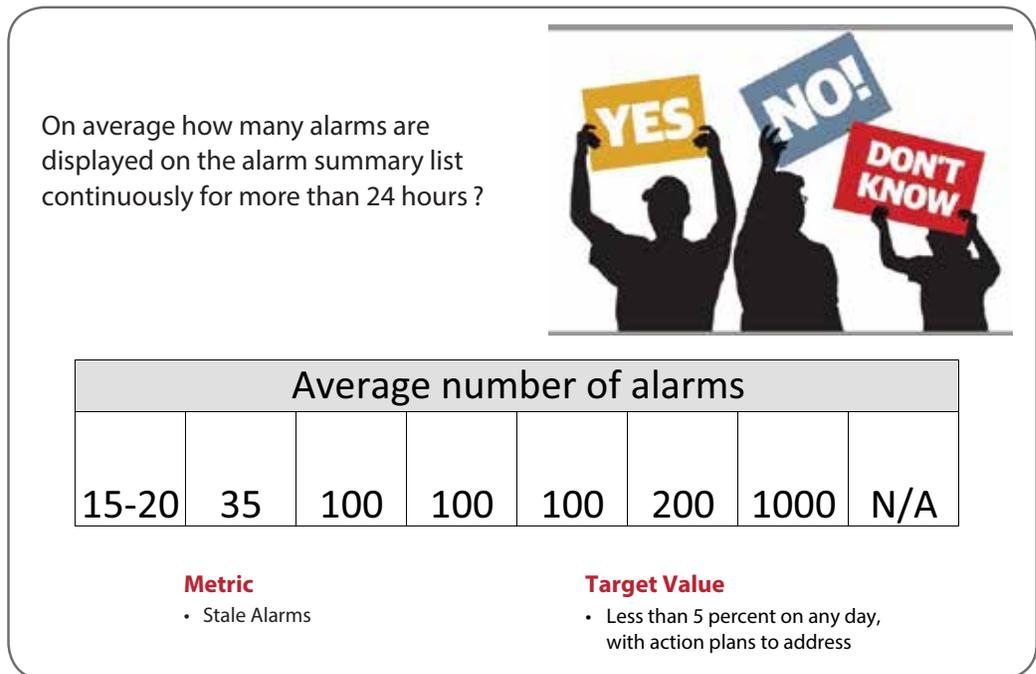


Figure 6

Gap Analysis

Benchmarking through alarm analysis and operator interviews provides the required information about the current performance of the alarm system for comparison with the Alarm Management Performance KPIs. The difference between the current situation and goals set for meeting ISA 18.2 requirements determines the gap to be filled for compliance. (See Figure 7).

The Gap Analysis identifies the most pressing issues to be addressed to update the alarm system to meet the 18.2 standard, and any systematic design problems. It also highlights desired improvements that are most critical to operators. The identified issues, problems and areas for improvement provide a large share of the source material for developing the Alarm Philosophy Document.

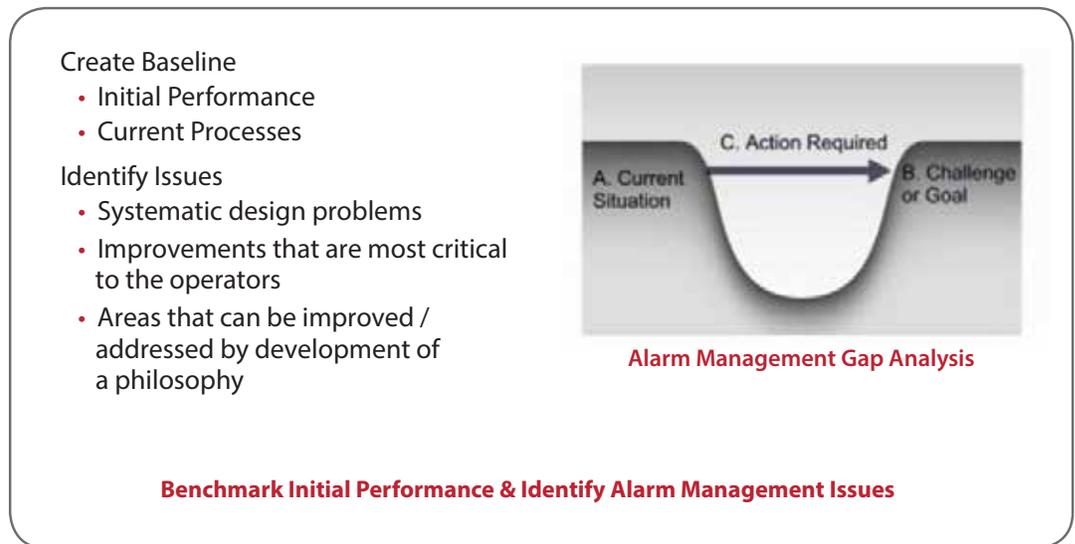


Figure 7

Alarm Philosophy Document Development

In the scenario proposed in this series of white papers, the Monitoring & Assessment entry point is the starting point for 18.2 alarm management for existing systems. As illustrated, using this entry point for an existing system provides immediate and cost-effective improvement. Once alarm system benchmarking and gap analysis have been completed, the next step to maturing the alarm management program is Alarm Philosophy Development. When implementing a new alarm management system, the entry point into ISA 18.2 is Alarm Philosophy Development.

The Alarm Philosophy Document defines how a company will address alarm management throughout the entire ISA18.2 lifecycle. It provides guidance for defining alarm management roles and responsibilities, establishing alarm definition and selection methods, determining design configuration, performing the alarm rationalization, and providing documentation and training. These are the major aspects of alarm management criteria to be included in the Philosophy Document for either the redesign of an existing system or the initial design of a new system.

Figure 8 lists the ISA 18.2 requirements for Alarm Philosophy contents.

The 18.2 standard requires specific steps for inclusion in the Alarm Philosophy document. These steps should be tailored to each alarm management system project. Every processing facility has its own goals and objectives. For example, the key steps in an Alarm Philosophy Document for a Rockwell Automation PlantPax system would include:

- Roles and Responsibilities
- Operator Notifications: Alarms vs. Alerts and Messages
- Alarm Prioritization
- How to Treat Diagnostic Alarms
- Alarm Classification
- Defining and Measuring KPIs
- Use of Alarm Shelving (Manual Suppression)

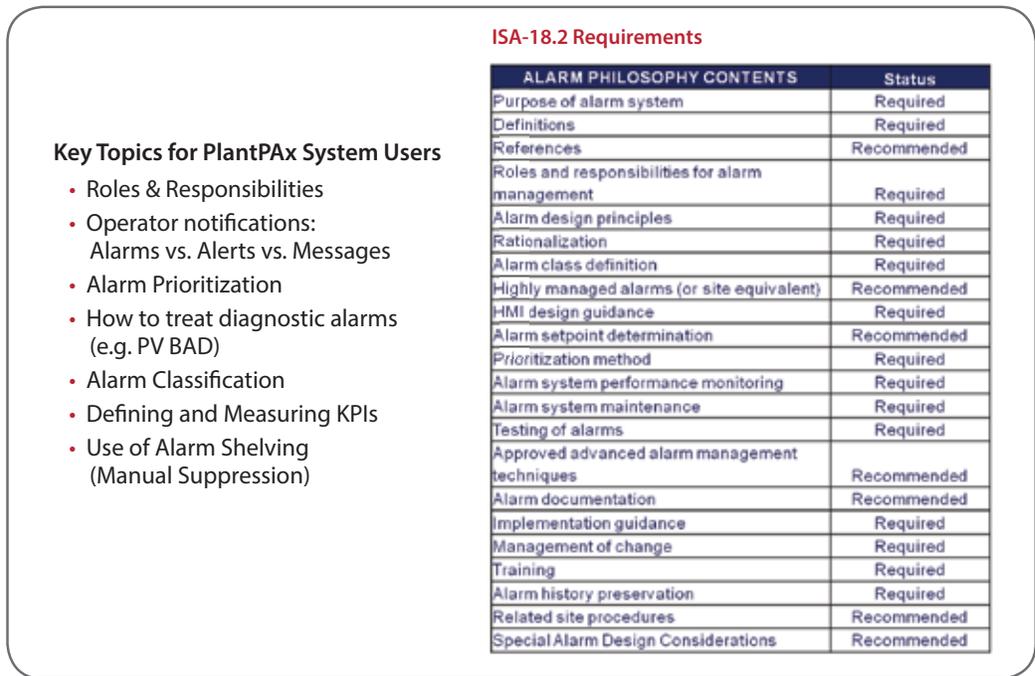


Figure 8

The Philosophy Document should define an effective alarm management program that complements the plant and facilitates efficiency.

Roles and Responsibilities – The Philosophy Document is the primary source for all team members associated with the Alarm Management System project. It provides definitions of the roles and responsibilities of team members, procedures, and key performance benchmarks.

The goal is to implement a system that helps operators make the right decision at the right time when responding to an alarm.

Alarms, Messages, and Alerts – There is a significant difference between alarms versus alerts and messages. Simply, an alarm requires an operator response. A message provides system status information, and an alert informs the operator of an abnormal process or equipment condition. While message and alert notifications contain information about system status, they don't require immediate operator response; an alarm does. An alarm informs the operator of an abnormal process and/or equipment condition that requires an immediate action to bring the process back into a safe and productive status.

Alarm Prioritization – As illustrated in Figure 9, prioritizing alarms is based on consequences of inaction and operator urgency (time to respond). Impact areas are Personnel, Environmental, and Financial, with consequences rated from none to severe. Operator urgency is rated from Not Urgent to Immediate. Alarm priorities should be based on these guidelines.

How to Treat Diagnostic Alarms – Common during the installation of a new system, diagnostic alarms also occur during start-up of an existing system that was shut down for maintenance. These alarms indicate a fault in the control system, are a source of nuisance alarms, and are often confusing to operators. During Alarm

Consequences of Inaction				
Impact Areas	Consequence Category 1 (None)	Consequence Category 2 (Minor)	Consequence Category 3 (Major)	Consequence Category 4 (Severe)
Personnel	None	Minor or no injury, no lost time.	One or more severe injury(s).	Fatality or permanently disabling injury.
Environmental	None	Minor	Release which results in agency notification, permit violation or fine.	Significant release with serious offsite impact.
Financial	None	Impact to equipment or production <\$50K.	Impact to equipment or production \$50K to \$500K	Impact to equipment or production > \$500K
Operator Urgency (Time to Respond)				
Not Urgent (> 30 mins)	No Alarm	Re-engineer the alarm for urgency		
Prompt (15 to 30 mins)	No Alarm	Medium	Medium	High
Rapid (5 to 15 mins)	No Alarm	Medium	High	Highest
Immediate (< 5 mins)	No Alarm	High	Highest	Invalid (redesign)

Figure 9

Rationalization, it may be determined to screen these alarms from operators and send them directly to maintenance personnel, or to route them to a separate diagnostic display. If, however, the Rationalization process establishes a method to prioritize diagnostic alarms, it is recommended to set their priority similar to the other alarms from the tag. For example, if the worst priority from the other alarms is low, there is no need for the diagnostic alarm to have a high priority.

Alarm Classification – This process identifies groups of alarms with similar characteristics and common requirements. Alarm characteristics include environmental, safety, building/facility-related alarms, and diagnostic alarms. Common classification requirements include such categories as periodic testing, periodic operation and staff training, as well as documentation and reporting requirements. Alarm classification will be addressed in detail in the third white paper in this series.

Defining and Measuring KPIs – The Philosophy Document incorporates benchmarking data to establish alarm system KPIs for performance and diagnostic metrics. Targets are established as well as action limits and frequency of reviews to ensure acceptable performance. KPIs can be measured and analyzed using software such as Rockwell Automation FactoryTalk VantagePoint.

Use of Alarm Shelving (manual suppression) – This is a mechanism, typically initiated by the operator, to temporarily suppress an alarm for a variety of reasons. Shelving helps prevent alarms from being suppressed for extended periods. The Philosophy Document establishes which alarms can be shelved; by whom, when, and for how long; and which alarms cannot be shelved. Shelving procedures should be put in place, including approval process, reasons for shelving, and a review list at shift change.

Using the Alarm Philosophy Document

In addition to the tasks described above, the complete list of items that are listed in Figure 8 should be considered for inclusion in the Philosophy Document. Alarm Philosophy Document Development is the only way to significantly improve an existing system. It is recommended that both the internal plant team and outside experts – with significant alarm management experience, detailed knowledge of process control, and in-depth knowledge of the process industries – work together during the 18.2 lifecycle compliance project.

The Philosophy Document contains the rules and guidelines for alarm selection and creation, classification, prioritization, configuration, handling methods, operator interface and response to alarms, as well as performance monitoring and management of change procedures. Implementing the stages that are established in the Philosophy Document transforms/prevents an overloaded alarm system and raises performance levels of the system as each stage of the 18.2 lifecycle is implemented.

As shown in the first white paper, managing the bad actor alarms during Monitoring & Assessment (See Figure 10) can quickly transform an overloaded DCS to the Reactive status, which is certainly an improvement. But this is only a beginning. In Reactive status, the alarm system functions at the stable level during normal operation, but slips back to overload status during abnormal situations.

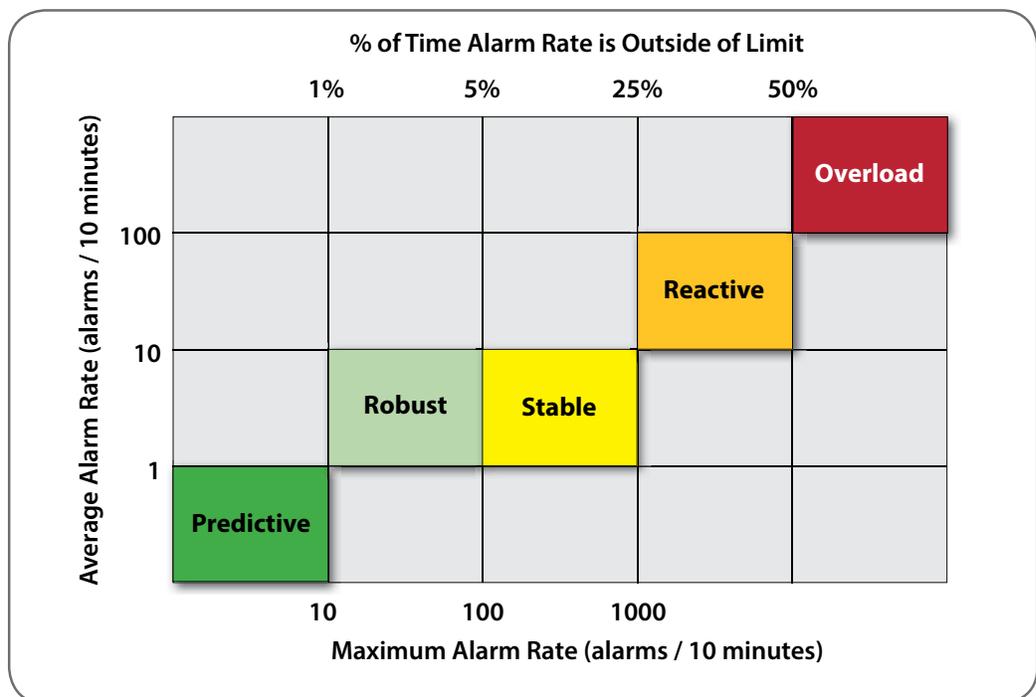


Figure 10

Now that Benchmarking and Philosophy Document Development are complete, performing and employing recommendations of the 18.2 Alarm Rationalization (addressed in the third white paper of this series) can move the system into either the Stable or Robust categories. Operators will then have a manageable alarm system that operates effectively during both normal and abnormal situations.

Predictive systems usually require adhering to the entire 18.2 standard and implementing extensive advanced alarming techniques.

Operators help ensure that a processing plant is running safely, productively, and economically. Their experience, skill and knowledge of process industries can never be replaced. But an effective alarm system is an invaluable tool for helping them identify abnormal equipment or process scenarios that could have serious personnel, environmental, or financial consequences.

Benefits of Benchmarking and Alarm Philosophy Development

Proper alarm management is an ongoing commitment. As noted in the first white paper, the Monitoring & Assessment entry point delivers immediate early success, but shouldn't be the sole step for improving alarm management. This white paper addresses how Benchmarking and Alarm Philosophy Development provide the next steps toward a comprehensive alarm management system.

Benchmarking provides a baseline for performance comparisons, identifies the alarm systems most pressing issues, and contributes critical information for Alarm Philosophy Development. The Alarm Philosophy Document is the roadmap for fulfilling the goal of ISA 18.2 compliance. Taken together, each stage of the 18.2 lifecycle results in three primary benefits: improved productivity, increased plant safety, and improved regulatory compliance.

Improved Productivity – Poor alarm system performance negatively affects operators and operations. It's one of the leading causes of unplanned downtime. Operators waste time dealing with the confusion caused by too many alarms and the unreliable information from nuisance alarms. Effective alarm management helps eliminate waste, improve processing quality, and increase productivity.

Increased Plant Safety – Alarm flooding impairs plant safety because of possible confusion when dealing with multiple nuisance alarms in short periods of time. Operators are uncertain about which alarms require priority response. Proper alarms that are meant to prevent plant incidents become ineffective in a flood of alarms. The 18.2 standard helps provide a blueprint for effective alarm management and increased plant safety.

Improved Regulatory and Best Practices Compliance – Benchmarking and Alarm Philosophy Development are the proper next steps following the Monitoring & Assessment entry point. They continue the journey toward implementing a comprehensive alarm management program that meets the 18.2 standard.

The third, and final, white paper in this series addresses Alarm Rationalization and Implementation, as well as system Audits to ensure alarm system integrity.

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