Paper T3005B

# Best Practices in Alarm Management
# Experience from the Field

Roundtable: Lessons Learned in Information Technology

Kevin T. Diamond
Lead Process Controls Engineer
Air Products and Chemicals, Inc
PO Box 0097
246 Johnson-Reilly Road
Calvert City, KY 42029

Nadya Dhalla
Matrikon Inc.
10405 Jasper Avenue Suite 1800
Edmonton, Alberta T5K 2X6
Canada

## ABSTRACT

Effective safety systems are a fundamental requirement of industrial facilities today. Matrikon's ProcessGuard alarm management product has been implemented at more than 100 facilities worldwide across a variety of industries. This presentation draws on extensive operational and vendor experience implementing and using this technology to discuss best practices in alarm management.

Prepared for Presentation at the 2004 Spring National Meeting, New Orleans LA, Apr 25-29
16th Annual Ethylene Producers' Conference
T3005: [21] – Information Technology Applications in the Chemical Process Industries

## Background

In 2002, Air Products recognized that the sheer number of alarms that were being generated from their Distributed Control System, which was installed in 1989, was not optimum for their operation. Efforts were made to make sense out of the excessive load of alarms by sorting through piles of printouts and series of text files. This did not significantly lower the alarm count, or improve their understanding of their alarm problem.

In early 2003, Air Products decided to take action on their alarm problem by implementing ProcessGuard, Matrikon's alarm management software. Initially, the software was used to identify alarm problems so that the plant staff could use this information to reduce the frequency of alarms and to rank alarm data by alarm count. The most frequent alarms were quickly identified. Plant Management and DCS Technicians met daily and reviewed the top 20 alarms from the previous day. The team used this list to identify the obvious "nuisance" alarms and addressed them by changing alarm limits, deadbands, etc. as needed. Once the majority of these "chattering" alarms were corrected, the software was used to identify "parent/child" relationships between alarms. Each "parent/child" group was then analyzed, and long-term process improvement projects resulted.

In the first two months of the project, Air Products noticed an 8:1 reduction in the number of alarms, by maintaining a consistent and sustained engineering effort on alarm management activities. The ProcessGuard technology reduced their effort from 1 week to a few minutes to identify problems associated with their alarms and events. Air Products realized a total return on effort and investment in just 3 months.

## Introduction

In order to understand the meaning of alarm management, it is necessary to define alarms themselves and discuss their importance within the plant environment. Simply stated, an alarm is a warning signal that notifies an operator of an unexpected event and demands a response. It should signal only when a process variable exceeds certain set threshold or safety limits.

A collection of alarms makes up an alarm system, the function of which is to provide the operator with clear, meaningful and timely information about the state of an industrial process. Alarm systems are implemented with the objective of running the plant safely and increasing the plant uptime. Poor management of alarms renders the entire alarm system ineffective and makes it difficult to achieve the above objective. As a result, billions of dollars are lost every year to accidents, equipment damage, unplanned plant or unit outages, off-spec production, regulatory fines and huge intangible costs related to environmental and safety infractions.

It is clear that alarm management is one of the best-understood activities that can bring significant hard benefits to an organization. Sound alarm management practices are becoming recognized as the cornerstone of regulatory compliance, improved operational integrity and productivity, and enterprise-wide business improvements that repay investment in such initiatives. More and more, proper alarm management is becoming a precondition to extending a facility's operating license. Also, with health and safety regulatory bodies closely monitoring the way facilities operate, alarm management provides a concrete demonstration of a plant's commitment to the safety and well being of the local community and environment.

In order to better manage their alarm system, Air Products and Chemicals Inc. decided to integrate Matrikon's ProcessGuard as their means to effective alarm management.

## Air Products and Chemicals Inc. Experience

An effective alarm management system is an aid to meeting safe and consistent operation within many chemical companies, including APCI, which has historically remained a leader in safety within the Chemical industry. Their existing DCS does not contain a built-in alarm management mechanism; although it would log alarm information directly to printers and text files. Although providing basic functionality – this system made alarm analysis very difficult. Users could not electronically access information – such as alarm summaries, nor were they able to perform more complex and useful alarm analyses. It quickly became apparent that the alarm strategy in the control system could not be efficiently maintained in the long run and so APCI decided to seek out an alarm management product. Matrikon's ProcessGuard was chosen as the solution due to its integration to a variety of DCS Systems, as well as the ease-of-use of its analysis tools.

The ProcessGuard tools were initially distributed to APCI's engineers and support supervisors, who used the preconfigured Excel reports to troubleshoot alarm problems and look for changes (i.e. new alarms ringing in, new alarm bursts, etc.). They were pleased at the amount of time they were saving by using the software to manage, collect, and make sense out of the alarms. Where it once took a week to analyze one-day worth of alarm data, now it took them mere seconds. Also, the identified messages are parsed out, separated and sorted into alarms, events, and sequence of event messages to allow for more effective and better quality reporting. ProcessGuard has allowed APCI to turn alarm data into valuable information and has provided them a way to address issues in a symptomatic fashion.

After 2 weeks of baseline data collection, modifications to the alarm configuration began. Plant management and DCS technicians met daily to review the alarm counts from the previous day. The top 3-5 bad-acting alarms were selected, and the methodology below was incorporated to identify possible modifications.

The main goal of alarm analysis with ProcessGuard is to understand which alarms are occurring in a plant, and to identify opportunities to eliminate unnecessary alarms. The general flow of the analysis is:

1. Run the *Alarm Distribution Over Time* report to quantify the amount of alarm traffic and select smaller time periods of interest (usually the peaks in the trend).
2. Run the *Alarm Count by Tag* to identify the most frequently occurring alarms.
3. Use the *Chronological Report, Ad Hoc Query*, or process trends to understand the sequence of events leading to a frequent alarm.
4. Use the *Chattering Alarms*, *Standing Alarms* and *Symptomatic Analysis* reports to characterize frequent alarms and investigate potential causes.
5. Combine the findings with process knowledge to decide how to improve the alarm system or process performance to reduce the frequency of alarms.

Some of the necessary modifications that were identified using the above methodology included:

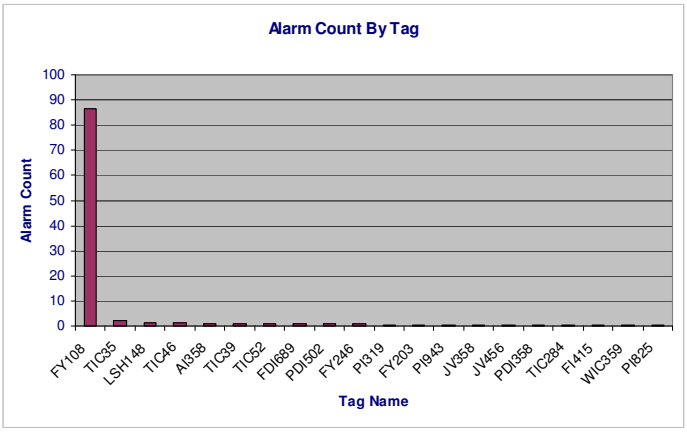
- Whether instruments are out of calibration (need to be calibrated)
- Change the range of the instrumentation
- Parent/child relationships between alarms

- Unnecessary alarms
- Increase deadbands and identify inappropriate limits on chattering alarms

Based on the EEMUA guidelines, a well-configured alarm system should generate no more than 1 to 2 alarms every 10 minutes, unless the operation is at an emergency condition. This benchmark is intended to give the operator enough time to respond appropriately to each alarm that occurs over the course of a shift. With this goal in mind, APCI and Matrikon began to analyze the alarm data. The following case study presents how APCI used the alarm history from ProcessGuard to analyze, understand, and improve their alarm strategy.

*Initial Count*

The following graph shows the Top 20 alarms normalized to 100. This report was generated based on the peaks within the Alarm Distribution over Time report (not shown). The Distribution report can be used to quantify the amount of alarm traffic that the operator sees during a specific timeframe.



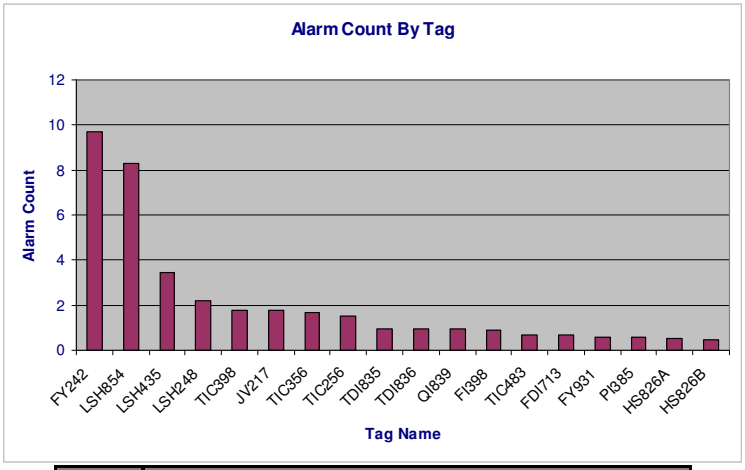

| Tag | Alarm Count (Normalized to a count of 100) |
|---|---|
| FY108 | 86.62 |
| TIC35 | 1.99 |
| LSH148 | 1.35 |
| TIC46 | 1.22 |
| AI358 | 1.02 |
| TIC39 | 1.01 |
| TIC52 | 0.94 |
| FDI689 | 0.77 |
| PDI502 | 0.69 |
| FY246 | 0.69 |
| PI319 | 0.64 |
| FY203 | 0.56 |
| PI943 | 0.46 |
| JV358 | 0.36 |
| JV456 | 0.31 |
| PDI358 | 0.31 |
| TIC284 | 0.28 |
| FI415 | 0.26 |
| WIC359 | 0.26 |
| PI825 | 0.26 |
| **Total:** | 100 |

**Figure 1: Top 20 Alarm Count (normalized to 100)**

The above Top 20 report shows the number of alarms each tag created during a specific timeframe. As shown, a large majority of the alarms were generated from just one tag. After the suspect tags had been selected, further review of the data was needed. *Frequency distribution*, *Chronological Reports*, *Ad Hoc Queries, Symptomatic reports (relationships between parent/child alarms)*, as well as process trends were used to determine the sequence of events that led to the frequent alarms.

*After 1 month*

The following trend shows the Top 20 alarms following 1 month of alarm management (normalized and compared to the initial alarm count of 100). As shown, the total number of alarms decreased from 100x to 37.96x.




| Tag | Alarm Count (normalized & compared to initial count of 100) |
|---|---|
| FY242 | 9.71 |
| LSH854 | 8.29 |
| LSH435 | 3.42 |
| LSH248 | 2.19 |
| TIC398 | 1.76 |
| JV217 | 1.76 |
| TIC356 | 1.66 |
| TIC256 | 1.51 |
| TDI835 | 0.92 |
| TDI836 | 0.92 |
| QI839 | 0.92 |
| FI398 | 0.89 |
| TIC483 | 0.69 |
| FDI713 | 0.66 |
| FY931 | 0.56 |
| PI385 | 0.56 |
| HS826A | 0.54 |
| HS826B | 0.48 |
| FY304 | 0.26 |
| PI742 | 0.26 |
| **Total:** | 37.96 |

**Figure 2: AFTER - Top 20 Alarm count**

The total alarm count for a 7-day period, after approximately 4 weeks of continuous improvement is shown below. Although there is 1 peak period, the primary measure of improvement was the fact that 35% of the 10-minute intervals now had an alarm count less than 2. Compared to a benchmark of 1 alarm every 10 minutes, the load on the operator is generally moderate (2 or less) with regular excursions over 10.

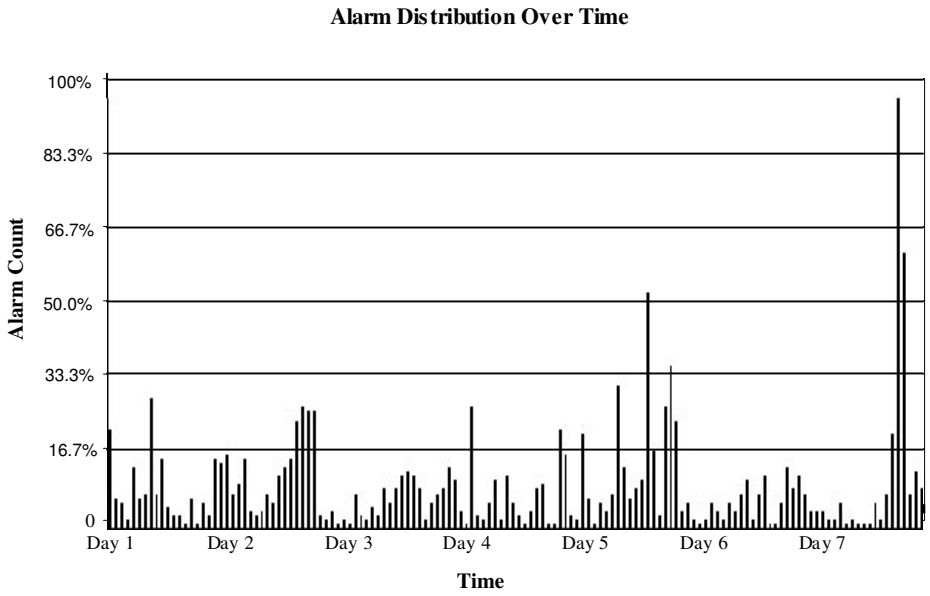



**Figure 3: AFTER - 10-minute alarm count for a 7-day period after 4 weeks of alarm management (zero counts not shown)**

*Performance Improvement*

APCI, with a very moderate amount of effort, was able to use ProcessGuard to help identify the frequency of alarms that were ringing in - as well as which alarms were giving them problems. A dramatic reduction in alarm count occurred in less than 1 week of effort, and further steady reductions were achieved by sustained engineering attention to identifying root causes and immediately rectifying issues. For each of the "top 20" alarms, an engineer was responsible for identifying the cause of the alarms, identifying whether it was due to a true upset condition or an instrumentation issue. For instrumentation issues, the root cause was identified and a maintenance work order was prepared to correct the alarms. Any configurations of plant changes were completed under the plant Management of Change Procedures.

The average daily alarm count was reduced by 63% within 4 weeks. By the end of the second month, APCI noticed an 8:1 reduction of alarms. This reduction was achieved with by utilizing a consistent work process and team of production, instrumentation and maintenance engineers.

Table 1 details the performance before and after the initial modifications. Alarm numbers have been scaled from 1-100.

**Table 1: Performance before and after improvements**

| | Week 1 | 4 weeks later | Change | 2 months later | Change |
|---|---|---|---|---|---|
| Daily average alarms | 100 | 37 | **- 63%** | 18 | **-82%** |
| Peak 10-minute alarm count | 100 | 37 | **- 63%** | 17 | **-83%** |

## ProcessGuard

ProcessGuard™ is an alarm management system developed by Matrikon Inc. to enable operators, managers, and engineers understand which alarms are occurring, and to identify opportunities for improvement. It easily interfaces with all control systems (e.g. DCS, PLC) in a plant in order to capture alarm information, report alarm summaries, and provide intelligent analysis tools. The ProcessGuard methodology of "capture, store and analyze" ensures that a best-practices approach to alarm management can be properly implemented and sustained over time.

ProcessGuard consists of the following components:

- *A&E Collector* is the point of entry for alarm or event data to the ProcessGuard system.
- *Rules Builder* helps create a set of rules. These rules are used by ProcessGuard to parse the data into appropriate columns in the database (i.e. alarm type, timestamp, value, priority etc.).
- *A&E Archiver* receives the raw alarm data from the *A&E Collector* then applies the rules from the *Rules Builder* and stores the parsed data in the alarm database.
- *A&E Viewer* is a tool for real-time monitoring of the alarm data.
- *A&E Excel Analysis Tool* is a Microsoft Excel Add-in that pulls data from the database. This lets you view predefined reports or perform ad hoc queries and statistical manipulation on the data based on EMUUA standards.
- *A&E Web Analysis* provides both out-of-the-box and customizable alarm reports via the web

Both the Excel and web analysis tools are the windows to the alarm system. With the use of existing pre-defined reports, ad-hoc queries and filters, users can easily convert their alarm and event data into useful information in a timely manner. All reports are based on the EEMUA (Engineering Equipment and Materials Users Association) guidelines, which are recognized as the accepted source of "Alarm Management" best practice.

## Summary

APCI has noticed the following benefits since implementing Matrikon's ProcessGuard as part of a consistent alarm management program:

Soft costs:

- Increased Safety
- Freeing operator time for better troubleshooting in other process areas. Now there are fewer alarms that require operator action.
- They are able to focus on operational, quality and on-stream issues now that they have dealt with the regulatory issues of safety and the environment.
- Reduce clutter and noise.
- Predict equipment degradation and failure.

Hard costs:

- Now able to identify and reduce the factors that cause downtime.
  <Decreased Downtime, Increased Total Production; Increased Reliability>
- Now able to identify what causes off-quality product and improve it.
  <Increased Product Quality; Less Off-spec Material; Reduced Overall Cost of Production>
- Efficient at reducing the 80% low priority, nuisance alarms and are now focused on the other original 20%, which are operational, quality and on-stream issues.
- Seen a return on both total effort and investment in just 3 months. This includes software, services and man-hours from both Matrikon and APCI.

Matrikon's initiatives in alarm management are extensive and are based on the wealth of experience and knowledge that many of our customers have provided. The net result is man-months of saved review time and better operations, resulting in improved production and safer operating conditions while reducing plant downtime.