Alarm Management Optimization (AMO) at Saudi Aramco

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Gas Processing Industry
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Program Purpose and Objective
Program Strategy
Alarm System key Performance Indicators
Example Case
Alarm Management Optimization Methodology
Alarm Management Optimization at Gas Plants
Conclusion
AMO Program Business Driver

AMO Program sprang from a survey conducted on 2004 to measure the alarm management system performance level at Saudi Aramco Facilities. Most sites were aware that operator overload and alarm floods are common during disturbances and abnormalities of operations. As we analyzed the issues around alarm management, we concluded that operator problems with the alarm system were outcomes of an inappropriateness of the design, implementation, and maintenance of alarm systems as well as improper alarming practices.
Program Purpose and Objective

- **Purpose**

  To outline a five-year corporate plan to improve the alarm management system at each plant in Saudi Aramco that will enable the consol operator effectively manage alarms being generated during normal operation and/or abnormal situation.

- **Objective**

  To achieve the higher Alarm System performance level that delivers higher plant safety, reliability and availability.
Program Strategy

- Conduct Site Survey
- Develop/use Alarm System Management Standard/Procedure
  - SAER-5895 Alarm Management Guidelines for Process Automation Control
  - SAEP-368, Alarm System Management (New)
  - ANSI/ISA-18.2 Management of Alarm Systems for the Process Industries
- Develop Alarm Philosophy
- Evaluate AMO Technology Applications
- Conduct AMO Training Courses
- Conduct Alarm Management Performance Study
- Perform Alarm Documentation & Rationalization
- Implement the Rationalized Alarms
- Implement Real Time Alarm Management
- Sustain the Improved Alarm Management System
# Alarm System Key Performance Indicators

<table>
<thead>
<tr>
<th>KPIs</th>
<th>Interim Target</th>
<th>Long Term Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average process Alarm rate</td>
<td>&lt;300 per day</td>
<td>&lt;150 per day</td>
</tr>
<tr>
<td>Percentage of time alarm rate exceeds target</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>Alarm Event Priority Distribution</td>
<td>~80% Low, ~15% High, ~5 Emergency</td>
<td>~80% Low, ~15% High, ~5 Emergency</td>
</tr>
<tr>
<td>Suppressed Alarms</td>
<td>Zero (Unless as part of defined Shelving, Flood Suppression, or State-based Strategy)</td>
<td>Zero (Unless as part of defined Shelving, Flood Suppression, or State-based Strategy)</td>
</tr>
<tr>
<td>Chattering Alarms</td>
<td>Not more than 10 occurrences/week</td>
<td>0 per day</td>
</tr>
<tr>
<td>Stale/Standing Alarms (more than 24 hours old)</td>
<td>Not more than 20 occurrences/week</td>
<td>0 per day</td>
</tr>
<tr>
<td>Floods (10 to 20 alarms in a 10 minute period)</td>
<td>Not more than 5 per day</td>
<td>Not more than 3 per day</td>
</tr>
<tr>
<td>Floods (&gt;20 alarms in a 10 minute period)</td>
<td>Not more than 3 per day</td>
<td>0 per day</td>
</tr>
<tr>
<td>Changes in Alarm Priority, Alarm Trip Point, Alarm, Alarm Suppression</td>
<td>None that are unauthorized</td>
<td>None that are unauthorized</td>
</tr>
</tbody>
</table>
Alarms Per Day (Annunciated)

- March 10, 2007 to May 10, 2007 -

<table>
<thead>
<tr>
<th></th>
<th>Total Alarms</th>
<th>Average Alarms per Day</th>
<th>Median Alarms per Day</th>
<th>Maximum Alarms per Day</th>
<th>% Of Days More Than 300 Alarms per Day</th>
<th>% Of Days More Than 150 Alarms per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annunciated Alarms</td>
<td>12,979</td>
<td>209</td>
<td>136</td>
<td>2,585</td>
<td>15%</td>
<td>42%</td>
</tr>
<tr>
<td>Annunciated Alarms without 10 Most Frequent</td>
<td>7,677</td>
<td>124</td>
<td>101</td>
<td>461</td>
<td>3%</td>
<td>24%</td>
</tr>
</tbody>
</table>

- Peaks Exceed 2500 -
Alarm Floods - Count

Alarm Floods - Alarm Count

- 62 Days -

199 Separate Floods

Highest Count in an Alarm Flood = 1,320

Longest Duration of Flood = 1.83 Hours

Alarm Flood Analysis

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Highest Alarm Count in a Flood</th>
<th>1,320</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Floods</td>
<td>199</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floods Per Day</td>
<td>3.2</td>
<td>Percentage of Alarms in Floods vs. All Annunciated Alarms</td>
<td>61.4%</td>
</tr>
<tr>
<td>Total Alarms in All Floods</td>
<td>7,971</td>
<td>Total Duration of Floods, in Hours</td>
<td>51.5</td>
</tr>
<tr>
<td>Average Alarms per Flood</td>
<td>40</td>
<td>Percentage of Time Alarm System is in a Flood Condition</td>
<td>3.5%</td>
</tr>
</tbody>
</table>
Average Alarm Rates

Announced Alarms per 10 Minutes

<table>
<thead>
<tr>
<th>Announced Alarms per 10 Min.</th>
<th>= 0</th>
<th>&gt;0</th>
<th>&gt;=10</th>
<th>&gt;20</th>
<th>&gt;30</th>
<th>&gt;50</th>
<th>&gt;100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative</td>
<td>66.1%</td>
<td>33.9%</td>
<td>3.2%</td>
<td>1.0%</td>
<td>0.6%</td>
<td>0.4%</td>
<td>0.2%</td>
</tr>
<tr>
<td>No. of Alarms</td>
<td>0</td>
<td>1-9</td>
<td>10-20</td>
<td>21-30</td>
<td>31-50</td>
<td>51-100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Instances</td>
<td>5893</td>
<td>2744</td>
<td>194</td>
<td>38</td>
<td>21</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>% of time</td>
<td>66.1%</td>
<td>30.8%</td>
<td>2.2%</td>
<td>0.4%</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

Avg. Alarms per 10 minute period: 1.45
Frequent Alarms (Annunciated)

Most Frequent Annunciated Alarms

- 32B4B2ON.CHOFST
- 32B4B2OFF.NRM
- 31A034.PVHI
- 32PC130.PVHI
- 30TI025.PVLO
- 32TI224.PVHI
- 32FR165.BADPV
- 32FS161.BADCTL
- 32LI140.PVLO
- 32LI201.PVHI
Priority Distribution

Alarm Priority
- Low
- High
- Emergency

Percentage

Total Alarm Settings Annunciated Alarms EEMUA

Counts % Counts % %
Journal 407 3% n/a 516 4% 80%
Low 8,413 61% 11,833 91% 15%
High 3,675 27% 1,324 10% 5%
Emergency 1,324 10% 630 5% 5%
Total 13,819 100% 12,979 100% 100%
Chattering Alarms (Annunciated)

Top 10 Annunciated Chattering Alarms - 3 in 1 Minute

- 32B4B2ON.CHOFST
- 31AI034.PVHI
- 32B4B2FF.OFFNRM
- 32LI201.PVHI
- 32TI224.PVLO
- 32LI201.PVLO
- 32TI224.PVHI
- 32LI132.PVLO
- 32FI157B.PVLO
- 32LI200.PVHI

Unique Annunciated Chattering Alarms (tag.parameter) 73
Produced These Annunciated Chattering Occurrences (of 3+ alarms in 1 minute) 1,661
Total Chattering Alarm Events: 4,983
Percentage of all Annunciated Alarm Events that are from Chattering Alarms 38.4%
Stale Alarms (Annunciated)

Annunciated Stale Alarms - Top 10

Number of Instances These Alarms Went Stale (>24 hrs) During Analysis Period
Alarm Management Optimization Methodology

- Conduct Alarm Management System Performance Assessment:
  - Collect alarm data from existing system
  - Analyze the gathered data
  - Identify improvement
    - Bad Actors Resolutions
    - Rationalization
  - Verify against standards:
    - SAES/SAEP
    - ANSI/ISA–18.2: Management of Alarm Systems for the Process Industries

- Implement Changes
  - Unnecessary Alarms
  - Trip Points
  - Priorities
  - Calibrations

- Maintain the Improved Performance:
  - Conduct post implementation assessment
  - Repeat the same steps as necessary
Alarm Management Optimization at Gas Plants

- Berri Gas Plant
  - Alarm Philosophy Document
  - Bad Actors Resolutions
  - Alarm Rationalization
- Ju’amah Gas Plant
  - Alarm Philosophy Document
  - Bad Actors Resolutions
  - Alarm Rationalization
- Hawiyah Gas Plant
  - Alarm Philosophy Document
  - Bad Actors Resolutions
  - Alarm Rationalization
- Hawiyah NGL Recovery Plant
  - Alarm Philosophy Document
  - Bad Actors Resolutions
- Uthmaniyah Gas Plant
  - Alarm Philosophy Document
  - Bad Actors Resolutions
- Shedgum Gas Plant
  - Alarm Philosophy Document
  - Bad Actors Resolutions
- Yanbu Gas Plant
Conclusion

- Evaluate new AMO software applications prior to application to ensure new versions meet SA requirements. AMO software is in a rapid development phase and it is anticipated that regular AMO package evaluations will be necessary.
- Target large value added facilities such as Gas Plants and Refineries first.
- Provide Corporate Training to users on a regular basis and on a site by site basis.
- Conduct annual AMO Roundtable discussion meeting.
- Maintain Engineering Guidelines for Alarm Management.
- Conduct a post-implementation analysis to measure the improvement of alarm system performance.
- Update Control System Standards to reflect the requirements of guidelines for AMO.
Thank You

Questions