Advanced Alarming Techniques

DeltaV™ | EMERSON™

Advanced Alarming Techniques

This whitepaper provides information to assist with implementation of Emerson's AgileOps™ Operations Management Software and several native advanced alarming module templates available for the DeltaV™ Distributed Control System.

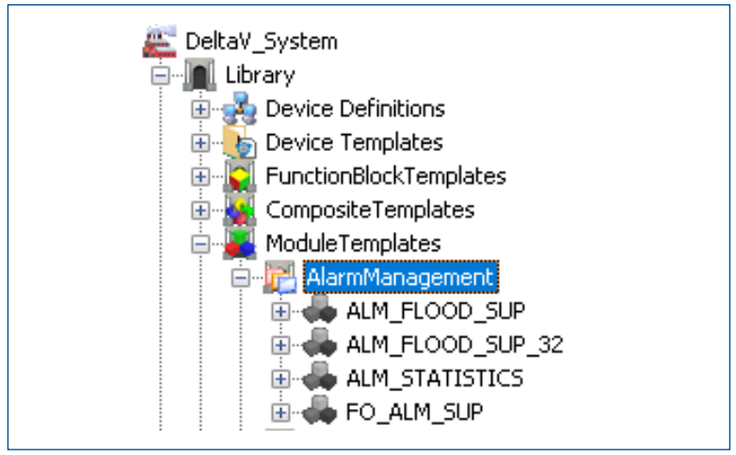
Introduction

This document describes Emerson's AgileOps Operations Management software, along with several native control module templates and associated displays available for use with the DeltaV™ distributed control system, to accomplish dynamic alarming, advanced alarm shelving and to collect alarm count statistics. The software and displays described in this document pertain to a DeltaV v14 system, but with minor modification they may also be applied in DeltaV system versions v10, v11, v12 and v13.

This document is technical in nature, intended for use by a skilled DeltaV control engineer.

The DeltaV module templates and human machine interface (HMI) displays described in this document are included with a standard DeltaV system at no extra cost. The modules are based on standard DeltaV system function blocks available since v10 for use in any system regardless of any customer-specific or standardized control library. The modules are intended to run in a DeltaV controller for maximum reliability and speed, and for application to operational systems where existing active control modules may not be modified. To request these module templates and displays, contact your local Emerson or Emerson business partner.

The AgileOps software described in this report is a standard add-on for the DeltaV system, with separate licensing and installation.



Advanced Alarming Module Templates in the DeltaV Explore.

Dynamic Alarming

Dynamic alarming describes various techniques for modifying alarm attributes based on plant operating state. The primary benefits are providing optimum alarm configuration in any the plant state and eliminating alarm floods. The benefits are realized through automatic modification or suppression of multiple alarms resulting from an equipment malfunction or process abnormality, or from a controlled shutdown or process transition. State-based alarming is the most powerful technique. First-out alarming, conditional alarming and dynamic flood suppression are also available. Dynamic alarming can be used to accomplish the following:

- Change alarm configuration when a change in operating state is detected (AgileOps)
- Suppress alarms when multiple alarms occur for a single process event (AgileOps, first-out alarming)
- Suppress excessive or irrelevant alarms which are generated when the process or equipment state changes unexpectedly (AgileOps, alarm flood suppression)
- Modify alarm attributes (priority, suppression state, alarm limit) when the process or equipment state changes unexpectedly (AgileOps)
- Determine the initiating alarm or trip (first-out alarming and alarm flood suppression)

Capturing Actual Alarm Counts

Most alarm system performance data can be obtained through analysis of system alarm and event records with AgileOps Performance Analytics.

AgileOps™ Operations Management Software

The AgileOps software suite is Emerson's premier product for alarm management. AgileOps is compatible with multiple control systems including Emerson DeltaV, Ovation, Honeywell Experion® and TDC®, Siemens PCS7® and Invensys Foxboro®, thus delivering a complete alarm management system for an entire site with one or multiple control system manufacturers. It can be used for the following tasks:

- Rationalize the alarms from the control system.
- Document the results in a master alarm database.
- Provide help information directly to the operator from the alarm display or control module faceplate.
- Define alarm dynamics by system operating cases and programmed alarm shelving by grouped lists to prevent alarm flooding scenarios.
- Update alarm configuration via bulk edit.

While the DeltaV native modules are a good fit for small systems with simple logic and a few alarms to manage, AgileOps is the recommended solution for:

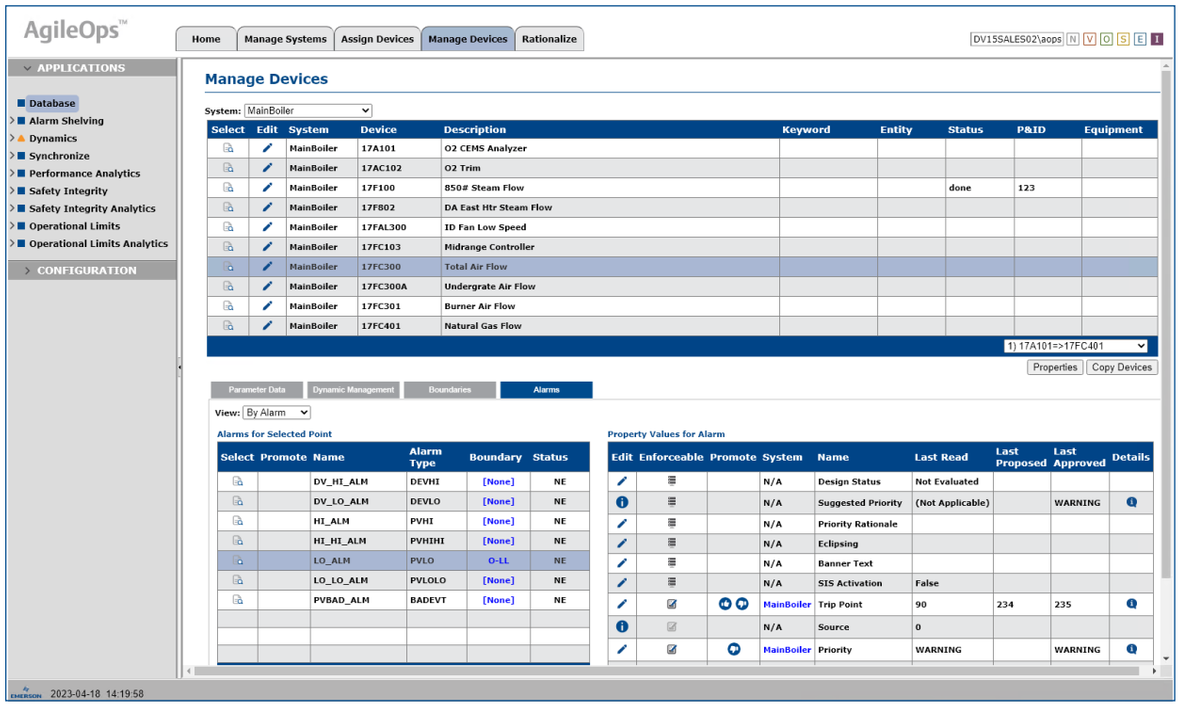
- Plant-wide dynamic (state-based) alarming and control.
- Advanced shelving capabilities including automatic shelving of stale alarms and alarm shelving by plant state.
- Alarm rationalization, documentation and master alarm database.
- On-line alarm attribute verification against approved master alarm database values with optional enforcement (scheduled and on demand).
- Flexible alarm metrics reporting and custom reports.

AgileOps displays are designed for easy view and configuration of rationalization results, operator help information, dynamic alarming settings, logic that determines operating state (case), and shelving criteria. Another distinct advantage of AgileOps lies in alarm auditing. The audit report will not flag as exceptions any alarm attribute modification that is done by AgileOps.

AgileOps is modularized for ease of navigation and to separate functionality. A short description of AgileOps features follows.

AgileOps Database

AgileOps provides a central source for proposed, approved and historical control system parameter settings including alarm system design (rationalization) results. This is the Master Alarm Database that is required by the ISA 18.2 standard. The AgileOps Database is used to configure other features of AgileOps, such as Dynamics and Alarm Shelving.



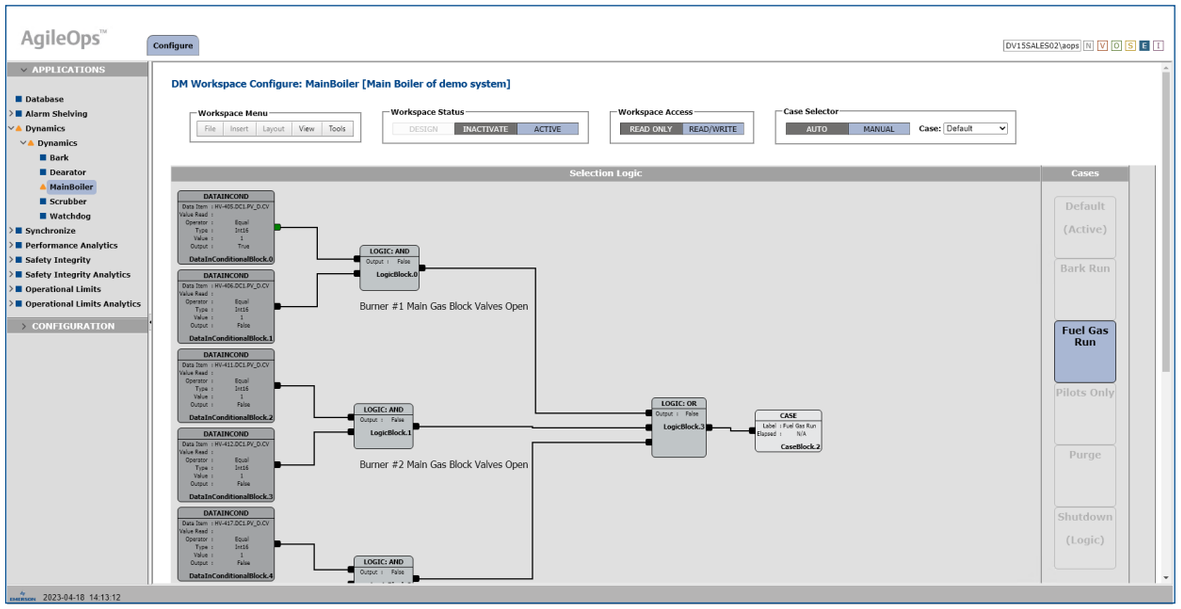
AgileOps Alarm Settings View.

The AgileOps Database also includes other features:

- **Synchronize:** automatically browses the control system and brings all of the necessary alarm information into AgileOps. After the initial sync with the control system, the Synchronize feature can be set to run on a periodic basis in order to verify if any alarms have been added or modified. If it finds any changes, it will flag the exception – the user can then decide to update the AgileOps Database to match what is on the control system if the change was legitimate. Unauthorized changes can be enforced back to the online database. This greatly cuts down on user errors when transferring all of the points on the control system to AgileOps.
- **Boundaries:** AgileOps supports effective boundary management. While configuring each tag, a user can also define its respective boundaries (operating limits or constraints). An equipment engineer may input a maximum pump safety limit, while the process engineer would input a maximum operating flow. AgileOps will catalogue all of these inputted boundary layers and display them in an intuitive format for alarm rationalization members to understand. Once all the boundaries are in place, determining alarm set points, priorities and corrective responses becomes easier to understand and implement.

AgileOps Dynamics

AgileOps Dynamics provides the capability to manage alarms through the states and state transitions of the unit according to pre-configured logic. Plant processes are dynamic by nature; AgileOps allows the alarm configuration to change appropriately as the operating state changes. Therefore, it can effectively eliminate alarm floods during process transitions and upset conditions; operators can focus on controlling the transition or stabilizing the plant rather than responding to unnecessary alarms. AgileOps also includes transition management to unsuppress or enable alarms only as needed during a process mode change. Alarm configuration changes available include priority and alarm limit modification, suppression and disabling. Without dynamic alarm management, a facility will usually not be able to meet the ISA 18.2 target metrics of peak alarm rate and % of time in flood.

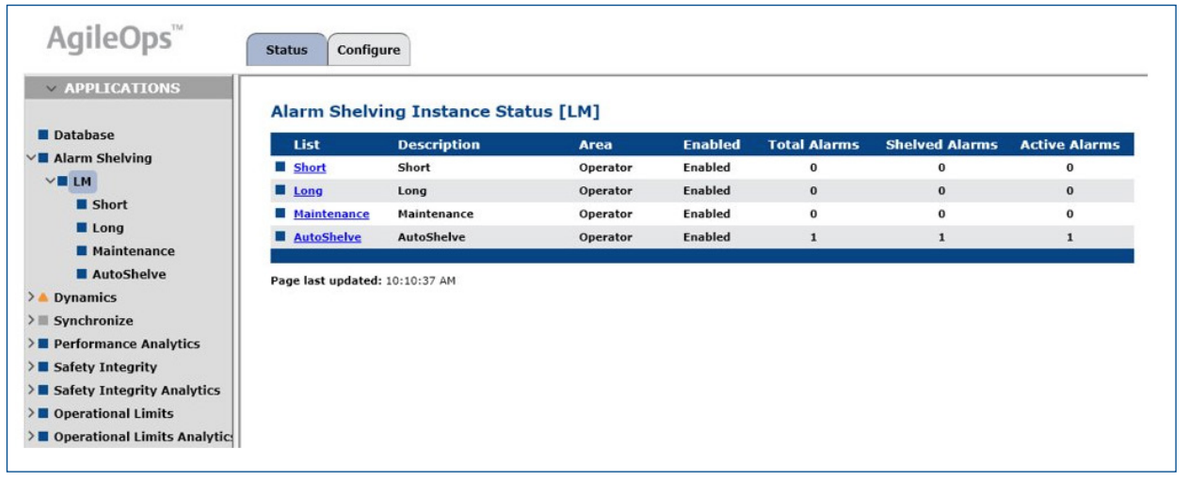


AgileOps Dynamics Logic Workspace.

AgileOps Alarm Shelving

AgileOps Alarm Shelving is an advanced alarm shelving tool that provides features not available in standard shelving included in DeltaV or any other control system. It not only allows operators to shelve nuisance alarms, but also can shelve stale, standing alarms automatically. AgileOps Alarm Shelving includes:

- Exclusion list (restricts which alarms an operator is able to shelve).
- Simple right-click entry from operator graphics.
- Entry validation – verifies roles and restricts multiple entries.
- Easy list configuration and management.
- Automatic shelving to remove stale alarms from the alarm summary.
- Automatic unshelving based on an alarm being inactive or using a fixed un-shelve timer.
- State-based shelving, in conjunction with AgileOps Dynamics.

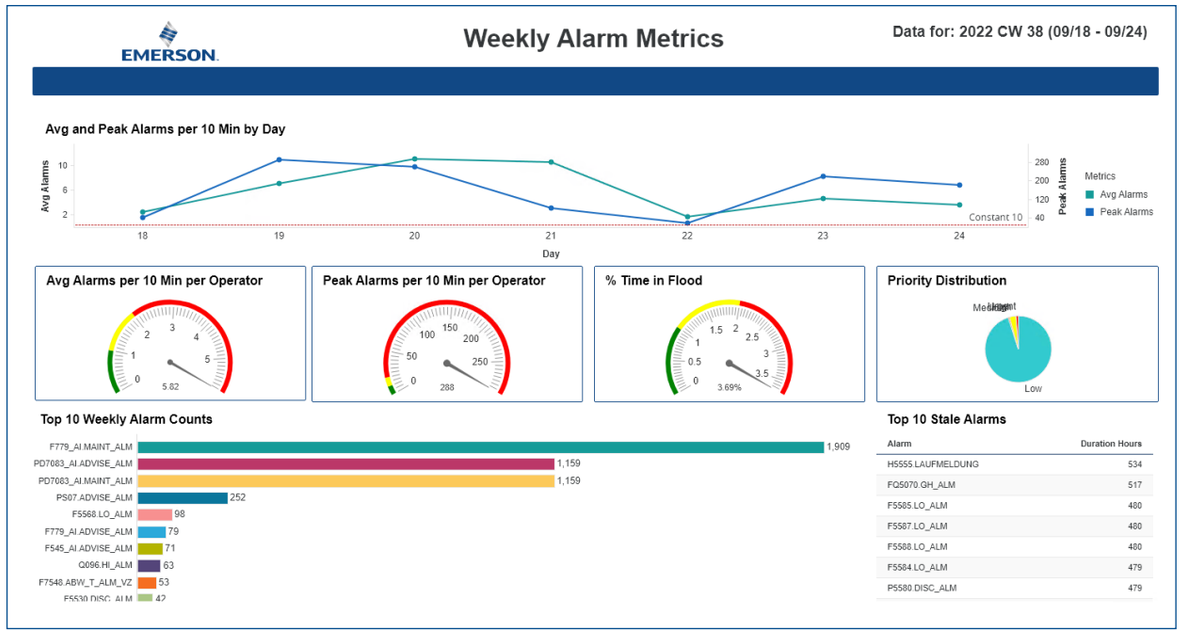


AgileOps Alarm Shelving List.

AgileOps Performance Analytics

AgileOps Performance Analytics allows the measurement, tracking and reporting of key performance indicators for events occurring in a facility. AgileOps reports alarm metrics as a result of data analysis which it collects automatically from one or more control systems. Metrics can be analyzed by the minute, hourly, daily, weekly, monthly or on a yearly basis. AgileOps is designed as an enterprise application that provides the necessary detailed information from local unit personnel up through complex-wide and cross facility views for the enterprise.

In addition to the standard dashboards and reports, users can create ad-hoc reports, generate new reports and publish them. Users can trigger reports to be run automatically and emailed if certain criteria are met or on a preset schedule. AgileOps provides the necessary information to document and support improvements in a facility's Alarm Management program.



AgileOps Performance Analytics Dashboard.

First-Out Alarming Module

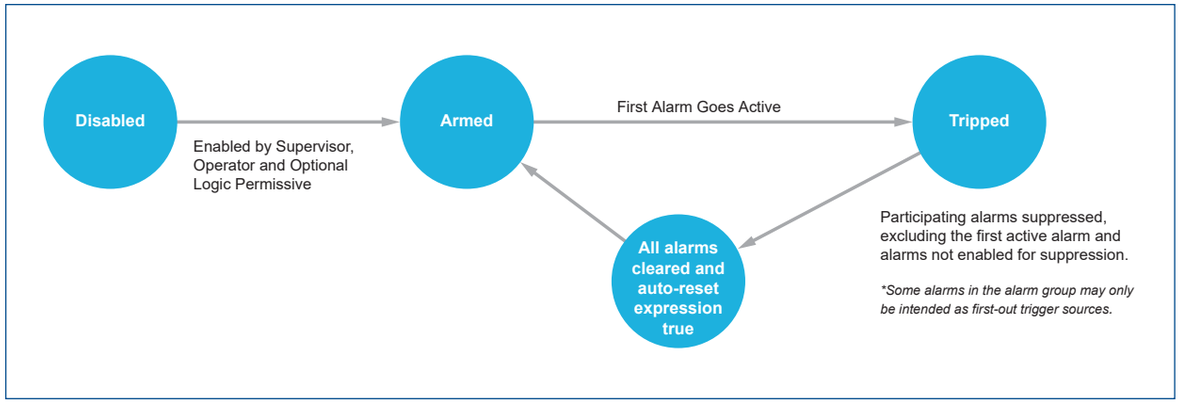
First-out alarming can be useful in cases where the shutdown of equipment causes a cascade of alarms that overload the operator making it difficult for them to determine the initiating cause and take appropriate corrective action.

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. In this example table for the boiler pictured below it, a first out alarm group is configured to determine which condition activated the Master Fuel Trip interlock:

First Out Alarming Example Table		
Tag	**Description**	**Alarm**
PT200	High Fuel Supply Pressure	High Alarm
PT200	Low Fuel Supply Pressure	Low Alarm
XD201	Loss of Combustion Air	Discrete Alarm
XD202	Loss-of-Flame	Discrete Alarm
XD203	Loss of Actuating Energy	Discrete Alarm

The module template FO_ALM_SUP is designed to implement first-out alarming. Key features include:

- Up to 16 participating alarms in a first-out group, where each alarm can be configured for suppression and/or priority change.
- First-out alarm indication.
- Supervisor, operator, and logic enablement.
- An alarm can be configured as a trigger only, without being suppressed by other first-out triggers.



First-out Alarming State Diagram.

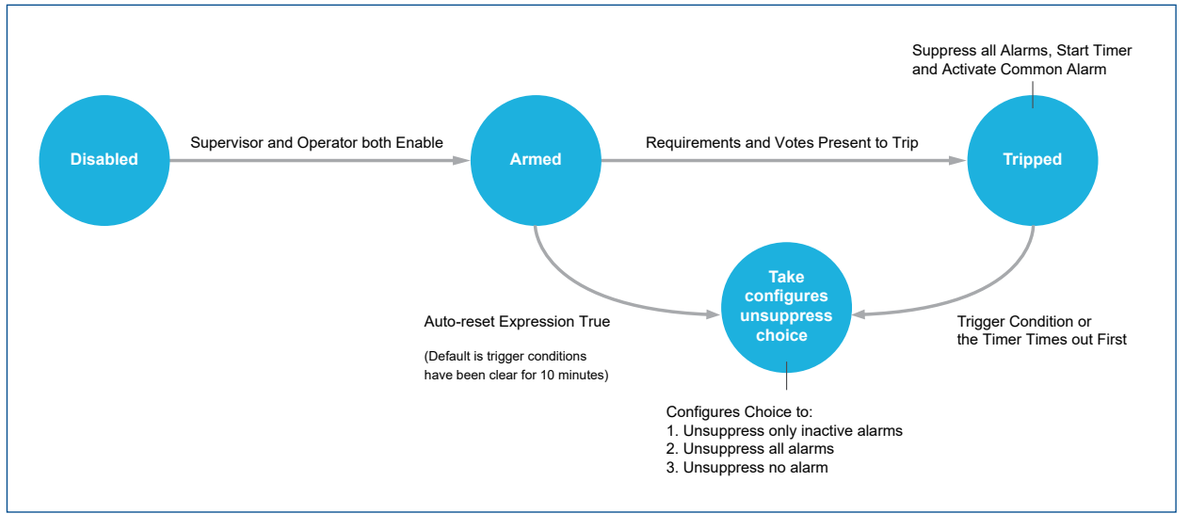
Alarm Flood Suppression Module

Alarm systems can be difficult to manage following a major event (such as the trip of a compressor) as operators may be subjected to more alarms than they can respond to. Such disturbances are particularly stressful and can be considered as relatively hazardous periods of operation. During an alarm flood, the operator's effectiveness is diminished, which could lead to an undetected unsafe plant environment due to critical alarms being missed. In order to minimize the number of alarms following the trip or event, alarm flood (dynamic) suppression may be required.

Dynamic flood suppression logic monitors process conditions to detect a significant equipment failure or process disturbance. When detected, a single 'common' alarm is presented to the operator, with related alarm help, and all of the expected consequential alarms associated with the event are suppressed. A typical application would be to eliminate an alarm flood associated with a compressor trip.

The module templates ALM_FLOOD_SUP and ALM_FLOOD_ SUP_32 are designed to implement flood suppression. Key features include:

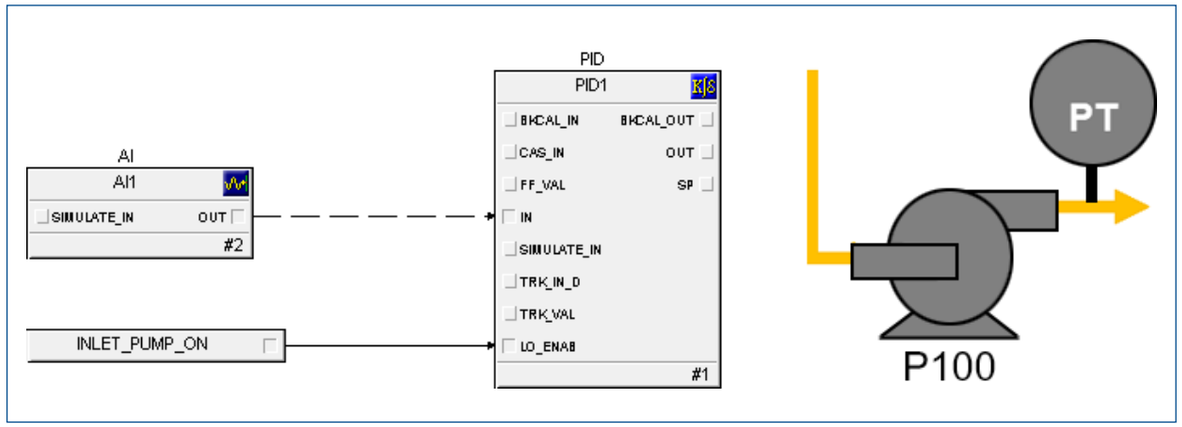
- Up to 32 participating alarms, extensible in blocks of 16, that can be configured for suppression and/or priority change.
- Zero to eight confirming (required) process conditions.
- Zero to eight triggering (voting) conditions with user-defined number of votes needed to initiate activation.
- First out indication for the triggering condition(s).
- Supervisor and operator enablement.
- A 'common alarm' with a configurable message, for use in situations where the initiating event doesn't have its own alarm.
- Configurable post trigger 'time-out' behavior, to either (a) leave all participating alarms suppressed, (b) remove suppression from all participating alarms or (c) remove suppression from all participating alarms except those that are still in an active condition.



Alarm Flood Suppression State Diagram.

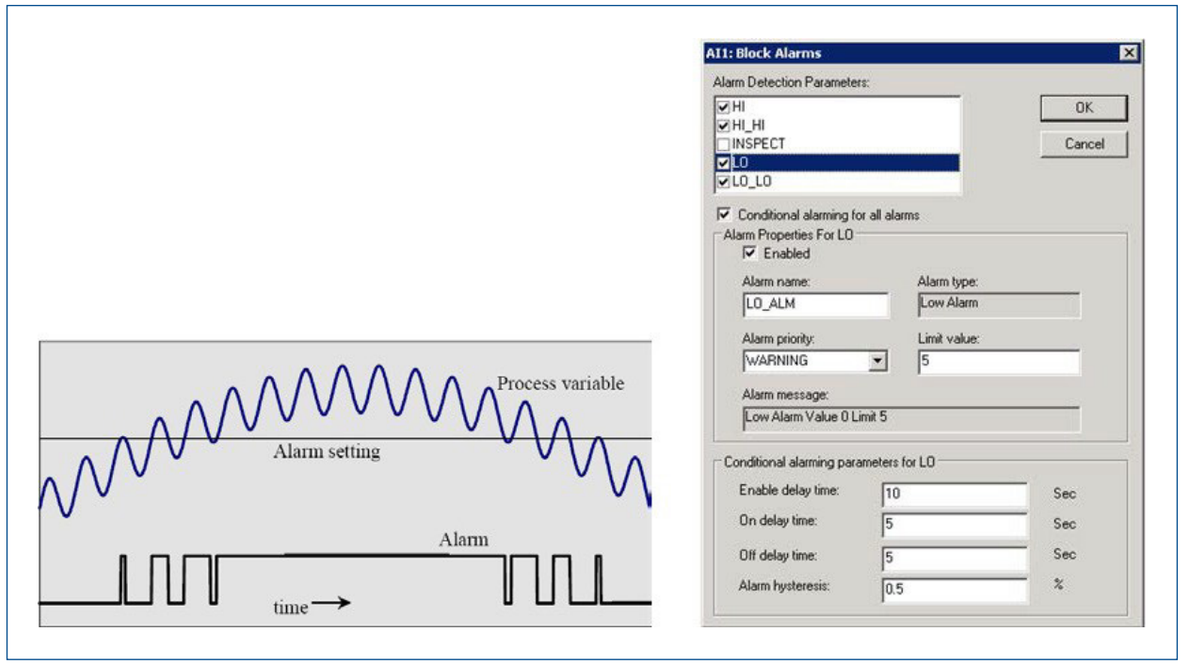
Conditional Alarming

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.



Conditional 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 tuning parameters such as hysteresis, on-delay and off-delay. These are also easy to configure in the same box as the conditional alarming parameters.



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

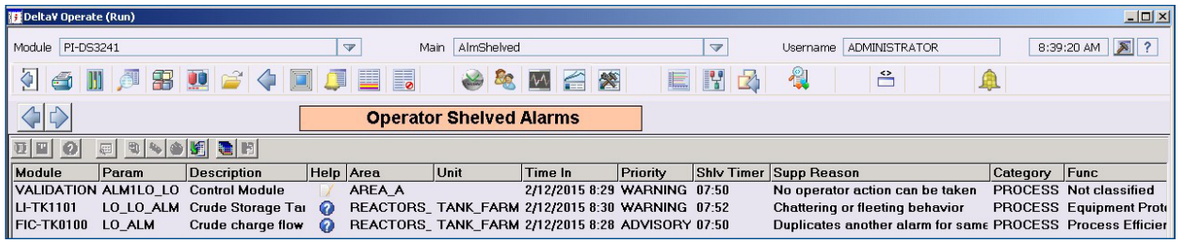
Alarm Shelving and Out of Service

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.

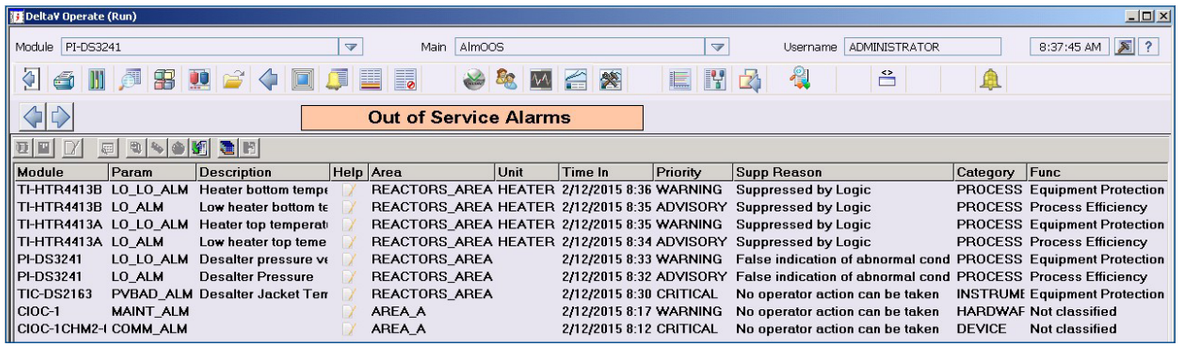
The DeltaV system distinguishes alarm shelving, where the operator is accountable for restoration to service, from out-of-service and logic-suppressed alarms where they are not. Alarms can be unshelved by the operator individually or in mass, completely independent of their out-of-service condition or 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.



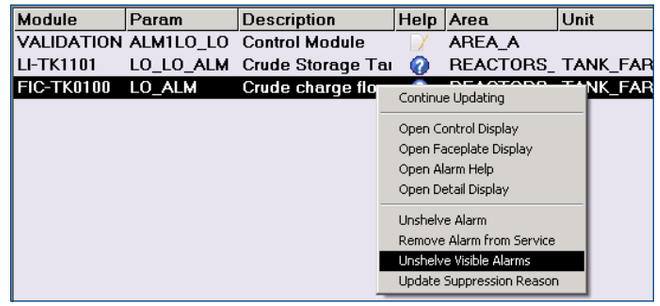
Module	Param	Description	Help	Area	Unit	Time In	Priority	Shlv Timer	Supp Reason	Category	Func
VALIDATION	ALM1LO_LO	Control Module		AREA_A		2/12/2015 8:29	WARNING	07:50	No operator action can be taken	PROCESS	Not classified
LI-TK1101	LO_LO_ALM	Crude Storage Tar		REACTORS_	TANK_FARM	2/12/2015 8:30	WARNING	07:52	Chattering or fleeting behavior	PROCESS	Equipment Prote
FIC-TK0100	LO_ALM	Crude charge flow		REACTORS_	TANK_FARM	2/12/2015 8:28	ADVISORY	07:50	Duplicates another alarm for same	PROCESS	Process Efficier

Shelved alarm lists show the reason. In this example the alarms are sorted by priority, then by remaining shelving time.

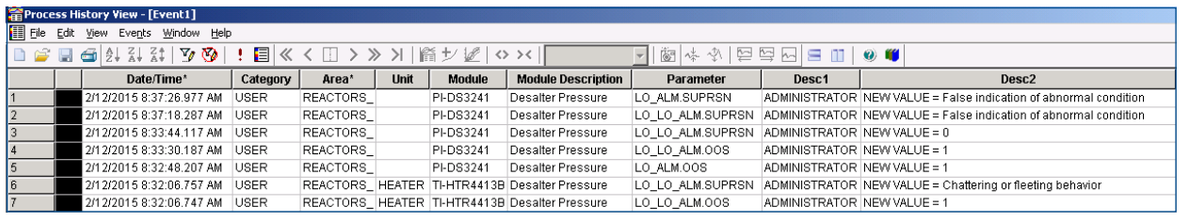


Module	Param	Description	Help	Area	Unit	Time In	Priority	Supp Reason	Category	Func
TI-HTR4413B	LO_LO_ALM	Heater bottom tempe		REACTORS_AREA	HEATER	2/12/2015 8:36	WARNING	Suppressed by Logic	PROCESS	Equipment Protection
TI-HTR4413B	LO_ALM	Low heater bottom te		REACTORS_AREA	HEATER	2/12/2015 8:35	ADVISORY	Suppressed by Logic	PROCESS	Process Efficiency
TI-HTR4413A	LO_LO_ALM	Heater top temperat		REACTORS_AREA	HEATER	2/12/2015 8:35	WARNING	Suppressed by Logic	PROCESS	Equipment Protection
TI-HTR4413A	LO_ALM	Low heater top teme		REACTORS_AREA	HEATER	2/12/2015 8:34	ADVISORY	Suppressed by Logic	PROCESS	Process Efficiency
PI-DS3241	LO_LO_ALM	Desalter pressure ve		REACTORS_AREA		2/12/2015 8:33	WARNING	False indication of abnormal cond	PROCESS	Equipment Protection
PI-DS3241	LO_ALM	Desalter Pressure		REACTORS_AREA		2/12/2015 8:32	ADVISORY	False indication of abnormal cond	PROCESS	Process Efficiency
TIC-DS2163	PVBAD_ALM	Desalter Jacket Tem		REACTORS_AREA		2/12/2015 8:30	CRITICAL	No operator action can be taken	INSTRUME	Equipment Protection
CIOC-1	MAINT_ALM			AREA_A		2/12/2015 8:17	WARNING	No operator action can be taken	HARDWAF	Not classified
CIOC-1CHM2-I	COMM_ALM			AREA_A		2/12/2015 8:12	CRITICAL	No operator action can be taken	DEVICE	Not classified

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.



		Date/Time*	Category	Area*	Unit	Module	Module Description	Parameter	Desc1	Desc2
1		2/12/2015 8:37:26.977 AM	USER	REACTORS_		PI-DS3241	Desalter Pressure	LO_ALM.SUPRSN	ADMINISTRATOR	NEW VALUE = False indication of abnormal condition
2		2/12/2015 8:37:18.287 AM	USER	REACTORS_		PI-DS3241	Desalter Pressure	LO_LO_ALM.SUPRSN	ADMINISTRATOR	NEW VALUE = False indication of abnormal condition
3		2/12/2015 8:33:44.117 AM	USER	REACTORS_		PI-DS3241	Desalter Pressure	LO_LO_ALM.SUPRSN	ADMINISTRATOR	NEW VALUE = 0
4		2/12/2015 8:33:30.187 AM	USER	REACTORS_		PI-DS3241	Desalter Pressure	LO_LO_ALM.OOS	ADMINISTRATOR	NEW VALUE = 1
5		2/12/2015 8:32:48.207 AM	USER	REACTORS_		PI-DS3241	Desalter Pressure	LO_ALM.OOS	ADMINISTRATOR	NEW VALUE = 1
6		2/12/2015 8:32:06.757 AM	USER	REACTORS_	HEATER	TI-HTR4413B	Desalter Pressure	LO_LO_ALM.SUPRSN	ADMINISTRATOR	NEW VALUE = Chattering or fleeting behavior
7		2/12/2015 8:32:06.747 AM	USER	REACTORS_	HEATER	TI-HTR4413B	Desalter Pressure	LO_LO_ALM.OOS	ADMINISTRATOR	NEW VALUE = 1

User suppression actions are captured in the event journal.

Considerations and Best Practices for Definition of Trigger Conditions

Creating well-thought-out trigger conditions is an important step to ensure that suppression or state-based alarming is activated only when it is necessary and appropriate. The following recommendations adapted from ISA-TR18.2.4-2012 and from Emerson experience are provided to guide the definition of effective suppression conditions.

- Use input from multiple sensors with at least 2 (3 is preferred) positive indications of state (2 of 2 or 2 of 3 voting).
- Avoid related measurements with a high probability of common cause failure.
- Avoid unreliable measurements.
- Use deadband with analog values to prevent mode cycling.
- Include error-handling capabilities incorporated into the voting scheme so that accurate state detection is still available when a sensor fails.
- Don't require operator confirmation of detected state; the dynamic alarming application is designed to alleviate alarm flooding, but this practice allows the floods to occur because of delayed response and unnecessary delays in alarm suppression.
- HMI should clearly indicate status of the trigger conditions and the state of the suppression group.
- Utilize delay timers and intelligent enabling to avoid potential alarm floods when multiple alarms are to be removed from suppression upon a state change.
- Test trigger conditions and logic on a test system and verify correct values are read on the live system before enabling the logic to suppress alarms.

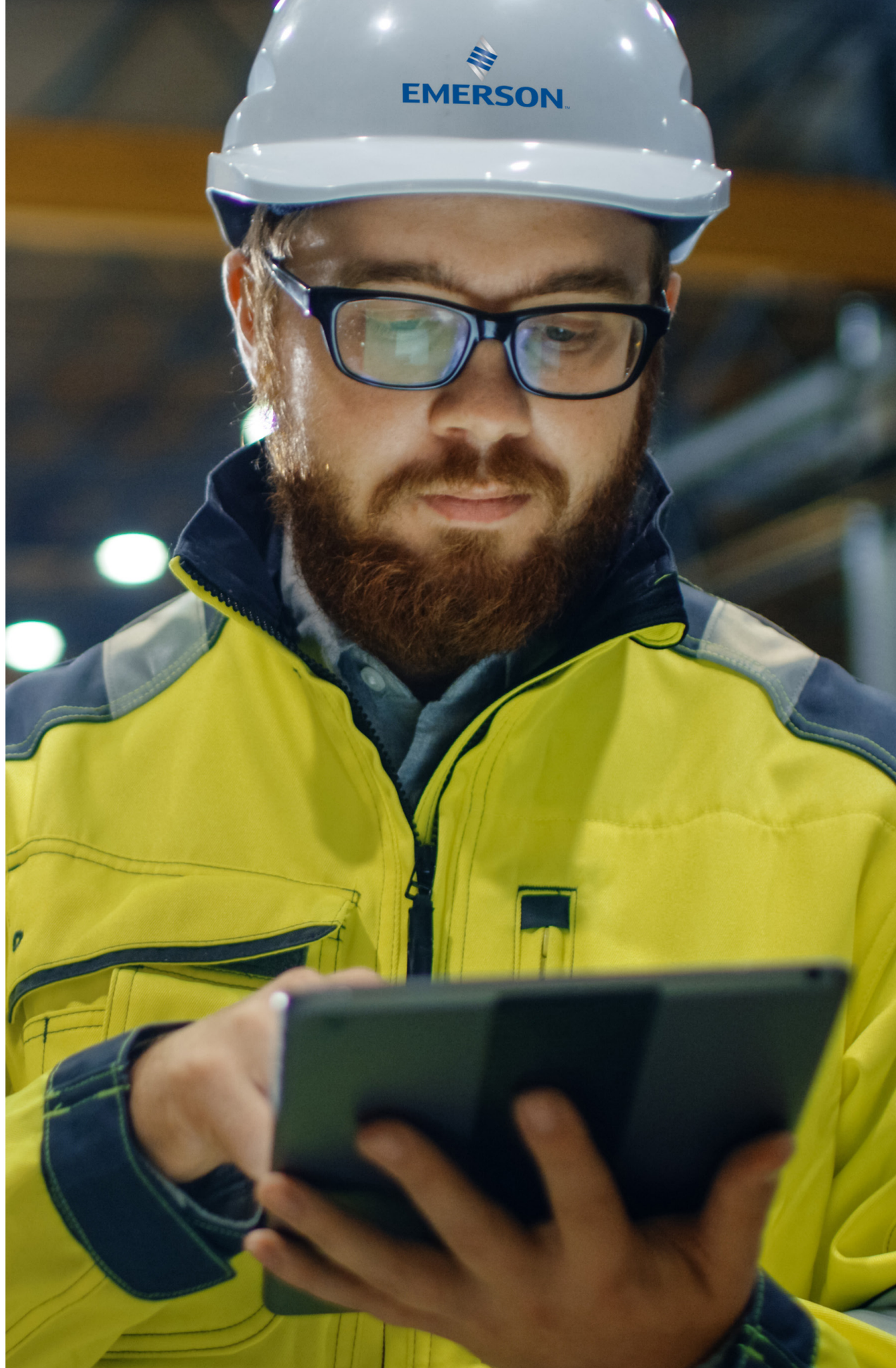
Considerations and Best Practices for Determining whether an Alarm can be Suppressed

Each alarm to be suppressed should be evaluated to ensure that it is acceptable to be suppressed in the proposed scenario. Safety alarms / safety related alarms may need to remain unsuppressed if potential hazards are still present. The following recommendations adapted from EEMUA 191 are provided to help guide the review of alarms to be suppressed.

- Agree on the alarm's basic purpose/intent.
- Is it referenced in HAZOPs or other Safety documentation? If so, verify that the hazard documented is no longer present in the condition proposed for suppression.
- Is the loss of the alarm function in the proposed operating condition likely to create a hazard or lead to an operational difficulty?
- Is the alarm used to infer a problem elsewhere? Will this other problem exist in the process condition that suppresses the alarm in question?
- Is there another alarm which will provide similar information (pump stopped/discharge low flow)? If so, the alarm in question may not be needed at all. Does this other alarm also need to be suppressed?

Final Considerations

In addition to state-of-the-art alarm management software and native DeltaV advanced alarming components, Emerson provides industry leading engineering services to assist users in all aspects of the alarm management program. Services include developing alarm management philosophy, front to back alarm rationalization, dynamic alarm design, software configuration and installation, metrics reporting and evaluation, recommendations for improvement, and periodic program auditing. Emerson engineering services are conducted by engineer personnel who are recognized subject matter experts. Emerson maintains voting membership on the ISA 18 committee and actively participates in other industry groups such as the Center for Operator Performance.



Contact Us
www.emerson.com/contactus