Alarm Management

An effective alarm management program is essential to safe and effective plant operations. This whitepaper provides an overview of DeltaV™ Distributed Control System alarm operations capabilities and related alarm management products and services, enabling a complete, robust and sustainable alarm management program compliant with ISA-18.2 – Management of Alarm Systems for the Process Industries.

Build an effective alarm management program that protects your people, assets and profitability.
Introduction

This document describes how the DeltaV distributed control system and related alarm management products and services from Emerson and its alliance partners combine to provide a complete and effective foundation for implementing and sustaining an alarm management program that conforms to ISA-18.2 – Management of Alarm Systems for the Process Industries.

Why implement an alarm management program? All too often process control systems are implemented with little attention given to the justification of and expected operator response to alarms. The near-zero engineering effort required to create alarms combined with many new alarm sources has contributed to their proliferation. The result is a heightened risk for alarm floods and nuisance alarms, with consequential adverse effect on product quality, process efficiency, equipment protection, environmental incident and personnel safety.

The definition of an ‘alarm’ is of central importance when establishing an alarm management program. The distinction between an alarm as defined in ISA-18.2 and other types of Operator notification are illustrated in the following diagram. The DeltaV system provides native capabilities to differentiate these Operator notifications.

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<th>Operator Must Act</th>
<th>FYI to the Operator</th>
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<td>Abnormal</td>
<td>Alarm</td>
<td>Alert</td>
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<tr>
<td>Expected</td>
<td>Prompt</td>
<td>Message</td>
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Operator Notification Types.

Note that customers pursuing general improvement in alarm system performance unrelated to ISA-18.2, or taking an incremental approach to compliance, may easily do so with no added burden to configuration or operation. Often, for systems already in operation the best place to start when building a comprehensive alarm management program is to first tackle the typical very small number of control modules that generate the majority of fleeting, chattering and stale alarms. DeltaV Analyze lets you easily spot these ‘bad actors’ and the DeltaV process control system provides the necessary tools to eliminate them.

Many control system owners have implemented alarm management programs based on EEMUA-191 Alarm Systems – A Guide to Design, Management and Procurement. They will be pleased to know that the ISA-18.2 standard is consistent with and builds upon this prior publication. However where EEMUA-191 is a guide, ISA-18.2 is an ANSI standard with normative clauses. ISA-18.2 is being rapidly adopted by the insurance industry and regulatory bodies as the basis for measuring good engineering practice relative to alarms. Thus an effective alarm management program is becoming more than a guide to good operational practices for operating a safer plant; for some it will become a mandated business necessity.

In late 2014 the international standards body International Electrotechnical Commission (IEC) released IEC62682 – Management of Alarm Systems for the Process Industries. This international standard was written as an extension of the existing ISA 18.2-2009 standard with due consideration of other guidance documents like EEMUA-191 that have been developed throughout industry.

This whitepaper cites ISA-18.2 throughout, but is completely relevant to EEMUA-191 and IEC62682.
An Overview of the ISA-18.2 Standard

ISA-18.2 – Management of Alarm Systems for the Process Industries (ISA-18.2 for short) provides a lifecycle framework for customers to manage every aspect of the alarm system.

![ISA-18.2 Alarm System Management Lifecycle.](image)

- **Philosophy** – The usual starting point in the alarm lifecycle is the development of an alarm philosophy. The philosophy provides guidance for all of the other lifecycle stages. It includes key definitions like the definition of an alarm, which by itself is a critical element to alarm management. It takes into account the alarm handling capabilities of the control system and other site specific considerations. The philosophy ensures the processes for other lifecycle stages are planned and documented.

- **Identification** – The identification stage of the alarm lifecycle includes activities like P&ID reviews, process hazard reviews, layer of protection analysis and environmental permits that identify potential alarms. ISA-18.2 does not prescribe requirements for alarm identification methods. These methods are already well documented. To ensure that the results are useful as an input to the alarm rationalization stage, it is helpful to document the cause, potential consequence, and the time to respond for each identified alarm.

- **Rationalization** – In the rationalization stage each potential alarm is tested against the criteria documented in the alarm philosophy to justify that it meets the requirements of being an alarm. The consequence, response time, and Operator action are documented. Alarms are analyzed to define their attributes (such as limit, priority, classification, and type). Alarm priority is typically based on the severity of the consequences and the time to respond. Classification identifies groups of alarms with similar characteristics (e.g. environmental or safety) and common requirements for training, testing, documentation, or data retention. The results of the rationalization are documented in a Master Alarm Database.
Detailed Design – In the detailed design stage of the alarm lifecycle, an alarm is designed to meet the requirements documented in the alarm philosophy and the rationalization. Poor design and configuration practices are a leading cause of alarm management issues. Alarm design includes the basic alarm design, setting parameters like the alarm deadband or off-delay time, advanced alarm design, like using process or equipment state to automatically suppress an alarm, and HMI design, displaying the alarm to the Operator so that they can effectively detect, diagnose, and respond to it. During the detailed design phase, the information contained in the Master Alarm Database (such as alarm limit and priority) is used to configure the system.

Implementation – The implementation stage of the alarm lifecycle addresses putting the alarms into operation. It includes the activities of training, testing, and commissioning. Testing and training are ongoing activities, particularly as new instrumentation and alarms are added to the system over time or process designs changes are made.

Operation – During the operation stage of the alarm lifecycle, an alarm performs its function of notifying the Operator of the presence of an abnormal situation. Key activities in this stage include exercising the tools the Operator may use to deal with alarms such as alarm displays, shelving functions, and accessing information gathered during rationalization such as an alarm’s cause, potential consequence, corrective action, and the time to respond.

Maintenance – The process of placing an alarm out-of-service transitions the alarm from the operation stage to the maintenance stage. In the maintenance stage the alarm does not perform its function of indicating the need for the Operator to take action. The standard describes the recommended elements of the procedure to remove an alarm from service and return an alarm to service.

Monitoring and Assessment – Monitoring and assessment of the alarm system is a separate stage of the alarm lifecycle because it encompasses data gathered from the operation and maintenance stages. Assessment is the comparison of the alarm system performance against the stated performance goals in the philosophy. One of the key metrics is the rate alarms are presented to the Operator. In order to provide adequate time to respond effectively, an Operator should be presented with no more than one to two alarms every ten minutes. A key activity during this stage is identifying “nuisance” alarms - which are alarms that annunciate excessively, unnecessarily, or do not return to normal after the correct response is taken (e.g., chattering, fleeting, or stale alarms).

Management of Change – The management of change stage of the alarm lifecycle includes the activity of authorization for all changes to the alarm system, including the addition of alarms, changes to alarms, and the deletion of alarms. Once the change is approved, the modified alarm is treated as identified and processed through the stages of rationalization, detailed design and implementation again. Documentation like the Master Alarm Database is updated and the operators are trained on all changes.

Audit – The audit stage of the alarm lifecycle is primarily focused on the periodic review of the work processes and performance of the alarm system. The goal is to maintain the integrity of the alarm system throughout its lifecycle and to identify areas of improvement. The alarm philosophy document may need to be modified to reflect any changes resulting from the audit process.
Solutions Overview for DeltaV Customers

In this section specific challenges and solutions are summarized for each stage of the ISA-18.2 lifecycle. More details and examples are provided in later sections.

<table>
<thead>
<tr>
<th>Lifecycle Stage</th>
<th>Lifecycle Stage Deliverables</th>
<th>Challenges</th>
<th>Available Emerson and Alliance Partner Solutions</th>
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</table>
| Philosophy      | ■ A site-specific document defining alarm management practices and principals | ■ Education on the ISA-18.2 standard  
 ■ Development of a site document compliant with ISA-18.2 normative requirements | ■ 2 day on-site course on Alarm Management Practices and principals  
 ■ 3 day on-site workshop to formulate the philosophy with site stakeholders and subsequent preparation of an ISA-18.2 compliant document by a qualified alarm management expert |
| Identification  | ■ A master alarm database with candidate alarms, or current alarms in the case of an existing system | ■ Selection of a master alarm database application that provides good productivity for rationalization of potential thousands or even tens of thousands of alarms  
 ■ Population of the database with existing system alarms | ■ A simple master alarm database integrated into the DeltaV system’s native configuration system  
 ■ An off-line built-for-purpose master alarm database application, SILAlarm available from Emerson’s alliance partner exida; ideal for multi-system sites (including non-DeltaV systems) or sites where the quantity of alarms requires extensive rationalization productivity aids  
 ■ RationalizationReady service, where existing system alarms are pre-populated into the SILAlarm master alarm database |
| Rationalization | ■ Documented alarm design requirements including alarm justification, priority, alarm thresholds consistent with the time allotted for operator action, and the expected operator action | ■ Auditable demonstration of good engineering practice and management of change  
 ■ Consistency of alarm requirements  
 ■ Productivity of the customer staff tasked to perform rationalization | ■ SILAlarm master alarm database, where alarm design decisions may be systematically checked against design criteria specified in the alarm philosophy and changes documented.  
 ■ On-site rationalization quick start assistance, typically 2 weeks in duration, where a qualified alarm management specialist leads the customer rationalization team, to build team skills, establish methodology and ensure the master alarm database application is being used in the most efficient manner  
 ■ Ongoing rationalization facilitation assistance services |
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<td>Detailed Design</td>
<td>■ Operator graphics conducive to good Operator situational awareness&lt;br&gt; ■ Basic alarm design, optimized to eliminate bad actors&lt;br&gt; ■ Selective use of advanced alarm design, where needed to avoid or mitigate alarm floods</td>
<td>■ Efficient, accurate translation of the alarm design specification from rationalization to an actual alarms in the DeltaV system&lt;br&gt; ■ Efficient implementation of dynamic alarm suppression as required to eliminate stale alarms and alarm floods</td>
<td>■ SILAlarm master alarm database, providing a native DeltaV bulk edit import and export function capable of fully configuring (or importing) a DeltaV alarm, including alarm help&lt;br&gt; ■ Pre-engineered DeltaV system display dynamos and color pallets optimized according to Human Centered Design (HCD) principles&lt;br&gt; ■ DeltaV native conditional alarming built into the AI, PID, ALM and other common use function blocks&lt;br&gt; ■ Pre-engineered control modules, faceplates and detailed displays for accomplishing first out and dynamic alarm flood suppression&lt;br&gt; ■ Expert engineering services to apply best engineering practices for maximum application of native DeltaV alarm management features</td>
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<tr>
<td>Implementation</td>
<td>■ Activation of alarm designs in the running system&lt;br&gt; ■ Execution of operator training and testing required</td>
<td>■ Transferring alarm knowledge gained in rationalization to the operator&lt;br&gt; ■ Capturing alarm knowledge possessed by expert senior operators</td>
<td>■ DeltaV Operator Training Solutions&lt;br&gt; ■ Emerson classroom, on-site and eLearning operator training&lt;br&gt; ■ MiMiC, providing process simulation integrated with DeltaV, for software acceptance testing and operator training.&lt;br&gt; ■ DeltaV Alarm Help, providing in-context and pre-alarm state Operator access to alarm guidance, probable cause and other alarm information captured during rationalization&lt;br&gt; ■ DeltaV Alarm Help, enabling controlled expert operator authorship of alarm guidance</td>
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| Operations      | - System tools and methods enabling operators to manage alarms effectively at all times | - Avoiding alarms before they happen wherever possible  
- Ensuring operator awareness of alarms  
- Ensuring expected operator action  
- Providing operators the tools needed to manage alarm floods | - Abnormal condition indicators and process trend integration in displays to identify abnormal conditions (e.g. interlock active) before alarms occur  
- DeltaV system alarm sounds, designed to easily identify the operator position and alarm priority in multi-operator control rooms  
- DeltaV alarm descriptions, allowing precise labeling of every alarm for certain operator identification  
- DeltaV SIS Alarm groups, enabling precise identification of SIS alarms as well as easy navigation to the proper operator graphics  
- DeltaV Alarm Help for in-context access to alarm-specific guidance  
- DeltaV alarm banner with native alarm prioritization and area eclipsing, to identify the most important alarms  
- DeltaV alarm shelving, allowing temporary operator suppression with reason entry and recording  
- DeltaV Alarm Mosaic, a graphical alarm list designed to reduces stress during an alarm flood and aid root cause identification, with activation history view for shift transition review |
| Maintenance     | - System tools and methods enabling approved personnel to manage removing alarms from service | - Ensuring visibility to and accountability for restoration of critical alarm to active service  
- Ensuring awareness of discrepancies between approved and run-time alarm settings | - DeltaV alarm removal from service, allowing suppression independent of operator shelving with reason entry and recording  
- DeltaV System Alarm Management (SAM) application, providing easy review of configured alarm parameters and automated reports to identify differences between approved and key alarm run-time properties |
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| Monitoring and Assessment | - Periodic key performance measurements against targets in the site alarm philosophy  
- Lists identifying bad actor alarms (fleeting, chattering, stale, most often suppressed, etc.) | - Collecting and managing raw alarm events and deriving meaningful actionable analytics  
- Generating metrics tailored to the site alarm philosophy  
- Providing management stakeholders with high level customized alarm KPI reports and dashboards for multiple systems and operator positions | - DeltaV Event Chronicle, to capture alarms, events and user actions  
- DeltaV Plantwide Event Historian, to aggregate alarms and events from multiple systems and other sources  
- DeltaV Analyze, to identify and investigate bad actor alarms  
- DeltaV Analyze, to schedule Alarm Statistics reports based on ISA-18.2 KPIs for individual operator positions  
- XLReporter™ by Emerson alliance partner SyTech, to aggregate and historize DeltaV Analyze alarm report content for custom report creation and distribution by multiple methods |
| Management of Change | - Auditable documentation showing alarm system changes are done in accordance with the site alarm philosophy | - Enforcing authorization policies  
- Auditing and enforcing master alarm database settings | - DeltaV system security and user rights management, providing access control down to individual parameters  
- DeltaV electronic signatures policies  
- DeltaV Event Chronicle, capturing every user transaction in the operating environment  
- DeltaV Configuration Audit Trail, capturing changes in the engineering environment including alarm help  
- DeltaV runtime alarm attribute audit reports  
- SILAlarm, capturing rationalization decisions and changes in the master alarm database  
- SILAlarm, to audit and enforce changes between SILAlarm master alarm database and DeltaV configuration |
| Audit | - A report or other authorities determination that the alarm management system is performing as documented in the site alarm philosophy | - Gaining easy access to alarm system performance (KPI) information  
- Obtaining an expert independent view | - DeltaV Analyze for runtime KPIs  
- SILAlarm for as-configured KPIs  
- A processes and practices assessment against both ISA-18.2 principals and site alarm philosophy if one exists, performed by a qualified alarm expert  
- An operator Interview program, conducted by a qualified alarm expert |
Native Simplicity for a Robust Easy Implementation

Alarm management functions that directly daily affect the operator and system control engineer are integrated into the core DeltaV system, including shelving, out-of-service designation, reason for suppression, alarm setting auditing, alarm help, conditional alarming and specialized alarm lists. As part of the core system they are easy to apply and use with no new skills required, are supported through DeltaV Guardian Support at no extra expense, and migrate effortlessly as part of any DeltaV system migration.

Non-native alarm management applications typically rely upon an OPC interface; to implement auditing of alarm settings, accomplish shelving and dynamic alarming and collect events to provide alarm analytics. This creates substantial additional effort for the process engineer to coordinate changes to alarm management functions.

Alerts from field devices and system hardware are integrated into the system for high availability and optimum presentation. Native mechanisms and out-of-box default settings ensure the appropriate information is presented to the operator, maintenance technician and other individuals in other roles.

DeltaV Analyze has local access to the Event Chronicle or Plantwide Event Historian, for immediate visibility and reporting of alarm information with no dependence on OPC or other remote data transfer methods. DeltaV Analyze requires no special configuration or report design. Simply install it and start using its native point-and-click analytics and fully defined alarm system performance reports.

Alarm Operations

Alarm management functions that directly and daily affect the operator and system control engineer are called Alarm Operations in the DeltaV System, distinct from Alarm Analytics and Alarm Rationalization. Alarm Operations functions are core components of the DeltaV system.

Operator Graphics

Dynamos that favor Operator quick visual scanning vs. reading, integration of abnormal situation alerts and embedded trends come together in the DeltaV runtime operator environment to maximize operator situational awareness. Based on Human Centered Design principals, every aspect of the operator experience from the selection of alarm sounds to optimized color pallets is tuned to make the system easy to use and easy to configure.

Both DeltaV Live and DeltaV feature smart color use, easy to see alarms and rapid access to alarm information.
Integrated abnormal event icons allow Operators to spot device alerts and other atypical conditions to anticipate and resolve situations before reaching an alarm condition.

![Alarm Icons](Image)

**Alarm Sounds**

Experts agree that human centered design of the process control room substantially contributes to greater Operator situational awareness, efficiency and effectiveness. This whitepaper addresses one aspect of the control room environment, alarm sounds. Selection of alarm sounds should not be a casual matter. Poorly conceived alarm sounds can contribute to Operator stress and confusion. Smart sound selection is especially important in multi-console control room environments.

By special licensing arrangement with Human Centered Solutions, LLP (HCS – at [www.applyHCS.com](http://www.applyHCS.com)), the DeltaV Process Control System features HCS Alarm Sounds for Multi-Console Control Rooms™, which have the power to communicate more information, take advantage of human strengths, and have a proven record for Operator acceptance.

The DeltaV system comes supplied with six copyrighted WAV files (©2009HCS in the file name), licensed for use by the system owner subject to the end-user System Software License Agreement. These six WAV files comprise two sets of alarm sounds, one each for two distinct operator console positions, where each set has three files that correspond to three levels of alarm priority.

![Sound Envelope](Image)

*Sound envelop of the HCS Alarm Sounds for Multi-Console Control Rooms™.*
High, medium and low priority alarm sounds are provided with the system for two console operator positions. Console 1 high, medium and low HCS WAV files are the default selections for critical, warning and advisory priority alarm sounds on a first console. All workstations within this first console would use this same set (e.g., Console 1 high, medium, and low HCS WAV files).

For a second console in the same control room, selecting Console 2 high, medium and low HCS WAV files results in easily distinguishable alarm sounds between the two consoles. Operators for either console will easily recognize which console and alarm priority is indicated.

**Alarm Descriptions**

For most alarms the combination of control module tag, module description and alarm name are completely sufficient for the operator to comprehend an alarm’s source and nature. For example LIC101 Solvent Tank HI_ALM requires no elaboration; the solvent tank has a high alarm. Some alarms are not as straightforward however, which is often the case for discrete alarms and alarms from SIS and other complex modules. Alarm descriptions enable precise labeling of the individual alarms within a module when needed, replacing the module description in alarm lists, Alarm Help and elsewhere. Alarm descriptions can be bulk edited. New and modified alarm descriptions can be downloaded to a system without effect on running control modules.

**SIS Alarm Groups**

Starting v14, SIS alarms can optionally be grouped in user-defined alarm groups for improved identification. You can create several alarm groups within a SIS module and assign function blocks and user-defined parameters within the SIS module to an appropriate SIS alarm group. For example, you might create an alarm group that includes all the function blocks associated with a voter (such as an analog voter block and multiple analog input blocks). You might also create a different alarm group for all the function blocks associated with a valve (for example, a discrete output block for the solenoid and a DVC block for the positioner). For each alarm group, you are able to specify an description and set of displays (primary control, detail and faceplate).

**Alarm Banner**

The DeltaV Alarm Banner and its associated horn behavior maintain constant focus on the most important alarms, even at times when the operator may be occupied filtering or sorting the alarm list.

*The Alarm Banner keeps constant focus on the most important alarms. Note the consolidation of all low-priority alarms in TANK_FARM unit to conserve alarm banner slots for more important alarms.*
The alarm banner’s auto eclipsing function can consolidate multiple alarms of a specified priority to a single slot in the banner for a control module or for an entire process unit, while at the same time allowing the individual presentation of higher priority alarms. To see all the individual low priority alarms the operator can click on the consolidated item in the banner to open the corresponding unit or module faceplate, or go to the system alarm list.

Alarm banner thresholds may be set independently by alarm source (control module, device, system hardware, SIS module, SIS device or SIS hardware) for each workstation, to fine tune alarm banner use for either operator or non-operator workstation applications. Default system settings ensure the alarm banner in Operator workstations are focused on process alarms while the alarm banner on a Maintenance workstation is focused on device and system alerts.

**Area Filtering**

Operator span of alarm responsibility is maintained using control module process area assignments, which can be targeted to both workstations and individual operators, to eliminate Operator confusion resulting from out-of-area process upsets. Where secondary areas are assigned to a workstation for backup purposes, they can be easily disabled or enabled by the Operator as required. The system is aware of field device assignments to control modules and automatically associates their alerts to the correct process area. Alternately, field device and hardware alarms can be assigned to unique areas, targeted to maintenance workstations.

Special purpose alarm lists are easily created using a powerful alarm summary control tool for precise selection of active vs. suppressed alarms, alarm source-priority range (six sources and twelve priority levels allowed), user-defined category (examples: process, rotating equipment or instrumentation), user-defined functional classification (examples: LOPA Listed, Process Efficiency, Environmental, or Equipment Protection) and shelved or out-of-service designation in the case of suppressed alarms. It only takes minutes to create a specialty alarm or alert list. For example, a specialty alarm list could be constructed containing only out-of-service alarms that are counted as a layer of safety protection.

**Alarm Help**

Operator alarm help is persisted to all operator workstations and presented in context. When an alarm is raised the operator is just one mouse click away from the prescribed guidance, probable cause and other information established in the alarm rationalization process. If no help is available, the help icon is masked to avoid operator frustration and eventual discontinued usage. Wasted seconds spent in an upset condition searching an external non-integrated alarm information source is avoided. Alarm help is a licensed DeltaV product feature.
Many aspects of alarm help can be easily customized with user-configurable name sets that determine property selections for time to respond, consequence of inaction categories and functional classifications. Even the labels for the three text boxes can be configured. This allows you to tailor alarm help to match an external Master Alarm Database or other local alarm response manual.

Bulk import/export features facilitate easy transfer of information between an external database and DeltaV Alarm Help. The exida SILAlarm master alarm database has been optimized to work in this manner.

If desired, senior operators can be granted permission to add/edit alarm help properties directly from the operating environment, and by a separate permission can also be allowed to distribute their changes throughout the system. Parameter level granularity allows chosen alarm help fields to be used in this way for operator knowledge capture, reserving other fields for ‘authorized’ read-only use.

Alarm help can be accessed from detail displays when alarms are inactive or suppressed.

Alarm help can be added, edited and flagged as ready for operator use, and then downloaded to a system without effect on running control modules.
Conditional Alarming

Conditional alarming is a useful technique to eliminate stale alarms, and is easily accomplished via simple configuration. A typical application would be preventing a low pressure alarm from activating until an upstream pump has been on for sufficient time to generate the expected pressure, and to prevent the low pressure alarm from activating each time the pump stops.

Advanced alarming is easy to implement with the advanced functions provided in the configuration environment.

Other problems such as chattering and fleeting alarms can be eliminated through application of hysteresis, on-delay and off-delay which are also easy to accomplish with built in alarm conditioning.

Built-in hysteresis, on-delay and off-delay can be applied to a noisy signal source.
**Dynamic Alarming**

Dynamic alarming describes various techniques for eliminating alarm floods through automatic suppression of redundant and consequential alarms resulting from an anticipated equipment malfunction or process abnormality. First-out alarming and dynamic flood suppression are the most common techniques.

Pre-engineered modules and displays are available from Emerson at no cost for both first-out alarming and dynamic alarm flood suppression, for DeltaV systems at versions 10 and above. They are designed for use in the controller for maximum reliability and speed, and for application to operational systems where existing active control modules may not be modified. They are based on standard DeltaV system function blocks for use in any system, independent of any customer-specific or standardized control library. To request these module templates and displays contact your local Emerson or Emerson business partner.

First-out alarming permits the first occurring alarm in a related group of alarms to annunciate and suppresses the rest. A typical application would be the alarms associated with a burner management system.

Exida’s SILAlarm tool can be used to easily define the alarms that are part of the first out group.
Dynamic flood suppression uses a combination of required and voting conditions (expressions based on process conditions vs. simple alarms as in the case of a first-out group) to confirm a significant equipment failure or process disturbance and when detected presents a single common alarm with related alarm help and suppresses all of the expected consequential alarms associated with the event. A typical application would be to eliminate an alarm flood associated with a compressor trip.

The exida SILAlarm tool can be used to define and configure the suppression design including trigger conditions, common alarm, and assessment of the safety implications.

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**Alarm Suppression**

Visibility and accountability for suppressed alarm is important to safe plant operations. The DeltaV system provides a high degree of visibility to suppressed alarms, in alarm lists, detail displays, alarm help, audit reports, and standard display dynamos for easy and effective communication of status during shift handovers. Native system capability allows you to distinguish the ownership of suppressed alarms and the reason for suppression.
ISA-18.2 defines shelving as temporary alarm suppression initiated by the operator for a limited period of time. It provides the operator with a mechanism to deal with the occasional nuisance alarm or alarms that are temporarily invalid for a short period of time. Operators are accountable for the alarms they shelve, and all shelved alarms should be reviewed and justified during the shift transition. Each alarm can be pre-assigned its own maximum shelving time (including 0 mins), ensuring that appropriate controls are provided for which alarms can be shelved and which cannot.

Out-of-service is another form of suppression defined in ISA-18.2. Alarms that are out-of-service are considered to be in a maintenance mode. Operators should be aware of out-of-service alarms, but generally speaking someone else is accountable for the alarm’s maintenance action and eventual restoration to active service. Un-suppression of out-of-service alarms is not automatic.

The third and final form of suppression is suppression by design, also called suppression by logic. Alarms are suppressed programmatically behind the scenes, but with displays to ensure operators always know what is going on. Sometimes the logic that is performing the automated suppression will use special displays or operator confirmation steps to ensure the intended degree of operator awareness and acceptance.

The DeltaV system distinguishes alarm shelving, where the operator is accountable for restoration to service, from out-of-service and logic-suppressed alarms where they are not. Alarms can be unshelved by the operator individually or in mass, completely independent of their out-of-service condition or suppression by logic. In addition, the DeltaV system allows the selection of a reason for suppression, where the available reasons can be modified via user-editable name set. To support suppression by logic, suppression reasons can be marked for use only by logic. User permissions for shelving and out-of-service suppression are also independent, such that only authorized personnel (or logic) are able to remove alarms from service.

Shelving state changes, out-of-service state changes and suppression reason are captured in the event history and included in alarm setting audit reports. Electronic signature policies can also be applied to them, for the highest level of accountability and tracking.
Shelved alarm lists show the reason. In this example the alarms are sorted by priority, then by remaining shelving time.

Operators have visibility to out-of-service and logic-suppressed alarms.

Context menus reflect user permissions. In this example the user has authority to unshelve one or all visible shelved alarms, update the suppression reason and remove the alarm from service.

User suppression actions are captured in the event journal.
Alarm Mosaic

Ideally, dynamic alarming is in place to eliminate alarm floods for known significant causes, like a compressor trip. However, it is very difficult to anticipate all possible alarm flood causes, and the engineering effort to devise dynamic alarming logic for every possibility is impractical. As an additional layer of protection against alarm floods, Alarm Mosaic allows operators to efficiently view up to 500 alarms at once through a graphical alternative to the standard alarm list that reduces stress, helps them maintain situation awareness and aids in root cause identification. Using Alarm Mosaic operators can quickly evaluate the relationships between control actions and the timing of new alarms, and evaluate shared alarm characteristics.

Alarm Mosaic provides both a real-time alarm presentation and an activation history view. The activation history view can be especially useful during shift transition reviews, providing a view of the alarms that occurred in the prior shift.

Alarm Mosaic requires no configuration. Alarm Mosaic is a licensed DeltaV product feature.

Alarms are presented iconically, cross-linked to the alarm list and time-related control actions. The current state view only presents alarms that are active or waiting acknowledgement. Alarms may be selected and filtered by shared characteristic.
Certain alarm properties can be modified in a running DeltaV system; priority, limit, alarm inversion and shelving time; and thus differ from configured system settings. Likewise, an alarm that is enabled for use in the configuration can be disabled or suppressed in the running system. Native alarm audit capability in the DeltaV system provides a convenient method for comprehensive identification of these differences. The system uses an efficient native method to accomplish the audit (not OPC) and prioritizes the activity to ensure no degradation of DeltaV engineering or operations functionality.

Two basic report types are provided, one that identifies differences between runtime and configured alarm properties and another that simply gathers the runtime settings for comparisons to an external master alarm database. Reports are created in both an html format for easy sharing and in xml format for consumption by off-line applications. Reports can be saved and scheduled. For added flexibility, saved or ad-hoc alarm reports can be generated by external command using a robust set of command line switches.

The activation history view includes cleared alarms, for post-flood study or everyday shift transition reviews.

**Alarm Auditing**

Certain alarm properties can be modified in a running DeltaV system; priority, limit, alarm inversion and shelving time; and thus differ from configured system settings. Likewise, an alarm that is enabled for use in the configuration can be disabled or suppressed in the running system. Native alarm audit capability in the DeltaV system provides a convenient method for comprehensive identification of these differences. The system uses an efficient native method to accomplish the audit (not OPC) and prioritizes the activity to ensure no degradation of DeltaV engineering or operations functionality.

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Alarm auditing reports allow precise selection of the alarms to be audited, including the ability to select by area, unit, module, node, logic solver, enabled state, source type (ex: alarms from SIS modules) and functional classification (ex: Safety related alarms).

Alarm audit reports can be saved, scheduled and directed to any network accessible destination.

A sample audit report in html format, identifying differences between configured and runtime alarm settings.
The exida SILAlarm tool can use these reports or a snapshot of the engineering configuration to perform a comprehensive audit against the settings in the master alarm database. Changes can be accepted, rejected, or designated for enforcement (restore setting in DeltaV to match master alarm database).

**Alarm Analytics**

For basic alarm analytics, DeltaV Analyze provides tightly integrated out-of-box capability to measure alarm system performance based on ISA-18.2 KPIs. Alarm statistics reports can be saved and scheduled, gathering statistics for either the full system or for a single operator workstation position. Reports include ‘top twenty’ lists of bad actor alarms to quickly identify the most often occurring chattering, stale and suppressed alarms. Reports are created in Excel format.

For aggregation of alarm statistics from multiple systems and operator positions in higher level custom reports, Emerson recommends using the XLReporter application from SyTech, Inc. This application is approved for use with the DeltaV system. It provides built-in capability to capture data from DeltaV Analyze reports. Reports are created using Excel like methods and several sample reports are include to learn from. Using XLReporter, reports can be distributed by email and published in a variety of methods including interactive dashboards.
DeltaV Analyze

Built-for-purpose, DeltaV Analyze provides immediate availability to useful ease-to-use alarm system performance information and an out-of-box report to measure ISA19-2 Key Performance Indicators (KPIs).

When problem areas are identified, DeltaV Analyze makes it easy to drill into the data to quickly isolate frequently suppressed alarms, chattering alarms and stale alarms.

Dynamic graphs and charts in DeltaV Analyze make it easy to find nuisance alarms using an intuitive point and click method.

By default the KPIs are set to the ISA-18.2 and EEMUA-191 suggested alarm rate thresholds but can be easily tailored to fit your site alarm philosophy.

Because the report is created in Microsoft Excel file format, it is easy to use the other tables of information in the report. The following illustrations contain partial excerpts from a sample report.
## Alarm Statistics Report

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Included Areas</th>
<th>Reporting Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Start: 5/6/2009 12:00 AM</td>
</tr>
<tr>
<td>Scope</td>
<td></td>
<td>End: 5/31/2009 11:59 PM</td>
</tr>
<tr>
<td>DeltaV and SIS</td>
<td>All Areas</td>
<td>Duration (Hrs): 624</td>
</tr>
<tr>
<td>Datasource</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XYZ, Inc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alarm Category</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Key Performance Indicators

<table>
<thead>
<tr>
<th>Reporting Period Metrics</th>
<th>Result</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number Of New Alarms</td>
<td>10279</td>
<td></td>
</tr>
<tr>
<td>Total Number of Alarm Floods</td>
<td>122</td>
<td>Start &gt;=10 in 10min. End &lt;5 in 10min.</td>
</tr>
<tr>
<td>Total Number of Alarm Suppression Actions</td>
<td>294</td>
<td></td>
</tr>
<tr>
<td>Total Number of Stale Alarms</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Standing Alarms at Period End</td>
<td>1297</td>
<td>Not including alarms &gt; 624+ hours old</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary KPIs</th>
<th>Result</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Alarm Rate (Per Day)</td>
<td>395.35</td>
<td>Manageable</td>
</tr>
<tr>
<td>Average Alarm Rate (Per Hour)</td>
<td>16.47</td>
<td>Manageable</td>
</tr>
<tr>
<td>Average Alarm Rate (Per 10 Minutes)</td>
<td>2.75</td>
<td>Manageable</td>
</tr>
<tr>
<td>Percent of Hours Containing More Than 30 New Al</td>
<td>14.9%</td>
<td></td>
</tr>
<tr>
<td>Peak Number of Alarms in a 10 Min. Period</td>
<td>207</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>Percent of Time in Alarm Flood Condition</td>
<td>9.21%</td>
<td></td>
</tr>
<tr>
<td>Top 10 Alarm Source Contribution</td>
<td>23.24%</td>
<td></td>
</tr>
<tr>
<td>Chattering and Fleeting Alarm Sources</td>
<td>342</td>
<td></td>
</tr>
<tr>
<td>Alarm Priority Distribution</td>
<td>See pie chart below</td>
<td>Counts are shown in AlarmPriority tab</td>
</tr>
<tr>
<td>Avg. Number of Alarms During Floods (Per Hr)</td>
<td>100.66</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>Avg. Number of Alarms Excluding Floods (Per Hr)</td>
<td>7.93</td>
<td>Manageable</td>
</tr>
</tbody>
</table>
### Other Indicators

<table>
<thead>
<tr>
<th>Other Indicators</th>
<th>Result</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Alarm Date and Time</td>
<td>5/22/2009 7:40 AM</td>
<td></td>
</tr>
<tr>
<td>Average Time to Acknowledge</td>
<td>00:03:18</td>
<td>Days.Hours:Minutes:Seconds</td>
</tr>
<tr>
<td>Peak Time to Acknowledge</td>
<td>15:41:32</td>
<td>REACTOR_1\FC22\FICFC1060</td>
</tr>
<tr>
<td>Average Time Alarm Active</td>
<td>00:51:24</td>
<td>Days.Hours:Minutes:Seconds</td>
</tr>
<tr>
<td>Peak Time Alarm Active</td>
<td>12:00:15:03</td>
<td>SEPARATION</td>
</tr>
<tr>
<td>Average Time Alarm Suppressed</td>
<td>1.14:04:51</td>
<td>Days.Hours:Minutes:Seconds</td>
</tr>
<tr>
<td>Peak Time Alarm Suppressed</td>
<td>12.07:52:45</td>
<td>FFC-416</td>
</tr>
</tbody>
</table>

### Alarm Timeline

![Alarm Timeline Graph]

### Alarm Distribution

#### Priority

![Priority Pie Chart]

#### New Alarm Rate

![New Alarm Rate Pie Chart]
## Top Twenty Alarm Sources

<table>
<thead>
<tr>
<th>Module/Node</th>
<th>Description</th>
<th>Alarm Quantity</th>
<th>Average Per Hour</th>
<th>Sum</th>
<th>Percent All</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>FITST111</td>
<td>50 lb Steam Reducing Stat</td>
<td>394</td>
<td>0.63</td>
<td>394</td>
<td>3.83%</td>
<td>UTILITIES</td>
</tr>
<tr>
<td>IIUP16P1</td>
<td>UP-C-04 Underflow P1 Pum</td>
<td>330</td>
<td>0.53</td>
<td>724</td>
<td>7.04%</td>
<td>REACTOR_2</td>
</tr>
<tr>
<td>FICUP1516</td>
<td>UP-C-04 Flash Tank Slurry</td>
<td>316</td>
<td>0.51</td>
<td>1040</td>
<td>10.12%</td>
<td>MIXERS</td>
</tr>
</tbody>
</table>

## Top Twenty Modules with the Shortest Average Activation Time

<table>
<thead>
<tr>
<th>Module/Node</th>
<th>Description</th>
<th>Times Active</th>
<th>Avg Active Time</th>
<th>Active Time</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONDENSATE_02_ST</td>
<td>09_MIXERS_01 Controller Health</td>
<td>12</td>
<td>00:00:00:00</td>
<td>00:00:11</td>
<td>SYSTEM</td>
</tr>
<tr>
<td>HSMP55AP1B</td>
<td>MP-55A P1 PUMP</td>
<td>2</td>
<td>00:00:00:00</td>
<td>00:00:01</td>
<td>REACTOR_2</td>
</tr>
<tr>
<td>HSUP1190</td>
<td>UP-C-01 Slurry Inlet Block Valve</td>
<td>3</td>
<td>00:00:00:00</td>
<td>00:00:02</td>
<td>MIXERS</td>
</tr>
</tbody>
</table>

## Top Twenty Modules with the Highest Average Activation Time

<table>
<thead>
<tr>
<th>Module/Node</th>
<th>Description</th>
<th>Times Active</th>
<th>Avg Active Time</th>
<th>Active Time</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAL-1323</td>
<td>PRESS LOW MP-32 SEAL OIL</td>
<td>1</td>
<td>2.19:38:24</td>
<td>2.19:38:25</td>
<td>REACTOR_2</td>
</tr>
<tr>
<td>ILK_UPC03-1</td>
<td>SIS Module</td>
<td>26</td>
<td>2.12:20:56</td>
<td>65.09:04:31</td>
<td>REACTOR_2</td>
</tr>
<tr>
<td>HS-P231</td>
<td>IP55-P2 Flash Condensate Pump</td>
<td>1</td>
<td>2.10:46:18</td>
<td>2.10:46:19</td>
<td>INTERMEDIATE</td>
</tr>
</tbody>
</table>

## Alarms Suppressed During the Reporting Period
*(Marked with exclamation point if suppressed at close of reporting period.)*

<table>
<thead>
<tr>
<th>Module/Node</th>
<th>Description</th>
<th>Times Suprsd</th>
<th>Avg Suprsd Time</th>
<th>Total Suprsd Time</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFC-416</td>
<td>RATIO - FD-01 Underflow to Xylene Ratio</td>
<td>2</td>
<td>12.07:52:43</td>
<td>24.15:45:28</td>
<td>REACTOR_1</td>
</tr>
<tr>
<td>FFC-616</td>
<td>RATIO - FF-01 Underflow to Xylene Ratio</td>
<td>3</td>
<td>7.06:15:12</td>
<td>21.18:45:38</td>
<td>REACTOR_1</td>
</tr>
<tr>
<td>OX6RATE</td>
<td>Oxidizer FF-01 Production Rate Master S</td>
<td>2</td>
<td>6.21:34:15</td>
<td>13.19:08:31</td>
<td>REACTOR_1</td>
</tr>
</tbody>
</table>

## Alarms Disabled During the Reporting Period
*(Marked with exclamation point if disabled at close of reporting period.)*

<table>
<thead>
<tr>
<th>Module/Node</th>
<th>Description</th>
<th>Times Disabled</th>
<th>Avg Disable Time</th>
<th>Total Disable Time</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>OX6RATE</td>
<td>Oxidizer FF-01 Production Rate Master S</td>
<td>1</td>
<td>7.09:23:18</td>
<td>7.09:23:18</td>
<td>REACTOR_1</td>
</tr>
<tr>
<td>FIC-752</td>
<td>SLURRY FLOW TO FP-50</td>
<td>2</td>
<td>4.15:53:45</td>
<td>9.07:47:31</td>
<td>REACTOR_1</td>
</tr>
<tr>
<td>PI-608</td>
<td>FF-01 Pressure</td>
<td>2</td>
<td>3.10:29:20</td>
<td>6.20:58:40</td>
<td>REACTOR_1</td>
</tr>
</tbody>
</table>

*DeltaV Analyze Partial Page Illustrations.*

www.emerson.com/deltav
**XLReporter**

XLReporter for DeltaV Analyze automatically extracts the alarm metrics and KPI’s from the Alarm Statistics reports to a database to enable a broader understanding of alarm activity through flexible, dynamic analysis of historized KPIs from multiple systems and operator positions.

XLReporter has three components, one to collect and consolidate data, another to create custom reports and another to publish information in multiple forms.

In the consolidation component DeltaV Analyze Alarm Statistics report data is collected into a database automatically and in the background. Existing Alarm Statistics reports can be easily included in the consolidation. Consolidation provides new KPIs for duration of your choice and system-to-system trend analysis.

In the reporting component pre-defined Excel templates for consolidated Alarm Statistics reports are provided. Custom templates are produced in the familiar environment of Excel using the built-in tools. Reports templates produce reports automatically and on demand. Dashboard templates provide users across the network to access the data easily for their own purposes.

In the publishing component information is distributed automatically. Reports can be produced in Excel, PDF and HTML formats. Reports can be distributed by email and FTP.

**Alarm Rationalization**

ISA-18.2 stipulates the use of a master alarm database to document every aspect of an alarm’s design. Emerson recommends using the SILAlarm master alarm database from exida, Inc., Emerson’s alliance partner for alarm management. SILAlarm is an off-line application to perform alarm rationalization and manage alarm specification changes. Alarm rationalization results documented in SILAlarm can be directly imported into the DeltaV system configuration database, saving substantial control engineering effort and eliminating opportunity for human error.
DeltaV’s bulk editing system enables efficient import and export of an alarm’s settings and alarm help, for information exchange with spreadsheets or an external master alarm database. SIL alarm provides built-in capability to read and write native DeltaV bulk export/import files.

**SILAlarm Master Alarm Database**

When it comes to alarms, more is not better. The idea is to create a system containing the minimum set of alarms needed to keep the process safe and within normal operating limits. Alarm rationalization is a process where a cross-functional team of plant stakeholders reviews, justifies, and documents that each alarm meets the criteria for being an alarm as set forth in a company’s alarm philosophy document. Rationalization also involves defining the attributes of each alarm (such as limit, priority, classification, and type) as well as documenting the consequence, response time, and operator action. For maximum efficiency when performing alarm rationalization on a large number of alarms or alarms from multiple systems the SILAlarm application from Emerson’s alliance partner exida can be a good choice.

Emerson and exida have formed an alliance to ensure that a complete Alarm Management Lifecycle solution is available to aid clients with implementing a sustainable approach that complies with the ISA-18.2 standard. The solution incorporates tools and capabilities for alarm rationalization (SILAlarm™ by exida), operator alarm response procedures (DeltaV Alarm Help), analysis and benchmarking of alarm system performance (DeltaV Analyze / Plantwide Event Historian), and the expertise of both companies.

SILAlarm features a bi-directional bulk edit transfer capability with the DeltaV process automation system configuration database, providing an accurate and convenient method for populating DeltaV Alarm Help and many of the DeltaV alarm properties such as limit, priority, shelving time, on/off delay and hysteresis.

After completing a thorough rationalization:

- The alarm system can be expected to provide significantly fewer alarm activations and less nuisance alarms (chattering, fleeting or stale alarms).

- Operator response to alarms will be more swift and effective because alarms are more trusted, accompanied by good guidance, prioritized for correct action sequence, and free from clutter of secondary and often redundant alarms.

The basic methodology used by the rationalization committee is relatively simple.

- Pick a piece of equipment, unit or control module then discuss what alarms may be used to prevent undesirable situations from occurring.

- Decide if the alarm is similar / identical to other alarms that have already been rationalized. For example if all compressors are to be treated the same, then information can be copied from the first set of compressor alarms in order to minimize level of discussion needed.
- Determine if the alarms are justified. What is the consequence(s) if the alarm was not addressed? Is there an available operator action to mitigate the event and sufficient time to do so? Note that acknowledging an alarm or writing an entry in a logbook is not considered a valid operator action as these responses do not correct the abnormal situation.

- Check to see if this alarm is duplicated by another alarm. If so, pick only one to keep that is the best indicator of the anomaly.

- Determine the correct priority based on the alarm philosophy rules. Typically it is a function of time to respond and consequence of inaction.

- Document all that is known and may be of use to the operator, such as possible cause(s), potential consequences, method to confirm/validate the alarmed condition, and recommended corrective action(s). Note that this information can be made available to operators via DeltaV Alarm Help.

- Document agreed-upon modifications to alarm attributes or specifications if the alarm is new. These would include the limit, hysteresis, off/on delays, conditional alarming, etc.

- For processes with differing operating states, specify alarm settings (limit, priority, suppression status) so that they track the operational state of the plant.

Capturing key alarm rationalization information in SILAlarm that can be used to automatically configure Alarm Help.
SilAlarm is setup for import and export of information to the DeltaV system including specification of what alarms and alarm parameters are to be updated.

Accessing Alarm Data

The DeltaV system provides a bulk edit system for efficient import and export of alarm configuration information.

A special bulk edit template for module alarms enables easy import and export of all 27 DeltaV alarm properties.
Another useful application for managing alarm configuration information in bulk is the System Alarm Management application. It provides a convenient way to view alarm properties for multiple related alarms, and allows multi-selection of alarms for mass modification of their priority, limit and shelving time. The application also provides a print to XML capability.

Another highly useful feature is available to capture standing alarm information, built into every DeltaV Alarm list.

A native alarm list feature allows users or silent scheduled applications to snapshot the standing alarms at an operator workstation.

Lastly, collection of key runtime system alarm properties can be done with audit reports (See Alarm Auditing).

Learn More

Additional whitepapers along with product demonstration videos and product data sheets describing DeltaV system alarm management solutions are available on-line, at [www.emerson.com/deltav](http://www.emerson.com/deltav).