

TiPS TechDoc - White Paper

Applying Six Sigma to Alarm Management

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Introduction

The TiPS white paper "The Real Cause of Alarm Problems" illustrates the various operating and business factors that impact alarm system design and performance. Influential factors can include those directly associated with control systems such as sensor calibration and loop oscillation, secondary influences such as product demand and environmental pressures, and uncontrollable factors such as ambient temperature changes or rainfall. "The Real Cause of Alarm Problems" draws a cyclical relationship between alarm design influences, the quality of process condition information, and the measurement of plant performance. Creating this relationship emphasizes the importance of adopting a system to continuously monitor the health of the systems operators rely on for process information, including alarms.

The dynamic pressure on alarm design is far too compelling to leave to its own agenda. Even if an alarm system is "perfect" there will still be a need to guard against rogue changes and to accommodate changes made to the process design or equipment. Sensors will be taken offline for maintenance, the weather will change, raw materials will vary.

Alarm management provides a structured mechanism to control alarm related changes and must be integrated into your culture as a part of normal procedures. Without a complete circuit of review, the alarm management process will break down, eventually degenerating into special interest silos at odds with each other regarding the "right" way to use alarms. Managing this cycle without overloading resources requires careful orchestration.

The Six Sigma process is perfectly suited for adaptation as an alarm management methodology that remains sensitive to resource scarcity and business constraints. Applying a Six Sigma structure to an alarm management effort creates a pathway to sustained alarm improvement, heightened situation awareness, and enhanced operator effectiveness.

Stakeholders

The factors that influence alarm system design can be grouped into the following categories:

- Operations Environment
- Control Assets and Design
- Management Objectives
- Production Environment

Factors from each of these categories impact the alarm system, which, in turn, affects various business units. The people with responsibility for those business units have a vested interest in the outcome of any issues related to the design and function of alarms. They are the "stakeholders" in the alarm management process.

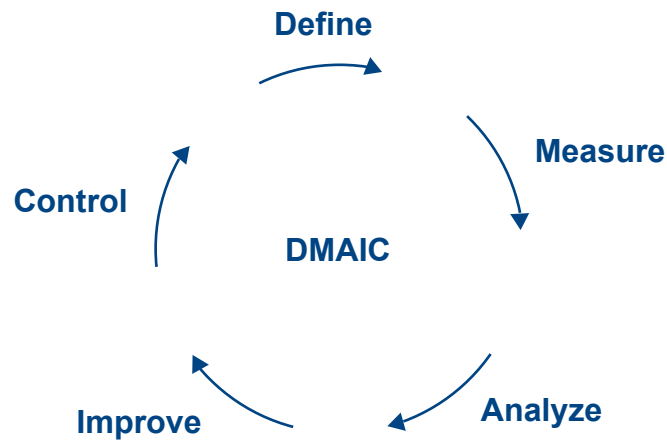
Each stakeholder should feel that they have the ability to voice a need or raise an issue that potentially involves the alarm system. Each stakeholder should be asked to participate in the decisions addressed by the alarm management process. Therefore, the stakeholders form the basis for the Six Sigma alarm management team.

Six Sigma and Alarm Management

Six Sigma is a methodology for improving quality through a continuous effort to eliminate defects. The defects can be in a product, a person, a process, anything. Six Sigma defines a workflow for identifying a defect, determining its probable cause, fixing the underlying issues, and integrating the evaluation process as a part of organizational culture.

Six Sigma stresses continuous evaluation with a goal of reaching a statistically consistent product. Continuous evaluation is a requirement because it not only continues to identify new defects, it inhibits the reintroduction of defects that have already been eliminated.

The basic Six Sigma design is described by the acronym DMAIC, which identifies the five tasks within the Six Sigma process: Define, Measure, Analyze, Improve, Control. These tasks are mapped together in a continuous workflow:



The Six Sigma DMAIC cycle

Six Sigma tasks can be directly mapped to alarm management actions:

Define

The first task in the Six Sigma process is to determine how to identify a potential defect. The Define task clarifies what to look for and how it will be found. Defect identification could be based on a quality metric, an output target, a customer service rating, a score on a performance review, or simply by personal selection.

In an alarm management scenario, the Define task is equivalent to the development of an alarm philosophy. Alarm defects could be identified as:

- Nuisance alarms identified in an activity report
- Alarms that operators repeatedly shelf or robotically acknowledge
- Alarms that operators specifically identify as troublesome or meaningless
- The next alarm on the rationalization plan

Six Sigma and Alarm Management (continued)

Measure

In the Measure task, you would apply the developed quality criteria to actual measurements. This task should lead to input into the defect evaluation process. If not, performance criteria may be too lenient or the importance of defect identification has not been accepted into the business culture.

Alarm performance metrics can identify a potential defect based on their comparison to stated targets. This might include a simple frequency analysis or more complex data involving correlated operator behavior or activity persistence. Measurement may not involve alarm activity at all, instead focusing on sensor data or maintenance requests.

Analyze

The Analyze task is an opportunity to confirm that the defect is real and to determine its root cause. In this task you will critically evaluate the mechanism that identified the defect and the possible reasons the defect exists.

This task leverages the full scope of the alarm management process. You will research the root cause through the assessment of input and opinions from each alarm performance stakeholder. In alarm management, analysis of the root cause of an alarm defect goes beyond a review of the alarm alone. You must consider all potential issues that could have revealed the apparent need for the alarm or for the poor performance of the alarm. Only then will you have a true assessment of the root cause and be able to address the issue at its core, rather than at a superficial level. Failure to completely assess the alarm will result in its eventual resurgence as a defect.

Improve

Once the cause of the defect is fully understood and the resolution is clear, the Improve task is engaged to make the changes necessary to attempt to prevent the defect from occurring again.

In the alarm management process, this is where the decision made by the alarm management team is implemented, making the changes within the process, design, operation, or organization in an attempt to correct the alarm defect.

Control

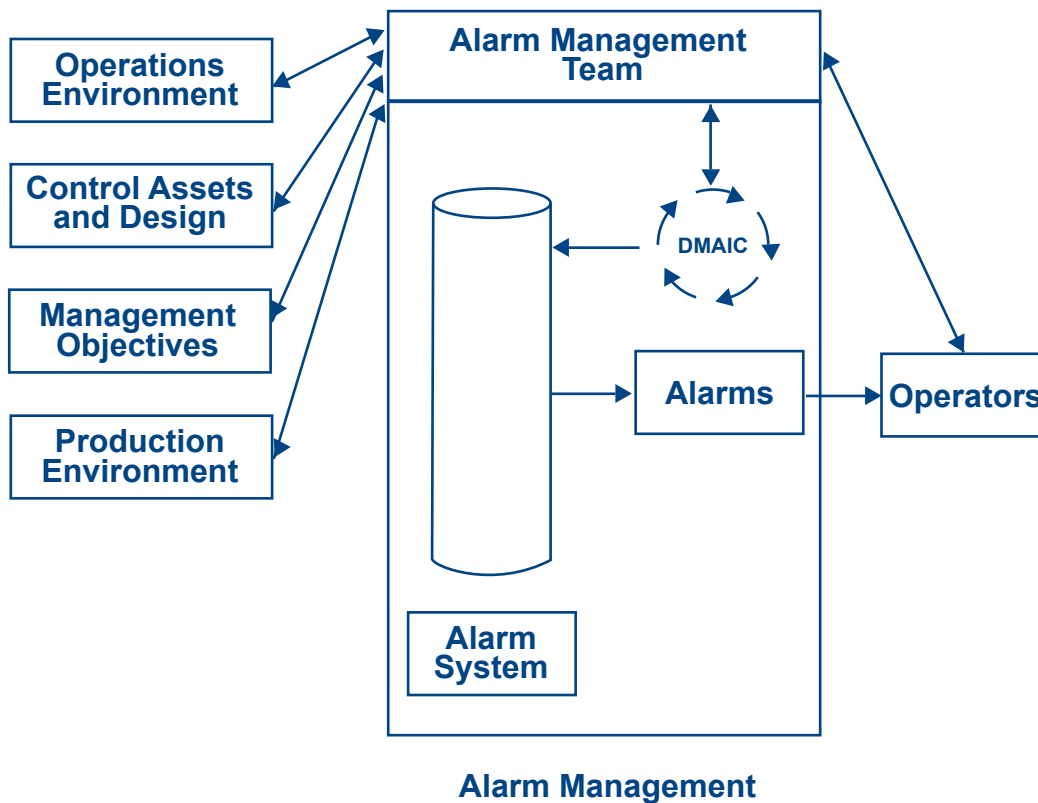
Control is the task that ensures the continuous nature of the Six Sigma workflow. Control maintains the effort to use the discoveries from the Analyze task to further refine the definition of quality and to continue to compare quality measurements to performance expectations. Control also integrates formal Management of Change (MOC) processes to preserve the forward momentum of the Six Sigma effort.

Control within the framework of Six Sigma is equivalent to the integration of alarm management into organizational culture. Deep understanding of alarm management encourages stakeholders to embrace the value of alarm management, leading to good alarm design, adherence to MOC procedures, and enthusiastic participation the Six Sigma process.

Six Sigma provides a structure for the activities involved in alarm management.

Alarm Management Workflow

A nicely structured workflow results from application of Six Sigma principles to an alarm management effort. To illustrate we can merge the Six Sigma DMAIC and the Alarm Management Influence diagrams.

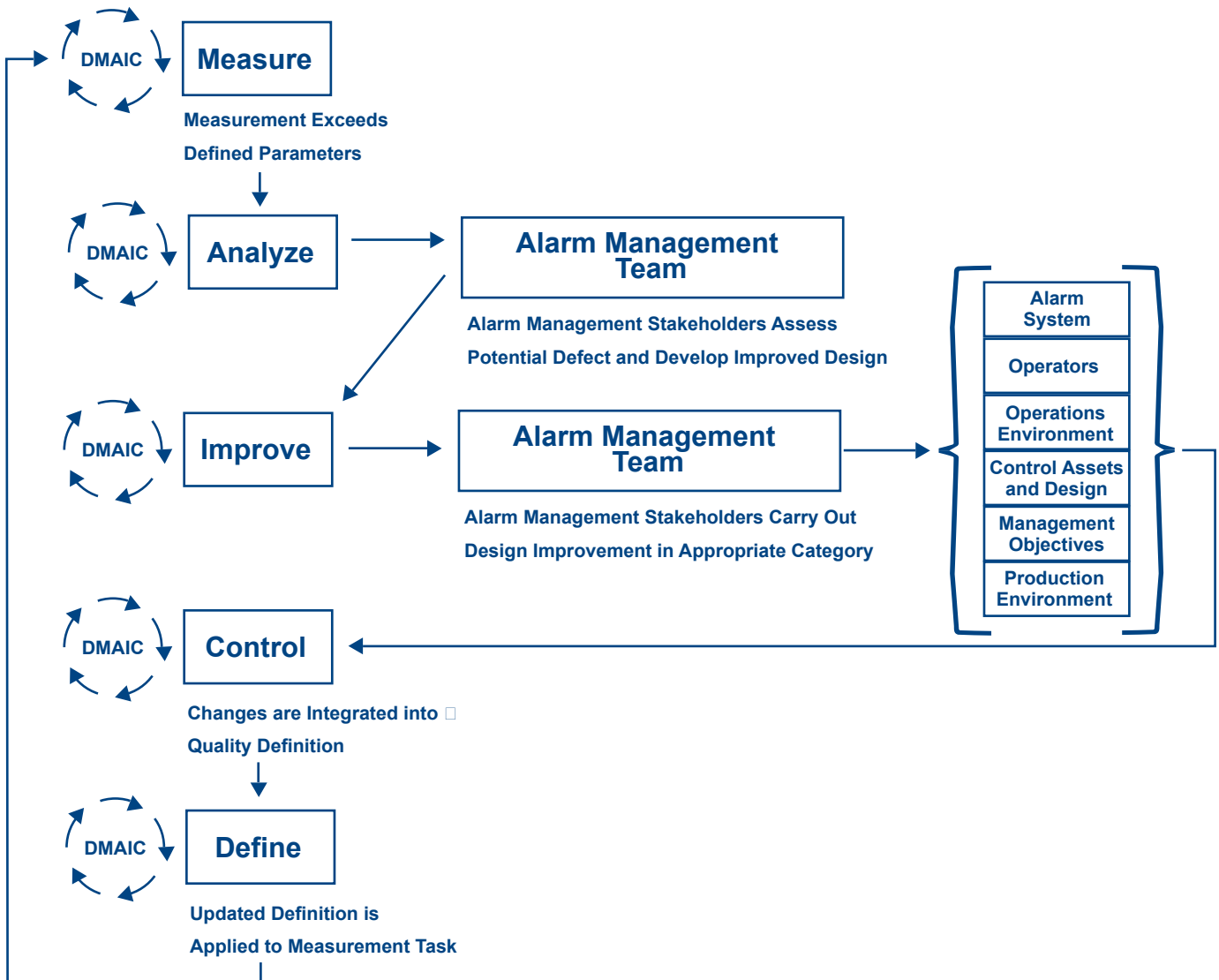


The Six Sigma DMAIC process has a two-way relationship with the alarm management team, providing a methodology for alarms being evaluated and functioning as a source for potential alarms to review. If the alarm in question results in a change to the alarm system, that change is forwarded on to the next step. If the alarm is reviewed and another corrective action is required that does not involve the alarm system, it is passed back to the alarm management team where the stakeholder for the root cause business category will take ownership of the issue and incorporate the necessary changes.

Alarm Management Workflow Examples

Alarm Performance Trigger

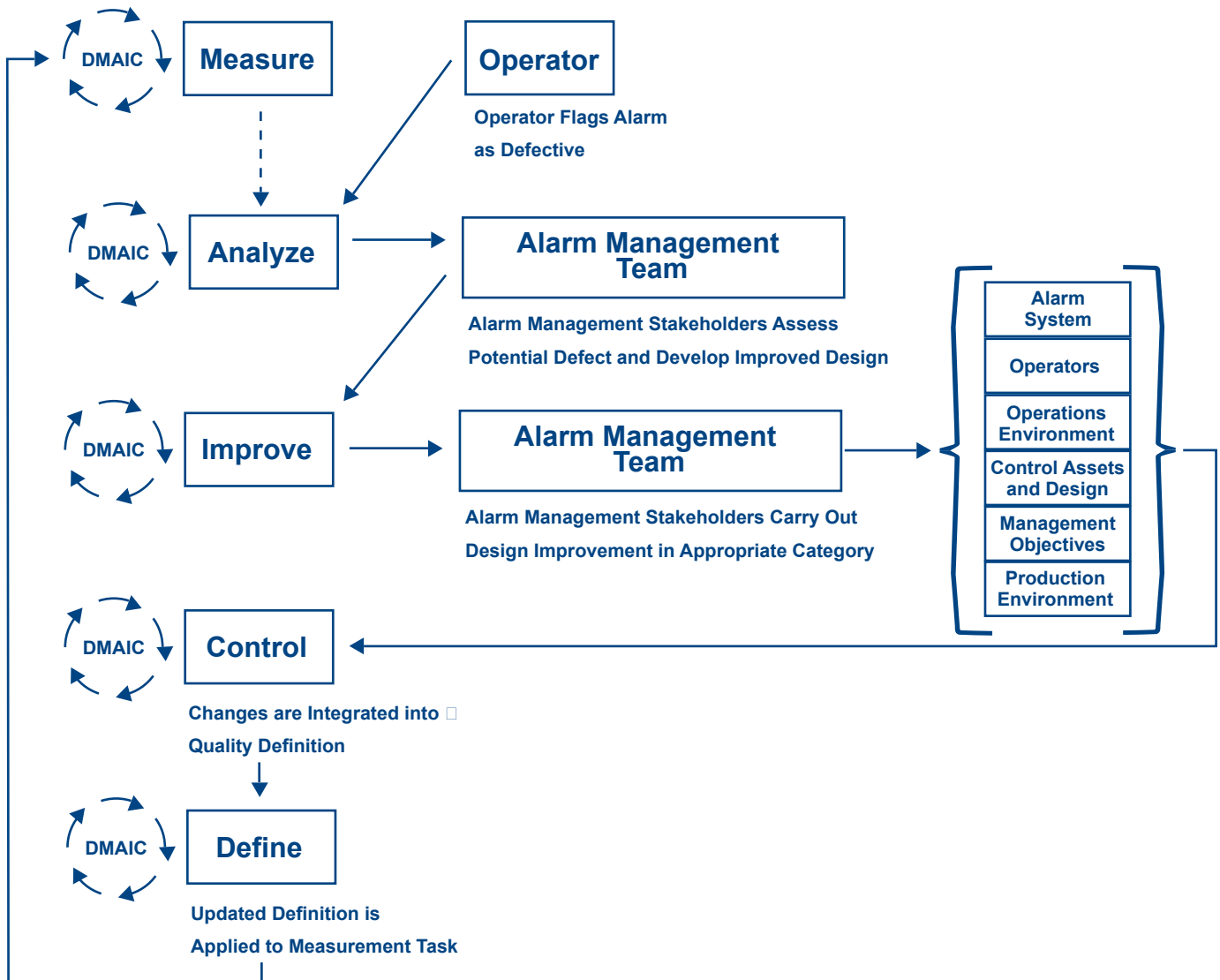
A typical mechanism for locating a potential defect in an alarm system is through analyzing alarm activity to identify undesirable behavior in the alarm system. Overactive, unacknowledged, and chattering alarms are all examples of undesirable alarm behavior. When Six Sigma is employed, the Measure task in the DMAIC process generates the potential alarm defect that is processed through the rest of the DMAIC circuit.



Alarm Management Workflow Examples (continued)

Operator ID Trigger

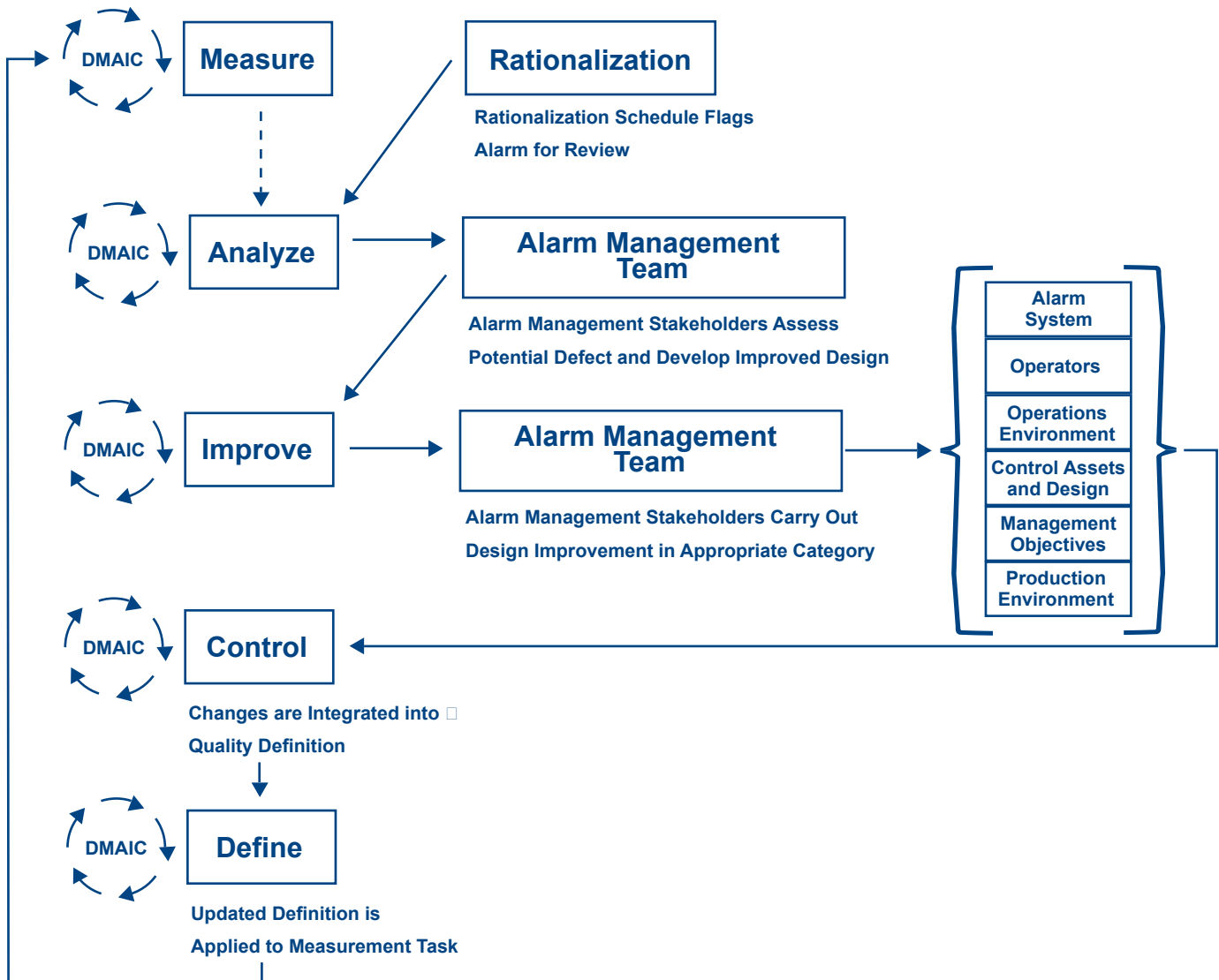
Some companies seek the input of the operating team in identifying problematic alarms. Operators are given the ability to "flag" alarms that they find troublesome or of little value. Those alarms are then forwarded through the review process. In this case, the operators essentially function as the measurement of alarm performance.



Alarm Management Workflow Examples (continued)

Rationalization Trigger

A risk assessment may determine the need for rationalization (design review) of all alarms in a given unit. During the course of the rationalization project, alarms will be driven through the DMAIC process. This workflow can be applied in brownfield (active) or greenfield (new/migrating) operations. Rationalization triggers do not necessarily rely on a performance assessment, but they can still leverage the Six Sigma process workflow.



Continuous Application

Six Sigma emphasizes the elimination of defects through continuous Control of an item's quality. Alarm management emphasizes optimization of the process information used by operators through continuous assessment of the operator environment. Continuous application of an alarm management workflow, Six Sigma or otherwise, is critical to the success of any alarm management effort, given the many stresses on alarm system settings and performance.

Alarm management has many different interpretations, the main differences being depth of personnel involved and whether the alarm system is improved as a single unit or on an individual alarm basis:

- Nuisance reduction
- Bad actor resolution
- Alarm rationalization
- Critical condition management
- Operator effectiveness
- Situation awareness
- Etc...

If you choose to work at the alarm design piece by piece, commit to continue the effort beyond what you think is "good enough". Adopt alarm management into your culture and tune alarms indefinitely.

If you choose to "fix" alarms by completely rationalizing and redesigning the system, implement an ongoing monitoring methodology. A complete system redesign will not eliminate the various pressures to change the alarm settings.

If you design an alarm system from scratch using all of the latest best practices, establish a culture that places a high value on alarm behavior, that is willing and eager to participate in the effort to protect that investment.

Six Sigma is a widely accepted process for product improvement that can be adopted for alarm management with minimal stress on resources. There are effective alarm management strategies for all situations. A stable, functional alarm system is crucial to safely reaching performance goals. The biggest mistake is assuming otherwise and doing nothing at all.