Honeywell

White Paper

A Guide to Effective Alarm Management

Executive Summary

Alarm management is often held as synonymous with software, and software tools play a crucial part in driving safety and plant efficiency. This paper, however, proposes a holistic approach to best realize the benefits these tools can bring. It outlines a model, based on five fundamental phases, to implement an effective alarm management strategy. This model captures knowledge and best practice, and leverages technology and standards through an effective framework for delivering business goals. The model ensures that these goals drive alarm management, and prevent the strategy from being limited by the capabilities or scope of the tools employed in delivering it.

Every plant has unique requirements. The paper does not, therefore, seek to prescribe the strategy in detail. However, the model presented is widely applicable. It is flexible enough to be used by any plant, no matter what their current level of alarm management maturity. It is also flexible enough to be scalable and can be implemented in stages to move plants from reactive alarm management to a proactive system driving continuous improvement in the operation.

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Introduction

It is not just the process industries for which alarm management is crucial. In April 2013, US non-profit the Joint Commission, which accredits the country's hospitals, warned that doctors were increasingly desensitized, immune or overwhelmed by constant hospital medical alarms – "alarm fatigue", as researchers put it.[1]

Between January 2005 and June 2010 the U.S. Food and Drug Administration's (FDA) Manufacturer and the User Facility Device Experience (MAUDE) database revealed that 566 alarm-related patient deaths were reported.

The issues will be wearily familiar to all those who have tackled industrial alarm strategies: Staff are faced with thousands of alarm signals from a myriad of medical instruments on every unit, up to 99% of which require no clinical intervention. As a result, the report found, physicians were prone to turn down alarm volumes, turn them off, or adjust the alarm settings outside safe parameters – with serious, potentially fatal, consequences.

Despite their experience, however, the process industries may have less to offer those coming new to this discipline than one should expect. That is because too often approaches to alarm management have been dictated by, and even restricted to, the capabilities and functions of specific tools or local site knowledge. Investments in software tools, for example, while an essential part of any alarm improvement program, can do little to resolve underlying problems if the results and findings are not actioned in a structured and timely way.

Even where organisations take a wider view to include software tools, formal standards and procedures, a framework to tie these disparate elements together is usually lacking.

This paper proposes an approach to deliver an alarm management improvement program based on field-proven, phased methodology that not only supports industry best practice, but also delivers it in a practical and cost-effective way. It consists of five key phases:

- Development of an alarm system foundation strategy
- Identification and elimination of bad actors and alarm system noise
- Plant Limit and boundary management integration
- Alarm rationalization
- Alarm flood analysis

The program provides the framework under which the tools, techniques, procedures, standards and guidelines deliver the benefits they should: improved safety, greater reliability and efficiency for a more sustainable operation. The result is to move an alarm system from its traditional reactive state to a manageable and proactive state.

Crucially, it also takes account of the sophistication of the current alarm strategy. We do not seek to dictate how or even in what order the phases are undertaken. It is, however, a process from which we believe every plant, no matter what their starting point, what their level of alarm management maturity, can benefit.

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[1] http://www.jointcommission.org/assets/1/18/SEA_50_alarms_4_5_13_FINAL1.PDF

Developing an Alarm Management Program

Program Drivers

At the very outset of this program, it is important for the organisation to be clear about their reasons for embarking on an alarm management project. These will vary between businesses, but without clear agreement on the benefits sought, it is impossible to tailor an effective program to the organisation's needs, or to achieve buy-in from those tasked with implementing it.

There are a number of common drivers:

- Regulatory compliance
- Safety improvement
- Operator efficiency
- Insurance premiums
- Reduction of trips
- Increased production
- Reduced maintenance costs

The impact of the insurance industry is an interesting driver. No insurer wants exposure to a Texas City or Milford Haven, and underwriters are increasingly insisting clients demonstrate a proactive approach to alarm handling before agreeing to cover.

However, all these are good reasons to embark on an alarm improvement program, and there is convincing evidence to show measurable benefits can be achieved. Honeywell's own research suggests plants can, on average, halve both unplanned downtime and the number and costs of incidents. Other benefits include 3% better capacity utilization, 5% better energy utilization, and a 5% improvement in mechanical availability.

What these figures show is that the primary goal of alarm management is not to reduce the number of alarms. A reduction will occur, but it is the result of a good system put in place to achieve business and operating goals, rather than the aim in itself. The quality and clarity of the alarms presented, not the number, is the most important aspect of any program.

There are, in fact, few areas of business improvement where better alarm management cannot have an impact. Whether the object is better reliability, productivity or performance, safeguarding the plant or reducing costs, alarm management can be an important contributor. Consider one example: the challenge of an aging workforce and skills gaps. An effective alarm management system will capture the knowledge of experienced staff, cataloguing causes, consequences and corrective actions for each alarm, and retain this information for less experienced recruits.

In all cases, the key to developing an effective alarm management strategy is to first understand why it is being developed. Within the same development framework, different requirements will drive different solutions.

Program Ingredients

Techniques, standards, tools and best practices all have a role in alarm management. Most plants will be familiar with and employ a range of these.

- **Standards and guidelines**: The EEMUA 191 guidelines are widely used in Europe; the ISA 18.2 standard in the US and across Asia, and the globally recognized IEC 62682.
- **Best practice:** This comes from a variety of sources, but the work of the Abnormal Situations Management (ASM) Consortium, founded by Honeywell, has been particularly important in driving best practice in alarm management.
- **Tools:** Software, databases and written procedures are all commonly used. Among the most frequently found are alarm management metrics, recording and analysis software, master alarm databases, and alarm response manuals.

A study presented to a meeting of the ASM Consortium by oil and gas giant Total in this respect is interesting[2]. It looked at all of these areas – standards, techniques, procedures and tools – to see if any one had an overwhelming impact on the effectiveness of the alarm management program. The conclusion: there was no "silver bullet". No single, specific action had the desired result; instead, a combination of actions made a positive and significant impact. An effective solution requires such a combination – a model.

The alarm management program provides the framework to ensure the various contributors are applied in a coordinated and coherent way that achieves the business goals (Figure 1). It ensures lessons learned in one area of a plant or facility can be captured and applied elsewhere. It also ensures the strategy is resilient: By building alarm management around a program rather than a specific tool, process or workflow, the strategy – the goal – is never undermined.

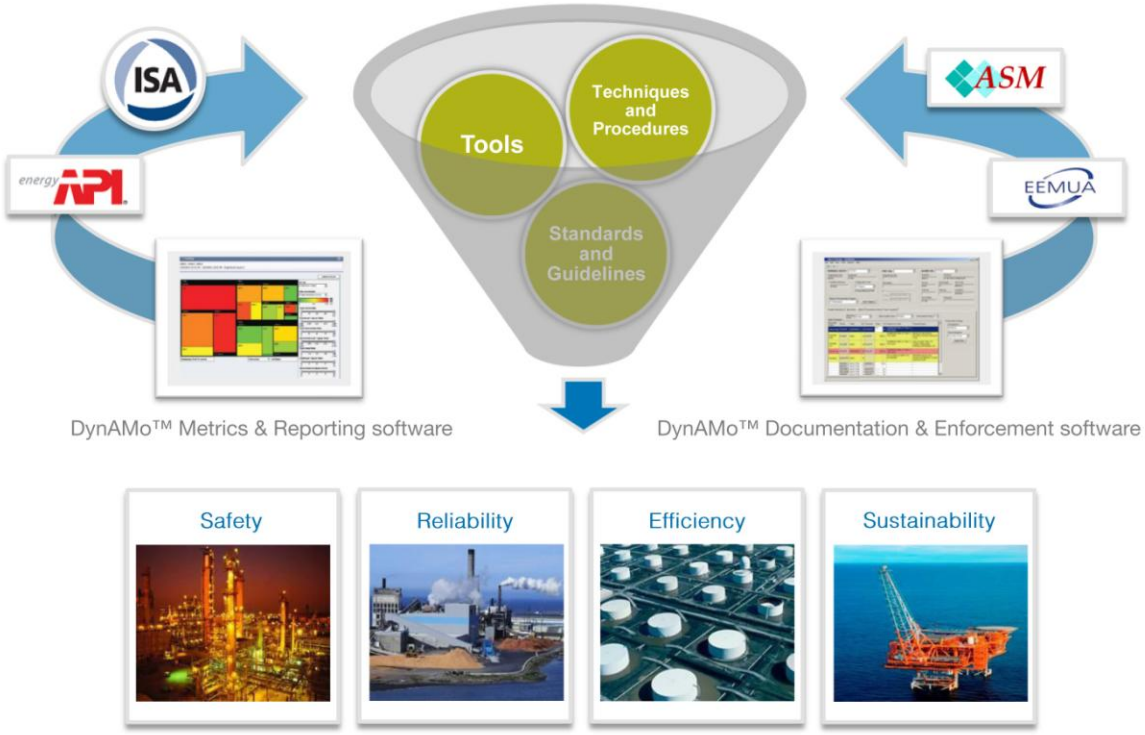

Figure 1: A Methodology tailored to business goals

[2] ASM Consortium *Operations Outreach* Seminar, 29 June 2012, Hull, UK

Human Factors

Human factors are, of course, crucial to effective alarm management. The operator is the most important link in the chain in any alarm system. They are the vital supercomputer, without which no system can be effective, regardless of how technologically advanced it might be.

Human factors are not included as a distinct element of this model only because they are integral to every part of it. Established best practice and research should inform every step within the program. If we know that it takes, on average, one to two minutes for an operator to read an alarm, understand the consequences, and take corrective action, there is little point, for example, in an alarm system that relies on alerting an operator with two emergency alarms at the same time. How do you prioritize the emergencies?

Operators should be engaged at every stage of the improvement plan, in part to ensure buy-in to the program, but also to capture their knowledge and insights into human limitations.

The Alarm Management Model

Model Overview

The model is built around five phases: infrastructure (including the Alarm strategy and foundation), identification and elimination of bad actors, alarm rationalization, alarm flood analysis, and operations and boundary management.

As each phase is successfully applied, the overall number of daily alarms will reduce, as will the alarm floods (Figure 2).

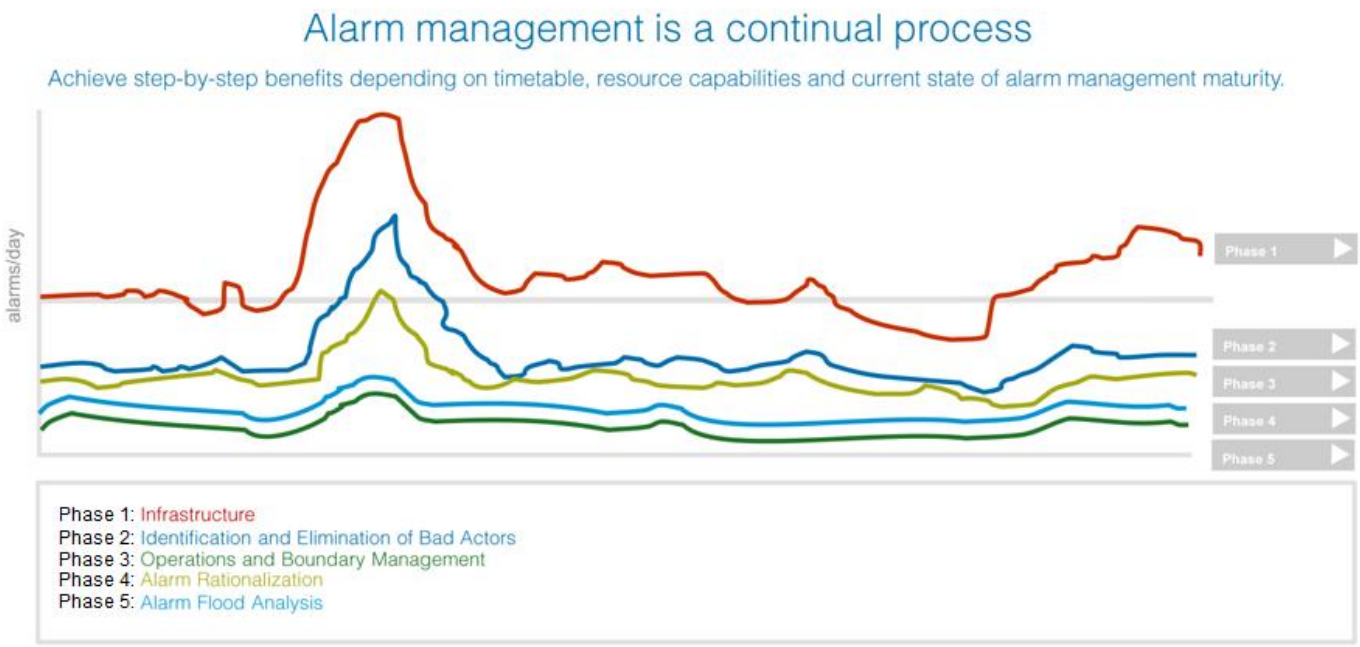

Figure 2: A model for continual improvement

Infrastructure

This phase sees the development of a site-specific alarm strategy. It includes the development of an alarm philosophy document – the rule book that defines how the site's alarm system will function. It also includes site assessments and interviews with operators, to ascertain how the system is performing and where improvements can be made. Any improvement needs a clear baseline to start from.

Data is collected from many sources, such as alarms, events, and operator actions, and compared against EEMUA and ISA best practices as a benchmark for the current system. These fundamentals will form a solid foundation for our alarm management improvement program.

A key deliverable from Phase 1 is the creation of the site-specific alarm philosophy document (APD). The document must provide long-term viability yet lead to clear determinations. It should include, but not be limited to, the following sections:

- The purpose of the alarm system
- Roles and responsibilities
- Alarm design principles
- Priority assignment
- Rationalization methodology
- How alarms are presented
- How operators should respond
- Key performance indicators (KPIs)
- Escalation policies
- Management of change
- Knowledge retention and training

Identification and Elimination of Bad Actors

This phase should focus on the areas of biggest risk and greatest returns first, while generating EEMUA, ISA-compliant KPI assessment reports with quantifiable deliverables. EEMUA and ISA compliant metrics are used because most regulatory or management bodies want to benchmark their assets against agreed best practices. EEMUA is a best practices guide; ISA is a standard.

Phase 2 is where the Alarm Management software is implemented. Once the strategy is clearly defined, the software tools can support it. Again, it should be noted that the model determines the strategy, while the software supports the strategy. The software tool should not determine the strategy or the overall direction of the alarm improvement project.

The correct tool will rapidly accelerate the return on the alarm management investment, particularly in the early stages. For example, fixing just three alarms a week may equate to a 60% reduction in bad actors over a one-month period. Most of these easy wins will come from removal of nuisance alarms, replacing faulty sensors or changing on/off delays and dead band timings.

Like every other phase, however, it is an ongoing task, and the plant operators must take ownership to deliver long-term improvement. This phase essentially never stops throughout the process, but a focus at this stage will not only drive clarity in the alarm system; it will also educate the stakeholders on what is required to maintain the alarm system going forward.

Alarm Rationalization

Alarm rationalization is commonly misunderstood. Effective alarm rationalization can only take place when the “noise” caused by the mass of nuisance alarms has been eliminated. Alarm rationalization is not specifically about reducing the number of alarms, but rather more about the quality of the alarm by ensuring the design of the alarm is correct in the first place.

The process involves analyzing each alarm and looking at its cause, potential consequences and any corrective actions that may be required: An alarm is only an alarm if there is a defined operator action. If there is no operator action it is not properly classified as an alarm. Operator alerts may be more beneficial in these circumstances.

Alarm Rationalization will include reviewing and actioning findings from Phase 2: grouping, cloning, and a tag-by-tag review, and addressing standing alarms and operating modes, alarm priorities and so on. This should lead to an end of assessment review, summary and training, highlighting the changes made and reasons for them.

Essentially, plants must determine if alarms have the correct priority, whether operators know what to do, and the action associated with each alarm. The purpose of priority is to indicate to the operator which alarm to respond to first when one or more alarms ring in at the same time. An alarms priority should conform to the guidelines set out in the alarm system strategy – the Alarm Philosophy. A typical alarm priority matrix will take into account the severity of the incident, against the time it takes an operator to safely respond. For example, if the consequence of the alarm is severe and the time the operator has to respond is less than 2 minutes, the alarm priority will be most likely be critical. An alarm with relatively minor consequences and greater than 30 minutes to respond will have a lower priority. The consequences and response time will be site-specific and detailed in the APD (Phase 1 of the process).

It is also critical at this stage to document the findings in a master alarm database and alarm response manual. This ensures the change management process is followed and that the knowledge of the exercise is captured.

Alarm Flood Analysis

This ideally requires analysis of at least six months’ archived data, after rationalization, to target and eliminate the worst alarms during flood situations. No matter how well managed an alarm system is, process upsets will occur and, in turn, will cause alarm showers not seen in normal steady state operation.

The analysis will help identify and detail common patterns and consistent areas of weakness, as well as chattering, redundant and consequential alarms. The information identified here, along with the previous rationalization phase, can be used to help define logic for more advanced alarm management techniques, such as Mode and State based alarming, as well as Dynamic Alarm Suppression.

Implementation

Entry Points and Flexibility

While the phases are broadly chronological, the model is flexible enough to accommodate a variety of levels of sophistication in existing strategies. Plants can simply begin at the phase that best reflects the current state of the process. Similarly, the methodology can adapt to different requirements. Phases 3 and 4, for example, may be interchanged depending on the findings of the initial benchmarking exercise, and the problems it identifies as most pressing.

Furthermore, the project does not have to be undertaken all at once. The phases can be executed as and when required. This is crucial, because all sites have different commercial and resource constraints. The flexibility of this model allows any site, of any size, to choose the phases to execute based on their current level of alarm management maturity.

The Role of Software and Services

Alarm Management software is an integral piece of any improvement program, but it's the model that is more important than any of the component pieces. It is therefore important to understand the interaction between software tools and core alarm management expertise. As ISA's Alarm Management Lifecycle (Figure 3) shows, software, in isolation, will not address all aspects of the program. Alarm Management services have ever increasing importance. As personnel in plants have become stretched, fewer resources are available to drive the alarm management initiative to where it needs to be. Services such as reports, training and analysis highlight potential actions and enable plants to harness potential benefits from their investments. Alarm assessment audits for example, can be used to identity a site's strategic plan for moving forward – this may include both software and services.

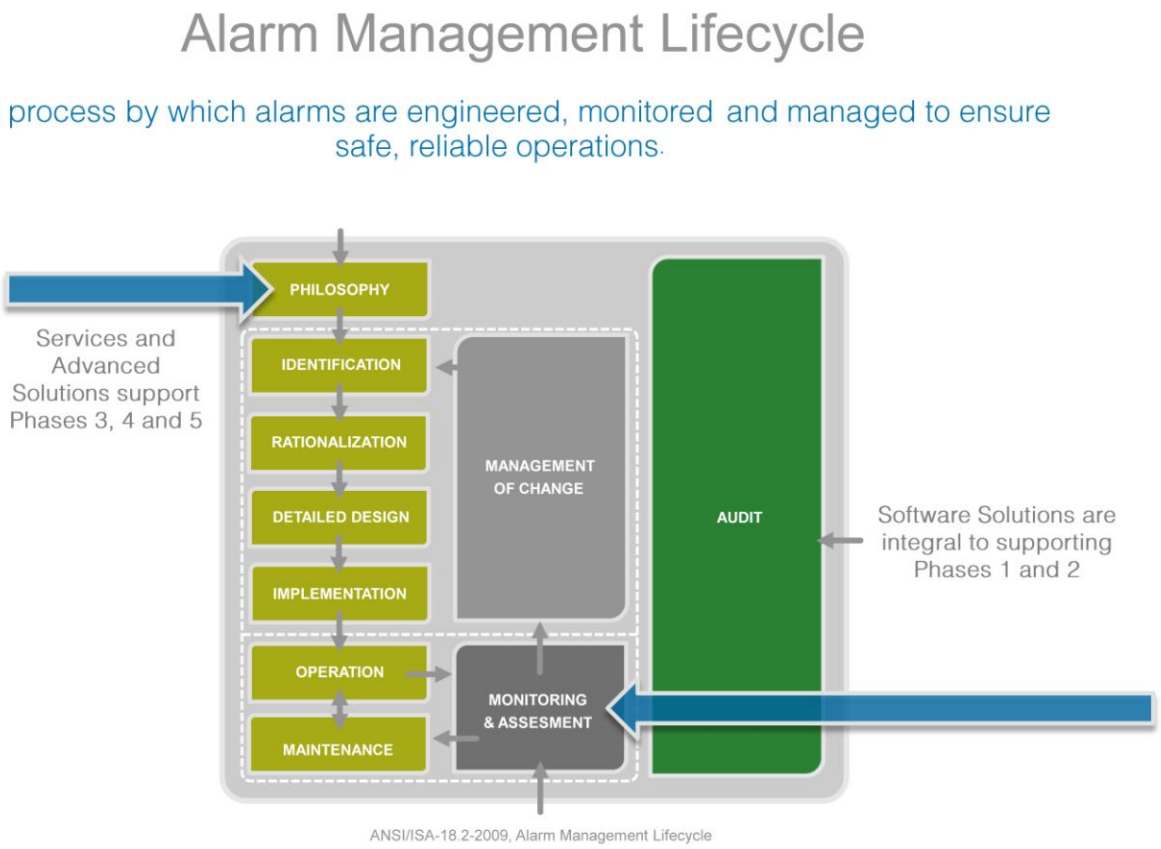

Figure 3: Software as just part of the picture

The Role of Standards

Standards such as ISA 18.2 and EEMUA 191 serve two main purposes. First, they provide the basis from which to develop and inform a tailored program of alarm management, also providing a useful framework for discussions in opening training workshops. Second, they provide much needed metrics against which to assess performance and progress.

The standards outline some key performance indicators. These include metrics such as the average number of alarms per day and peak alarms within a 10-minute period, and the distribution of those alarms in terms of their priority (Figure 4).

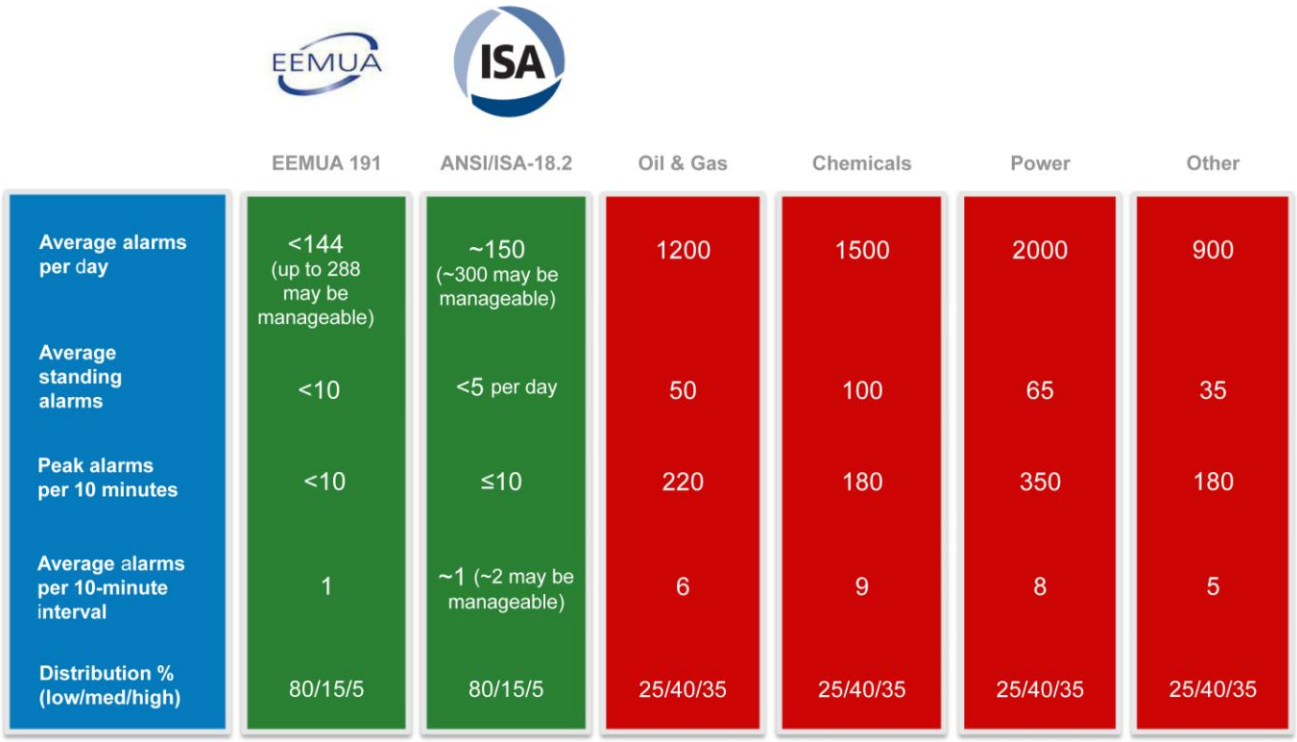

Figure 4: Setting the benchmark with standards

Most fall below the recommended standards in at least some respects, but without clear reference to these standards this may pass unnoticed. The red columns in Figure 4 show typical numbers in different industries. It is often only when a plant's figures for the distribution of alarms, for example, are set against the targets laid out in the standards, that it is clear how poorly the current alarm management system is performing.

Nevertheless, the standards should not dictate the strategy. The standards and metrics used must be appropriate to the particular strategy in question. Again, the model is more important than any of its components.

Benefits and Case Studies

Numbers from a recent project show the impact a typical program can have, and are shown in Table 1 (below).

Metric	Before	After
Configured alarms	30,000	21,000
Priority %: high/medium/low	25/40/35	5/25/70
Alarms enunciated each week/hour	8,000/50	1,700/10
Unplanned shutdowns in last 12 months	3	1

These figures can be achieved relatively quickly. Applying the rule that if there is no action required, no alarm is enunciated significantly reduces operator burden. A detailed rationalization phase as part of the process can aid in the reduction of the overall number of configured alarms. Typical benefits include a 15% reduction in run to fail maintenance as well as a 40% drop in standing alarms.

Despite this, the example still shows one unplanned shutdown. This is to emphasize the importance of education. Operators accustomed to being overwhelmed by alarms become inured to them, being in the habit of simply acknowledging alarms for which no action is required. Following alarm system improvement and rationalization, however, the alarms coming into the control room are real and require action. Unless operators are encouraged to take ownership of the program through education and training, the culture change required may not take place. A number of other real-world examples prove the efficacy of this approach.

Irving Oil Refinery, North America

Too many configured alarms meant operators were overwhelmed with alarm floods during plant upsets. The key benefits following the alarm improvement program were as follows:

- A reduction of 35% in the number of configured alarms
- Average daily alarm rate decreased by 45%
- Improved operator effectiveness, with operators able to concentrate on correctly prioritized alarms.

Shell Shearwater, North Sea, Europe

High numbers of standing alarm and alarm floods during start-up hampered operations, while over 20,000 alarms were configured with some having no priority. The key benefits:

- A reduced alarm rate, from 1,200 per hour to just 288 per day
- A reduced number of trips per year
- Improved operator effectiveness.

Kestrel Coal, Bowen Basin, Australia

The maximum number of alarms exceeded EEMUA guidelines with the existing alarm management system proving essentially useless. The alarm management program saw a radical overhaul:

- A reduction of 97% in average daily alarm counts
- Increased safety with high priority alarms clearly defined
- The root cause of alarms identified, enabling the plant to focus on maintenance and reducing downtime.

Conclusion

The drivers and current sophistication of industrial operators' alarm management systems diverge widely. However, the first principles that underpin the applicable standards can be harnessed and applied in a model that is flexible enough to bring significant improvement to safety and efficiency in any plant, and at their speed.

It must, however, be the model and business goals that drive the alarm management strategy, not its individual component parts. Alarm management software tools and other tools are crucial, but their scope, functionality and capability should not dictate the approach and scope of the strategy; they should support it. If they do not, the result is often that little changes.

The model presented incorporates and channels these tools to enable users to deliver long-term benefits. Beyond increasing safety, it leads to a program of continuous improvement that enables the alarm strategy to ultimately drive a better business.

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For More Information
Learn more about how Honeywell's Alarm Management solutions can improve your plant safety and profitability, visit our website www.honeywellprocess.com/software or contact your Honeywell account manager.

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