

TiPS TechDoc - White Paper

A Fresh Look at Alarm Performance Metrics

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Introduction

Alarm performance benchmarks are typically designed to measure the effect of alarm activity on operator performance. Human factors research clearly states that too much information is just as harmful as too little. In the context of process alarms, that realization generates the need for a way to determine the "sweet spot" between too many alarms (too much information), and too few.

In addition to alarm activity metrics used to find the "right" amount of alarm activity there are other classes of metrics that accurately expose shortcomings in alarm design and implementation, or those having little or no operational value. Using a good mix of all types of alarm performance metrics builds a better foundation from which to evaluate the performance, health, and value of an alarm system.

Operator Loading Metrics

The most widely accepted mechanism for determining the appropriate amount of alarm activity for a given operation is through an evaluation of operator loading. Monitoring the impact of alarms on an operating team helps determine the maximum thresholds for alarm activity in the context of all other operator responsibilities. Operators can do their job more effectively when alarm activity complies with established benchmarks.

By far the most widely recognized alarm performance benchmarks come from the EEMUA® Publication 191, Alarm Systems: A Guide to Design, Management and Procurement. EEMUA, the Engineering Equipment and Materials Users' Association is a UK-based organization that worked in conjunction with the Abnormal Situation Management® Consortium, the ASM® Consortium, to produce a comprehensive guideline for configuration and assessment of alarm systems.

The EEMUA alarm performance targets were established through extensive operator behavior studies at various refineries and chemical operations. While the raw numbers produced by the EEMUA study may not apply to all industries, the methodology used to develop them is. Use the EEMUA guide as a reference and starting point, and use the methodologies outlined in the guide to determine if the EEMUA benchmarks need to be modified for your operation.

Examples of environments where the EEMUA numbers might need to be adjusted include outside operators on a pipeline or in a mineral processing plant. Carefully observing and interviewing operators will determine appropriate performance targets, which may or may not align with the recommendations found in EEMUA 191.

The EEMUA recommended alarm system performance metrics are summarized on the next page in a KPI grid created by Ian Nimmo, President of User Centered Design Services®. Ian was a founding member of the ASM Consortium, managing many of the control room studies that led to the creation of the EEMUA benchmarks.

EEMUA Derived Alarm Performance Metrics

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KPI (Key Performance Indicator)	Target
Manageable Steady State	1 per 10 minutes
Flood State	10 in 10 minutes
Average Process Alarm Rate	5 per hour (120 per day)
% of Time Alarms Exceed Target Average Rate	0%
Peak Alarm Hourly Rate	15 per hour
Peak Alarm Minute Rate	2 per minute
Alarm Activity Priority Distribution	~ 5% ~ 15% ~ 80%
Alarms Within 10 Minutes of a Major Upset	10 or less
Chattering Alarms	0
Stale alarms (more than 1 day old)	0
Average Alarms / Controller	4
Unauthorized Changes to Alarm Settings	0

Manageable Steady State - The maximum rate at which a single operator can effectively address alarms.

Flood State - The rate at which a single operator is overwhelmed by alarm activations.

Average Process Alarm Rate - The average rate at which a single operator can be expected to perform as required.

% of Time Alarms Exceed Target Average Rate - The percentage of time that alarms exceed the target average alarm rate.

Peak Alarm Hourly Rate - The target peak hourly rate for the most active hour within the evaluated time period.

Peak Alarm Minute Rate - The target peak minute rate for the most active minute within the evaluated time period.

Alarm Activity Priority Distribution - The suggested approximate distribution of alarm activity by priority.

Alarms Within 10 Minutes of a Major Upset - The maximum rate in the 10 minute period following a major upset.

Chattering Alarms - Encourages proper maintenance and the use of alarm logic such as signal deadbands and filters.

Stale Alarms - Encourages the evaluation of alarms that remain active for an excessive period of time.

Average Alarms / Controller - A configuration target aimed at encouraging design discipline.

Unauthorized Changes to Alarm Settings - Encourages a strong management of change policy.

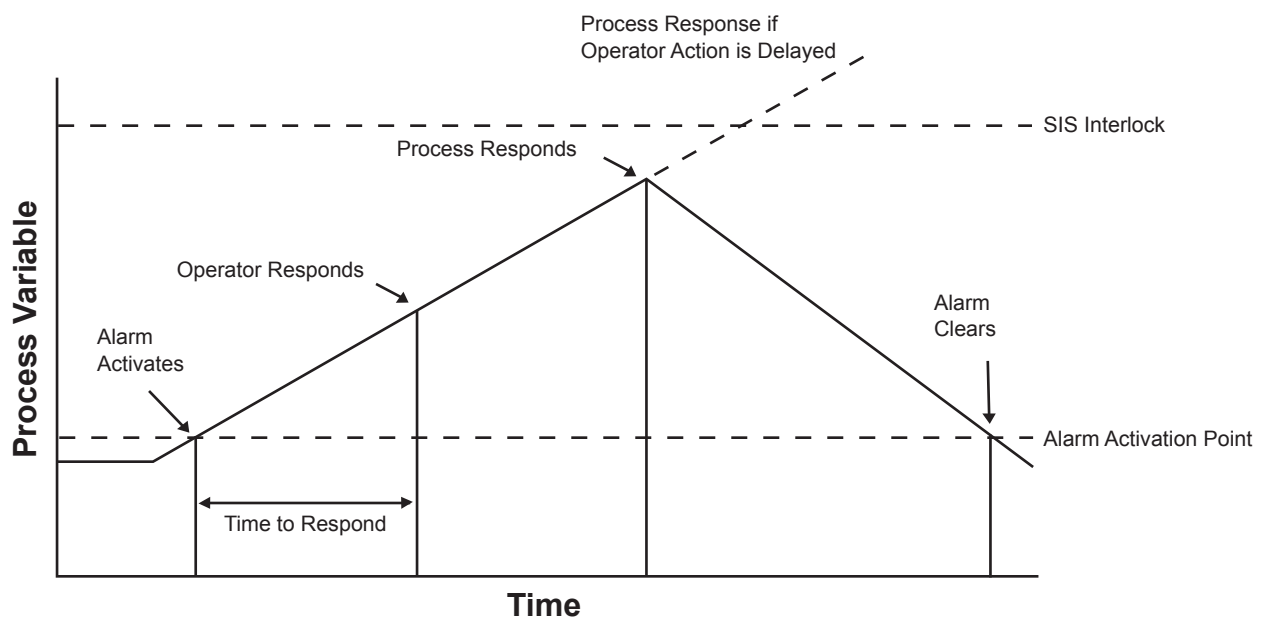
Alarm Duration Metrics

Alarm performance benchmarks derived from EEMUA guidelines or from similar operations evaluations quantify the operator loading effect of alarms. Alarms designed to perform within those types of parameters should enable operators to work effectively within the constraints and variables of their environment. Another type of alarm system metric correlates the duration of an alarm with the amount of time allotted for response to identify design and utility issues within the alarm system.

Alarms that remain active longer than the time allotted for a safe and effective operator response can be identified as potentially not having any value to the operation or that are difficult to address in a timely manner.

Correlating alarm duration with the response requires two parameters, "Time in Alarm" and "Time to Respond". Time in Alarm is calculated by comparing the alarm activation timestamp with the associated "clear" or "return to normal". Time to Respond is an operating procedure parameter which is usually determined during an alarm design or rationalization process. Time to Respond is not typically contained in a control system configuration, it is derived from process knowledge.

Time to Respond establishes the amount of time the operator is allowed to take corrective action in order for that action to result in a successful reversal of an abnormal trend. For example, if a process is trending toward a condition where a safety interlock will be activated, the operator must respond to that condition quickly enough to reverse the trend. Time to Respond determines when that action must be taken. The graph below illustrates the Time to Respond paradigm.



Alarm Timeline Diagram illustrating the design purpose of Time to Respond

Alarm Duration Metrics (continued)

Time to Respond is usually included in operator documentation or standard operating procedures, while Time in Alarm can be automatically calculated and stored electronically. Having Time to Respond and Time in Alarm in two very different containers poses a challenge. Fortunately there are ways to "virtualize" the Time to Respond parameter so it can be programmatically compared to alarm duration.

Generating a list of alarms with durations longer than their associated Time to Respond creates a "hit list" of items for careful review. Exposing the issues underlying duration discrepancies requires targeted questions such as:

Is this alarm being purposely ignored?

Was there enough time available during this upset for this alarm to be addressed?

Is the presentation of this alarm inadequate?

Was this alarm obscured by other information or alarms during this upset?

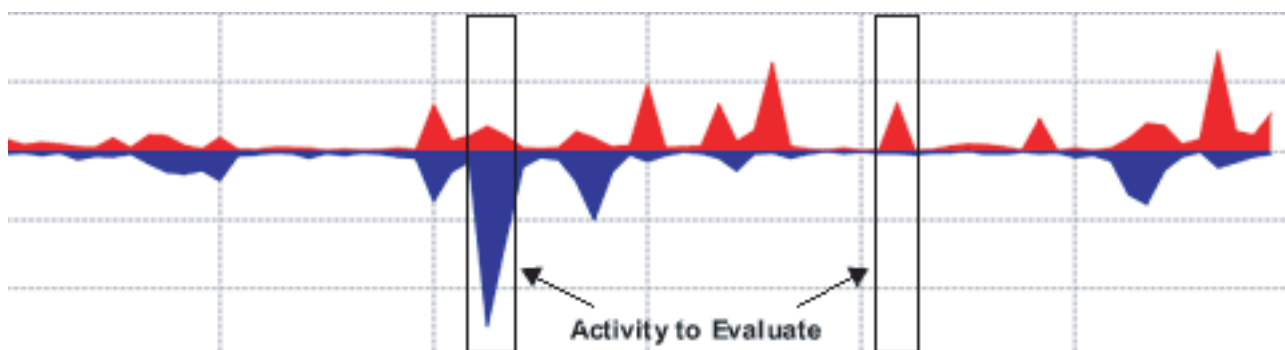
Does this alarm have an inappropriate priority?


A quality question and answer session can be very effective in identifying the changes needed to improve the treatment of important alarms or in determining alarms that should be reconfigured or removed.

Operator Response Metrics

Correlating alarms and operator actions is an alternative or supplemental method of discovering design issues or alarms with little operating value. Alarms that result in no control changes, or that result in frantic changes, can be indications of inadequate advance warning, poor documentation, a need for better training, or perhaps an alarm that needs to be removed.

One method of finding interesting groupings of alarms and actions is to plot both along a time axis. Good data mining tools will allow you to trend alarms and actions, then drill into the periods with unbalanced ratios, such as high alarm activity and low action count, or low alarm activity with high action count.





Thoroughly understanding the different types of alarm performance metrics will facilitate their positive influence on good alarm system design and good alarm management practices. The richness of alarm activity data joined and contrasted with other data resources yields compelling insight into alarm system health, and exposes opportunities for productivity gains through changes to the alarm design and beyond, to changes throughout the control system and control assets.

Maintaining control of operator loading is the foundation of alarm management. Complementing alarm activity metrics with additional event and configuration based analysis strengthens the alarm management process and improves the efficiency with which alarm-related problems can be located and addressed.