Meet the Experts – Sept. 20/21., 2011

Alarm Management
Outline

- Typical Problems
- Financial Impact
- Industry Guidelines
- ABB Fingerprint
- Typical Findings
- Recommendations
Alarm Management

How is your alarm system performing?

Do you recognize any of these behaviors?
- Operators acknowledge / silence alarms without looking at or acting on them?
- Incidents or near-incidents where operators missed alarms?
- Too many alarms without well-defined actions?
- Alarms disabled / suppressed for long periods without review?

Do you measure?
- Number of alarms / hour?
- Number of alarms disabled / suppressed?
- Time to silence / acknowledge?

How stressed are your operators?

Do you have a documented alarm philosophy?
- Have you described roles and responsibilities?
- How do you review and modify alarm settings?
Alarm Management
Example: Texaco Milford Haven 1994

- Explosion injured 26 people and caused damage of around $70 million
- Key factors included:
  - There were too many alarms and they were poorly prioritized
  - In the last 11 minutes before the explosion, the operators had to recognize, acknowledge and act on 275 alarms
Alarm Management Outline

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Alarm Management

Financial Impact

- plant state
  - nuisance alarms
  - standing alarms
  - missed alarms
  - critical alarms

- normal
- disturbed
- upset
- shutdown

- performance target
- operator priority
  - Process Optimization (important)
  - Production (very important)
  - Equipment Damage (urgent)
  - Safety & Environmental (critical)

- plant state
  - poor control
  - energy waste

- nuisance alarms
  - material expenses
  - containment loss
  - excess energy

- standing alarms
  - more wear & tear
  - equipment damage

- missed alarms
  - injuries/deaths

- critical alarms
  - environmental violations
Alarm Management
Benefits

- Avoid unintended shutdowns from missing alarms or responding too slowly to alarms
  - Lower equipment repair costs and increased operational efficiency and/or production rates.
- Increase operator availability and effectiveness with reduction in average alarm and event rate
  - If initial rate is 25/hour/operator and each consumes an average of 45 seconds, then workload can be reduced almost 1 hour per 12 hour shift if rate is reduced by 25%.
- Reduce Minor and Major Incidents from better alarm management
Alarm Management

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Engineering Equipment and Materials Users’ Association (EEMUA) has published guideline


International Society of Automation (ISA) has published standard

- ISA-18.2: Management of Alarm Systems for the Process Industries
Alarm Management
Definition of an Alarm System

EEMUA 191

- Purpose of an alarm system is to direct the operator's attention towards plant conditions requiring **timely** assessment or action.

- Each alarm should:
  - alert, inform and guide
  - be useful and relevant to the operator
  - have a defined response

- Adequate time should be allowed for the operator to carry out his defined response.
Alarm Management
System Management Guidelines

Define responsibilities
- Design
- Management
- Operation

Define procedures and standards
- Design
- Implementation
- Management
- Operation

Alarm Philosophy document
- Define what to alarm
- Standards for alarm annunciation and messages
- How the operator will interact with alarms

Alarm System Design document
- Define purpose
- Priority
- Operator response for each alarm

Define standards for configuration
Alarm Management System Management Guidelines

- Define methods to address nuisance alarms and standing alarms
- Define alarm priorities based on impact and reaction time
- Provide alarm system training for operators, engineers and technicians
- Define procedures for management of changes to the alarm system
- Create reports, records and tools for monitoring alarm system performance
The use of three priority bands within any one type of display is ergonomically effective

- High – Medium – Low ( + sometimes critical)
- Written rules on priority assignment required.

Example:

<table>
<thead>
<tr>
<th>impact</th>
<th>reaction time</th>
<th>&lt; 1000 $</th>
<th>&lt; 10000 $</th>
<th>&gt; 10000 $</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 10 Min.</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>3 to 10 Min.</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>&lt; 3 Min</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>
## Alarm Management

### Industry Findings vs. Guidelines

<table>
<thead>
<tr>
<th></th>
<th>EEMUA</th>
<th>Oil &amp; Gas</th>
<th>PetroChem</th>
<th>Power</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average Alarms per Day</strong></td>
<td>144</td>
<td>1200</td>
<td>1500</td>
<td>2000</td>
<td>900</td>
</tr>
<tr>
<td><strong>Average Standing Alarms</strong></td>
<td>9</td>
<td>50</td>
<td>100</td>
<td>65</td>
<td>35</td>
</tr>
<tr>
<td><strong>Peak Alarms per 10 Minutes</strong></td>
<td>10</td>
<td>220</td>
<td>180</td>
<td>350</td>
<td>180</td>
</tr>
<tr>
<td><strong>Average Alarms/10 Minute Interval</strong></td>
<td>1</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td><strong>Distribution % (Low/Med/High)</strong></td>
<td>80/15/5</td>
<td>25/40/35</td>
<td>25/40/35</td>
<td>25/40/35</td>
<td>25/40/35</td>
</tr>
</tbody>
</table>

Source: Matrikon
Alarm Management
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Optimization Services Methodology

- **Diagnose**
  - Measure and Benchmark
  - Detailed Improvement Plan
  - Document Goals, KPI’s

- **Implement**
  - Improve Performance
  - Apply corrective actions

- **Sustain**
  - Maintain Performance
  - Continued Improvement

**Proactive Solutions – not Reactive**
- Six Sigma Similarities

![Diagram showing the process flow from Diagnose, Implement, and Sustain leading to Increased Performance.](diagram)
Alarm Management Lifecycle

- Alarm Design Strategy
- Culture Change
- Alarm Rationalization
- Alarm Management
- Training

1. Where are we now?
- Assess the Current Position
  - Typically a short focussed assessment by experienced consultant engineer
  - Assessed against benchmarks and targets

2. Where do we want to be?
- Identify the Change Program
- Goal Setting (KPIs, Project success criteria)
- Identify deficiencies and corrective actions
- Planning/Budgeting

3. How successful were we?
- On-Going Alarm Management
  - owned by operations/ maintenance
- Audit and Measurement programme
Alarm Management
Fingerprint – The first step

- Goal: reduce alarms that are not useful to the operator, clarify alarms that are important
Alarm Management
Fingerprint

Alarm System Performance
- Calculate alarm statistics
- Compare to EEMUA guidelines

Alarm System Management
- Evaluate alarm system documentation
- Evaluate methods and procedures for configuring, operating, and managing alarm system
- Compare to EEMUA guidelines

Recommendations for improvements
Alarm Management
Fingerprint Steps

Interviews
- Operators, Supervisors, Process Engineers, Technicians

Review of procedures and instructions
- Documentation
- Methods

Measurement of Alarm System Performance
- Alarm Rates in steady state and upset conditions
- Frequency of alarms - nuisance alarms
- Standing and Shelved alarms
- Prioritization
Alarm Management
Fingerprint

- Findings and recommendation described in the report

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Alarm Management
Alarm Rate vs. EEMUA Guideline

- Calculate alarm rates for each 10 minute period
- Compare to EEMUA guideline of 1 alarm per 10 minute period
Alarm Management

Alarm Rate vs. EEMUA Guideline - Burst Rate

- Calculate burst alarm rates for each 10 minute period
- Compare to EEMUA burst rate guideline of 10 alarms per 10 minute period

08-AUG 8:22  318 / 20 min or 15.9/min
19-SEP 11:00  681 / 20 min or 34.1/min
20-OCT 00:40  719 / 20 min or 36.0/min
09-DEC 07:45  61 / 2 min or 30.5/min
22-JAN 12:10  410 / 20 min or 20.5/min

750 incidents of 10/min in 6 months
Alarm Management
Alarm Frequency Analysis

- A small number of tags are often responsible for a large percentage of the total alarms.
  - Top 10 represent 66% of alarms
Alarm System Performance Reporting

Tags sorted by no. of events

Alarm priority distribution
Alarm Management
Standing and Shelved Alarms

- Shelved Alarm: An alarm that has been temporarily disabled until an underlying problem can be corrected. Such alarms should only be shelved for a period of time, not permanently disabled.

- Standing Alarm: An alarm that has remained in an active alarm state for a significant period of time (e.g. 4 to 8 hrs)
Alarm Management
Alarm System Management Findings

- Alarm Philosophy documentation does not exist
- Alarm Design documentation does not exist
  - Alarms defined when control system was commissioned
  - Almost all tags configured as alarms
  - Alarm priority classes seldom utilized
- Changes to alarm system are undocumented
- No methods to monitor alarm system performance
Alarm Management
Summary of Findings

- Limited alarm system documentation
- High alarm rates
  - Too many nuisance alarms going into and out of alarm state
  - Too many alarms configured
- Too many standing alarms
  - Equipment that is out of service
  - Bad quality instruments needing maintenance
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How to Eliminate Nuisance Alarms

- Reconfigure alarms that require no operator action as event
- Eliminate instrument malfunctions
- Tune chattering control loops
- Optimize alarm parameters: set limit thresholds, hysteresis
- Advanced Alarming
  - State based alarming
  - Flood suppression
What-if scenario: Reducing nuisance alarms

Minimum limit: was set too high
Minimum limit: lower limit gets rid of nuisance alarms

Analyzing the time trend using histograms:
- Which alarm limits will result in which alarm rate?
- Find the best alarm limits (e.g. reduce the minimum threshold)
Alarm Management
Alarm Rationalization

- Form team to review all alarms
- Define purpose of each alarm – some alarms may be reclassified as events
- Define new priority using EEMUA and ISA recommendations
- Determine required operator response and alarm description
- Remove redundant alarms
- Create Alarm Design documentation
Alarm Management Recommendations

- Maintenance issues
  - Follow up on long standing issues
  - Shelve / Deactivate alarm if problem not fixed
  - Keep list of shelved alarms and periodically reevaluate

- Preventive Maintenance
  - Use a control loop management tool to improve tuning and identify instrumentation problems
Alarm Management
Alarm System Performance Monitoring

- ABB Smart Logger software
  - Capture and store alarm data
- ABB Smart Client software
  - Compute alarm statistics and compare with EEMUA guidelines
  - Monitor performance improvements over time
Alarm Management
Features in System 800xA

- Structured organization and single source of truth
- Pre-configured and ad-hoc filtering, live values
- Single click from alarm to multiple informational displays
- Alarm Hiding - Dynamic alarm handling
- Alarm Shelving - Operator based alarm hiding
- Built-in, operator accessible alarm analysis
Improving Operator Effectiveness
Effective decision support environment

- Consolidated alarms & events
- Right click access to integrated information
- Seamless integration of data from multiple systems
- Personalized Workplace based on operations philosophy
- Filterable, separated asset alerts
- Configurable Application Bar
- Graphics based on MS WPF
- Seamless integration of data from multiple systems
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