Optimizing Operations with Perpetual Alarm Management

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Abstract*: Alarms universally remain to be a big problem to all Process control systems both in Process Industries and Manufacturing. Despite conducting several Alarm rationalizations and managements there are many poorly performing Alarm systems risking not only to minor trips and upsets contributing to major incidents which will have a significant effect on the plants bottom line. Operators are overwhelmed by the large volume of alarms preventing them to take effective actions to abnormal conditions leading to severe incidents. We do not need more alarms, we need better Alarm management and even better an automated perpetual Alarm management. The aim of this paper is to advance the current Alarm management systems for being further effective and improve operations of Process control systems as a continuous development process instead of it being a discrete activity.

Keywords: Alarm system, Alarm management, Alarms, Operators, Process control, Rationalization.

I. INTRODUCTION

Alarm systems are critical to communicate abnormal process conditions or equipment malfunctions, it serves as a layer of protection before escalating to severe events. A facility control room operator has the responsibility of managing multiple unit operations with thousands of Instrumentation producing numerous alarms requiring actions. Alarm management is performed for assessing, improving and optimizing alarms, thereby increasing the operator effectiveness by only notifying them when their intervention is needed. However, the efficiency of Alarm management system can either aid or be a major interference to the process operations. Poor Alarm management was identified as a contributing factor in many major process incidents impacting safety and environment, resulting in inefficient operations and higher production costs. Henceforth, the Alarm management system need to be redesigned to take advantage of the vast capabilities and benefits it can offer for efficient operations.

II. ALARM MANAGEMENT AND ISA 18.2

Alarm management system is a design and implementation development of the process control system that is used to alert Control room operators to improve safety of the facility by reducing needless shutdowns. It also plays a critical role to help avoid controller overload and ensures alarms are accurate while confirming safe operations. It's well known that with latest automation system, the number of alarms is virtually limitless as additions and changes to alarms are made simply by reconfiguring software. This ease-of-use improves the alarm systems while making Alarm management more challenging. In building Alarm management, both Process Industries and Manufacturing have both industry best practices and regulatory requirements to follow. ANSI/ISA-18.02 Management of Alarm Systems for the Process Industries ISA-18.2, provides guidance that will help users design, implement, and maintain a well performing Alarm system [2]. The recommendations in the standard provide a methodology for preventing and eliminating the most common Alarm management problems. ISA18.2 standard suggests completing audits periodically, however leaves discretion to the companies Alarm management philosophy and policy.

When implementing an Alarm management improvement program, the maximum benefit strategies include alarm storm assessments, tuning alarm settings on nuisance alarms, adjusting deadbands of repeat alarms, and eliminating alarms with no defined response. Strategies of medium benefit include suppression of alarms from 'out of service' equipment, replacing absolute alarms with deviation alarms, and filtering or suppressing repeater alarms. Other alarm improvement strategies 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 added alarm counts.

Table - I: Ten stages of Alarm Management life cycle (Figure 1) as per ISA18.2 [1, 2,7]

Stage	Activity
Philosophy	Document the objectives, guidelines and work processes for the Alarm system
Identification	Determine potential Alarms
Rationalization	Rationalization, classification and prioritization
Detailed design	Basic alarm design, HMI design, and advanced alarming design
Implementation	Commissioning, testing, and training prior to taking it to operational status
Operation	Operator refresher training when certain alarm classes are in operation
Maintenance	Maintenance repair and replacement, and periodic testing

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Monitoring and assessment	Monitor Alarm system's performance against goals of the Alarm Philosophy and record results
Management of change	Authorize changes to Alarm system generated from engineering studies or functional safety requirements
Audit	Frequent reviews need to be conducted to maintain the integrity of the Alarm system and work processes

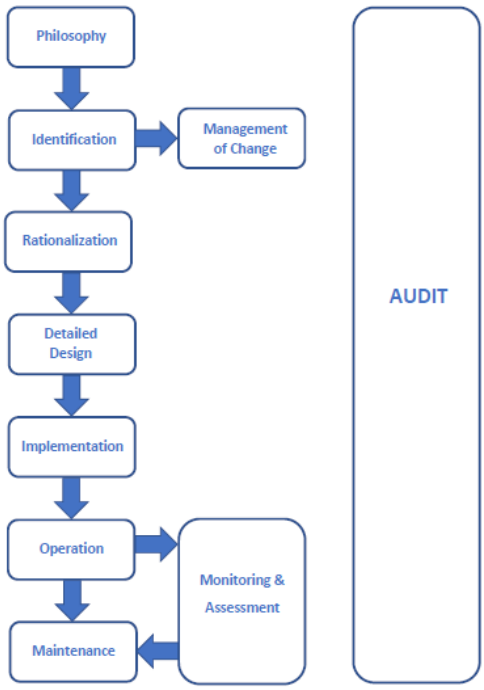

Figure 1. ISA-18.2 Alarm Management Lifecycle

III. BAD ACTOR ALARMS

As Alarm systems become less effective, they diminish the effectiveness of the automation system resulting in excessive number of alarms, loss of production and accidents putting the entire facility at risk. Manufacturing is a dynamic environment where changes are endless, it is vital that the Alarm settings must be adjusted alongside with any operational changes.

Alarm Limit – Alarm limits need to be attuned to account for new equipment installations, equipment performance changes, operational range of aging equipment and operations setpoint changes.

Alarm Dead band – Configure the alarm dead band to ensure it is larger than any expected signal noise as per the Instruments. Analog alarms need to have specified dead band as any slight variation or line noise can trigger multiple alarms.

Alarm Delay Time – Delay timers ON-Delay and OFF-Delay each presents unique consequences. ON-Delay keeps a bad actor alarm hidden from operators if the alarm fails to remain in effect longer than the delay time specified while OFF-Delay annunciates an alarm immediately. An analysis needs to be done to elect between ON or OFF Delay to manage chattering and fleeting alarms.

Alarm Latch – Another way to eliminate chatter alarms is to configure latch to discrete alarms.

Alarm Flicker – These are constantly recurring alarms due to faulty sensors. Operators should obscure these alarms until the sensor is fixed or for a certain interval in order to ensure that hidden alarms are not forgotten.

Alarm Flood – Alarm flood should be avoided as the operators may not be able to react to the urgent and most important alarms and primarily the system should not be overburdened [4].

Process Filter – Process filter algorithms are used to reduce noise that is generated by process variable signals for process control systems. Filter time lengths need to be adjusted as per the process variables - flow, level, pressure and temperature signals.

Tuning bad actor alarms is a highly effective, immediate solution for reducing Alarm system overload. A limited number of alarms result in a low-cost and highly visible alarm system improvement. However, Monitoring & Assessment does not evaluate process conditions and identify root causes of DCS installation or hardware issues. Alarm metrics, Performance Benchmarking and developing an alarms management Philosophy followed by the Alarm Rationalization can address some of these problems.

To eliminate bad actors and nuisance alarms, identifying bad actors with reporting software and compare them with recommended KPIs (Key Performance Indicators) for performance targets and eliminate bad actor alarms by Tuning the alarms.

IV. HUMAN FACTORS

Alarm systems are important information for operators responsible for preventing and responding to abnormal conditions, mitigating the occurrence of safety incidents. Operators are confronted with thousands of alarms a day in the control room, Alarm management reduces this number to a maintainable level. To prevent accidents caused by human error, it is significant to reduce the high alarm rate in the control room to improve operator efficiency. Nuisance alarms, alarm floods and improperly prioritized alarms all contribute to operator confusion, and thus increase incidents frequency.

Key alarm KPIs per ISA 18.2 and EEMUA guidelines [1, 2, 3],

- Average Alarm Rate: 1 Alarm / 10 Minutes
- Maximum Alarm Rate: 10 Alarms / 10 Minutes

Alarm KPIs and acceptable targets include:

- Alarm floods: 10 alarms/10 minutes <1%
- Most frequently occurring alarms: < 5% of Total
- Chattering Alarms: 0
- Stale Alarms: < 5
- Priority distribution of Alarms: 80% Low, 15% Medium & 5% High [5] [3]

Table - II: ISA 18.2 Alarm Performance KPIs [1,2,7]

Metric	Target Value	
Annunciated Alarms per Time	Very likely to be acceptable	Maximum Manageable
Annunciated Alarms per 10 Minutes per Operating Position	~1 (average)	~2 (average)
Percentage of hours containing more than 30 alarms	<1%	
Percentage of 10-minute periods containing more than 5 alarms	<1%	
Maximum number of alarms in a 10-minute period	10 or less	
Percentage of time the alarm system is in a flood condition	<1%	
Percentage contribution of the top 10 most frequent alarms to the overall alarm load	1% to 5% maximum, with actions plans to address	
Quantity for chattering and fleeting alarms	Zero, action plans to correct any that occur	
Stale Alarms	< 5% 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	
Unauthorized Alarm Suppression	Zero alarms suppressed outside of controlled or approved methodologies	
Improper Alarm Attribute Change	Zero alarm attribute changes outside of approved methodologies or MOC.	

Other Alarm management advanced methods include [6]
Shelved State : Temporarily suppresses an alarm when initiated by the operator
Suppressed State : Based on the facility circumstances and operational conditions, alarms can be suppressed per significance.
Disabled (Out-Of Service) State : Alarm received when the alarm indication is suppressed manually for maintenance purposes.

V. CONCLUSION

Alarms management needs to be a perpetual and consistent maintenance to progression and improvement of alarm systems

1. Alarms need to be prioritized and adjusted periodically contingent to the changes in the facility and operation demands
2. Predictive alarms need to be setup per upcoming operational abnormalities for operators to take preventive measures
3. Set delay time settings and latches that are critical for solving nuisance Alarms which is a complex task
4. Reducing bad actor alarms and nuisance Alarms perpetually will be a significant improvement in Alarm Management
5. All Complex, manual and time-consuming tasks need to be automated to improve safety, operational quality, reduce costs and productivity
6. Calculations, presumptions and actions that are taken manually in the event of Alarms should also be automated by setting and programming predefined actions to Alarm management for much safer and efficient operations
7. An effective Alarm management program needs to be developed to improve operator's ability to manage DCS alarms on larger sections of the plant, which reduces the control room footprint directing operator attention towards those plant

conditions that require assessment on information to act correctly

8. The developed program needs to include monitoring process control loops continually for irregularities such as Alarm storms, nuisance Alarms, fault detection of process conditions, analytics of instrumentation and failures.
9. Data needs to be obtained which needs to be periodically analyzed and layers of protection need to be created, the layers of protection instead of manual responses by operators needs to be automated.

All the stated periodic modifications of Alarm settings and Automation of manual processes will enhance the capabilities that Alarm management can offer preventing the abnormal conditions and incidents to not only improve operations and serving facilities to operate with increased safety and enhanced productivity.

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AUTHORS PROFILE

Smitha Gogineni is an Instrumentation and Controls engineer with engineering degree in Electrical and Electronics and who works on Engineering design and construction large scale projects. In 18 years of experience in Instrumentation and Controls engineering in Oil & Gas and Semiconductor industries she also served as an Editorial board member for International Society of Automation ISA's Intech journal, reviewed technical articles for many publishers and is an active Senior member of ISA.