Setting the Standard for Automation™

How to apply ISA-18.2 Alarm Management Techniques to SCADA Systems

Common workarounds for applying alarm management to systems that were never designed for it

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weftec 2015 the water quality event™ TECHNICAL SESSION

About the Speaker

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- Senior I&C Engineer, Eramosa Engineering

- ISA18 “Alarm Management” Standards Committee – Voting Member
- ISA18 Working Group 7 “packaged systems” – committee co-chair
- IEC committee responsible for IEC-62682 – named Canadian expert

- Director, ISA Water/Wastewater Division (2013-2015)
- Past Chair of the 2012 & 2013 ISA Water/Wastewater and Automatic Control Symposium

- Has published over 30 papers and articles on automation topics
- Recipient of 2013 ISA awards for Volunteer Leader, Division Leader & Division Excellence
- 2011 ISA “Keith Otto” award for best article of year in InTech “SCADA Standardization”
- Background in various industry sectors including municipal water/wastewater

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Presentation Outline

- What is Alarm Management
- Overview of ISA-18.2
- Key SCADA Software Features Required

- Master Alarm Database
- Alarms vs. Notifications vs. Logged Events
- Alarm Summary Display
- Alarm Priorities
- Alarm Shelving and Alarm Out-of-Service

- Standardizing Alarm Design: Using Alarm Function Blocks
- On-Delay, Off-Delay, and Deadband
- Change Control, User Permissions, and Change Logging
- Final Words

The SCADA Alarms Challenge

- Old Days: a few dozen alarms
  - A few dozen Alarm Lights

- Modern SCADA Systems
  - Can easily add hundreds of alarms with a few keystrokes
  - Many, many, many software configuration options
  - How do we decide how to configure and use alarms?
  - How do we avoid alarm overload?
  - Do we really need all these alarms?

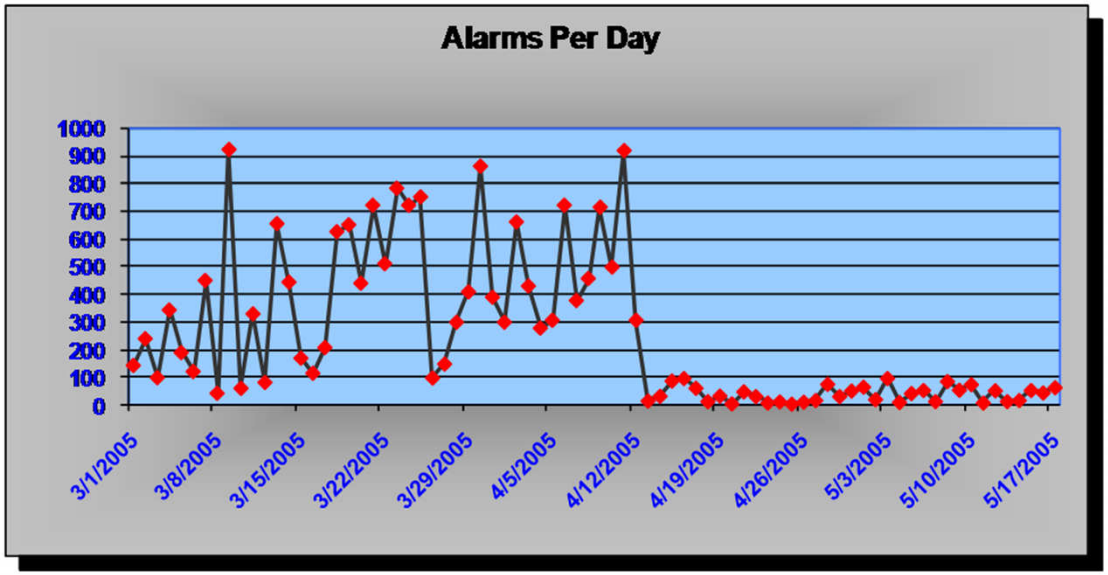
Typical Before / After for applying 18.2

ANSI/ISA-18.2-2009 & IEC-62682,

Management of Alarm Systems for the Process Industries

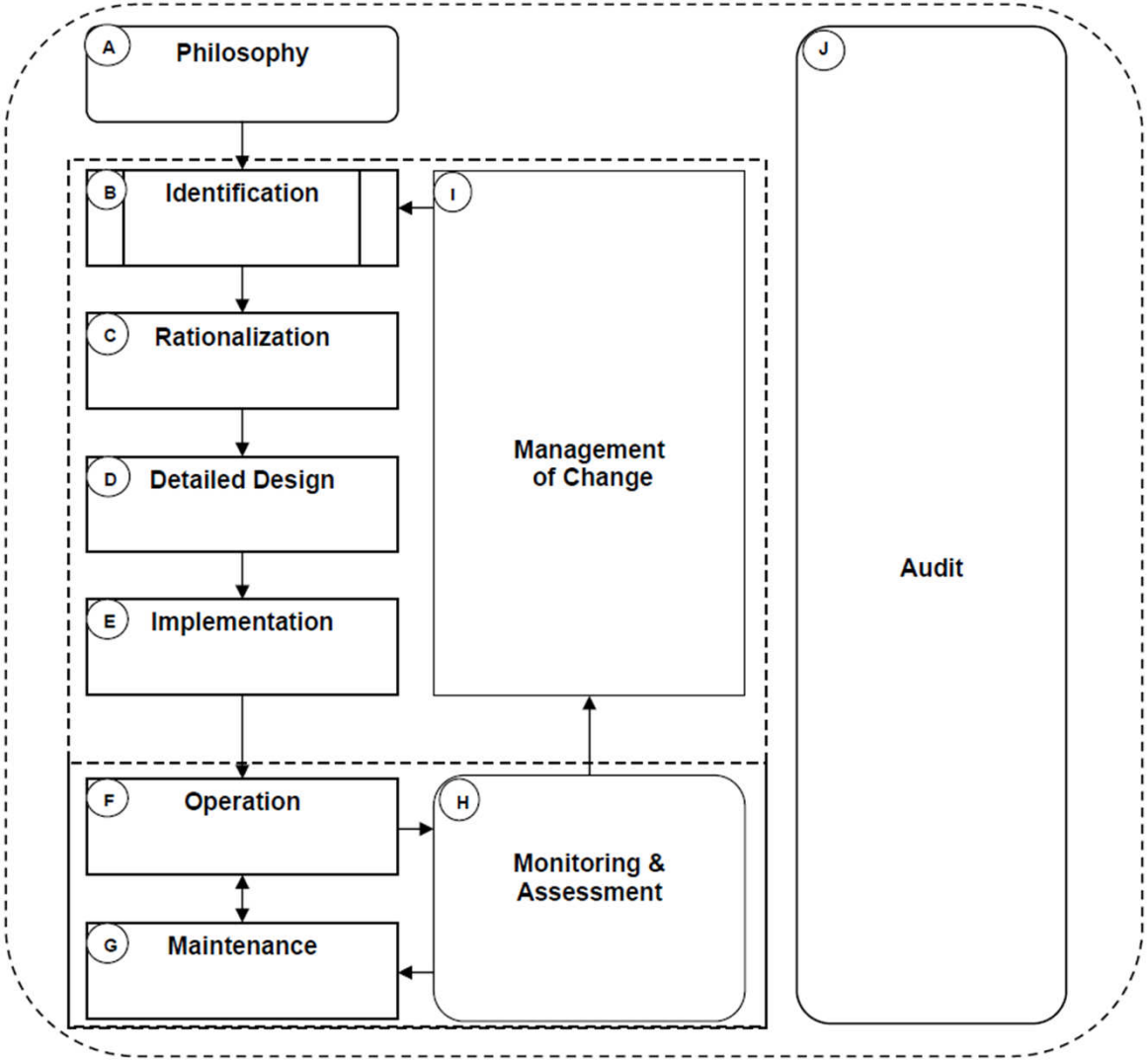
Alarm: *An audible and/or visible means of indicating to the operator an equipment malfunction, process deviation or abnormal condition requiring a timely response.*

Methodology for identifying, rationalizing and designing alarms to be a powerful tool for operations, and eliminating non-useful alarms



Typical example of results of 18.2 being implemented (showing before/after)

ISA 18.2 Alarm Management Lifecycle



Key SCADA Software Features 1 of 2

- Master Alarm Database
- Ability to create non-alarm messages and logged events
- Support for Alerts, Prompts, and Maintenance Messages
- HMI Alarm Summary Display Screen
- Alarm Sorting, Filtering, Routing
- Alarm Areas/Grouping
- Alarm Priorities
- Alarm Classes

Key SCADA Software Features 2 of 2

- Standardizing Alarm Features with Function Blocks
- On-Delay, Off-Delay, Deadband
- Conditional Alarming: base condition plus additional logic
- Alarm Shelving Method with Authorization / Logging
- Alarm Out of Service
- Change Control – Permissions, Setpoints, Configuration
- Configuration Change Logging
- Alarm Setpoint/Attribute verification & enforcement

Master Alarm Database (MADB)

- Master Alarm Database
  - Central repository of approved alarms and their configuration

Tag	Priority	Desc.	Condition	Consequence If Ignored	Consequence Severity	Expected Operator Response	Time to Respond
P1-380-LAH-201	LOW	Aeration 1 High Level	High Level Switch Activated for 10sec	Overflows in Secondary clarifiers.	MINOR	Check Level Controller	2 hours
P1-380-AAL-102	MED	Aeration 1 Low DO	DO below 3ppm for 30min	Loss of Biological Action, Risk of Damage to Biological Mass	MAJOR	Investigate and turn on additional blowers	1 hour
P1-380-PALL-456A	LOW	Aeration 1 Air Pres. Low Low	Less than 15psi for 5min	Loss of Energy if Air Leak, Poor Aeration (Note: there is a low DO alarm)	MINOR	Check pressures in air distribution system via HMI, check valves in field	4 hrs

MADB Contents

- **Alarm Tag**
- **Alarm Description** (full description & what is shown on HMI)
- **Identification:** Trigger Condition, Purpose
- **Rationalization**:
  - Consequence & Severity if Ignored
  - Expected Operator Response, Time to Respond
  - Alarm Priority & Alarm Class
- **Design:** Trigger Condition, On/Off Delays, Additional Filtering Logic, Setpoints, Routing/grouping information for the HMI
- **Operation:** When put into service, If Periodic Testing is required

MADB Implementation

- Common Approaches
  - Built-in MADB in SCADA package (nice to have, but rare)
  - Excel Spreadsheet (often used)
  - Customized Microsoft Access Database
  - 3rd Party Application

- Tips
  - Keep it simple – not too many columns
  - Capture Setpoints, and document why those setpoints were selected
  - Periodically check against what is actually programmed in PLC/RTU
  - Have a “last updated” date for each alarm
  - Keep it up to date

HMI: Alarms, Events and Notifications

- SCADA Systems can have multiple types of notifications

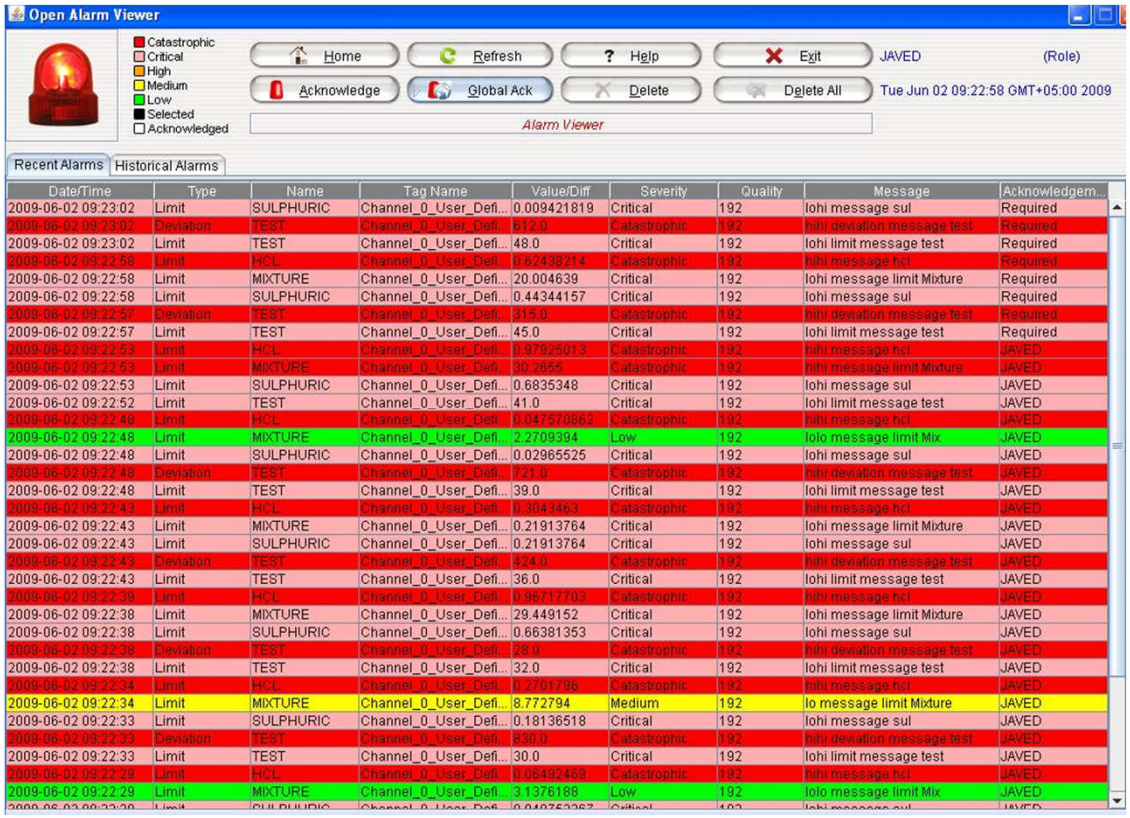
Operator notification types	Operator is expected to take an action	Operator might need to be aware but is not required to take action *(Action might be expected from someone other than the operator.)*
Arises from an abnormal process or equipment situation	Alarm	Alert
Arises from a normal situation	Prompt	Status

Figure 6 – Sample criteria for notification types from an alarm philosophy

- SCADA systems should have support for:
  - Alarms
  - Other notifications: alerts, prompts, maintenance messages
  - Event messages
  - Logged-only events

HMI: Alarm Summary Display Screen

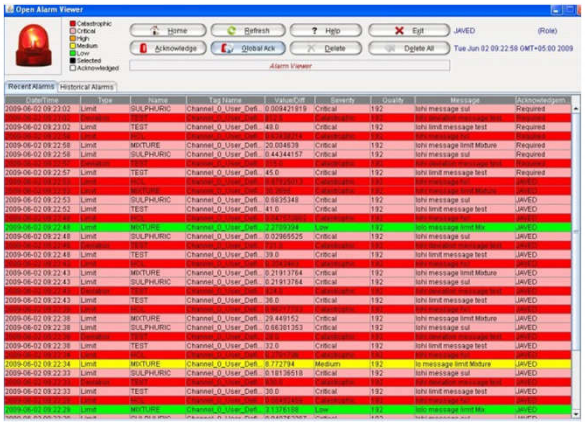
- Dedicated screen for displays alarms – only alarms
- Ideally on its own dedicated monitor in multi-monitor setup



Date/Time	Type	Name	Tag Name	Value/Diff	Severity	Quality	Message	Acknowledgem...
2009-06-02 09:23:02	Limit	SULPHURIC	Channel_0_User_Defi...	0.009421819	Critical	192	lohi message sul	Required
2009-06-02 09:23:02	Deviation	TEST	Channel_0_User_Defi...	612.0	Catastrophic	192	hihi deviation message test	Required
2009-06-02 09:23:02	Limit	TEST	Channel_0_User_Defi...	48.0	Critical	192	lohi limit message test	Required
2009-06-02 09:22:58	Limit	HCL	Channel_0_User_Defi...	0.62438214	Catastrophic	192	hihi message hcl	Required
2009-06-02 09:22:58	Limit	MIXTURE	Channel_0_User_Defi...	20.004639	Critical	192	lohi message limit Mixture	Required
2009-06-02 09:22:58	Limit	SULPHURIC	Channel_0_User_Defi...	0.44344157	Critical	192	lohi message sul	Required
2009-06-02 09:22:57	Deviation	TEST	Channel_0_User_Defi...	315.0	Catastrophic	192	hihi deviation message test	Required
2009-06-02 09:22:57	Limit	TEST	Channel_0_User_Defi...	45.0	Critical	192	lohi limit message test	Required
2009-06-02 09:22:53	Limit	HCL	Channel_0_User_Defi...	0.97925013	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:53	Limit	MIXTURE	Channel_0_User_Defi...	30.2655	Catastrophic	192	hihi message limit Mixture	JAVED
2009-06-02 09:22:53	Limit	SULPHURIC	Channel_0_User_Defi...	0.6835348	Critical	192	lohi message sul	JAVED
2009-06-02 09:22:52	Limit	TEST	Channel_0_User_Defi...	41.0	Critical	192	lohi limit message test	JAVED
2009-06-02 09:22:48	Limit	HCL	Channel_0_User_Defi...	0.047570862	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:48	Limit	MIXTURE	Channel_0_User_Defi...	2.2709394	Low	192	lolo message limit Mix	JAVED
2009-06-02 09:22:48	Limit	SULPHURIC	Channel_0_User_Defi...	0.02965525	Critical	192	lohi message sul	JAVED
2009-06-02 09:22:48	Deviation	TEST	Channel_0_User_Defi...	721.0	Catastrophic	192	hihi deviation message test	JAVED
2009-06-02 09:22:48	Limit	TEST	Channel_0_User_Defi...	39.0	Critical	192	lohi limit message test	JAVED
2009-06-02 09:22:43	Limit	HCL	Channel_0_User_Defi...	0.3043463	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:43	Limit	MIXTURE	Channel_0_User_Defi...	0.21913764	Critical	192	lohi message limit Mixture	JAVED
2009-06-02 09:22:43	Limit	SULPHURIC	Channel_0_User_Defi...	0.21913764	Critical	192	lohi message sul	JAVED
2009-06-02 09:22:43	Deviation	TEST	Channel_0_User_Defi...	424.0	Catastrophic	192	hihi deviation message test	JAVED
2009-06-02 09:22:43	Limit	TEST	Channel_0_User_Defi...	36.0	Critical	192	lohi limit message test	JAVED
2009-06-02 09:22:39	Limit	HCL	Channel_0_User_Defi...	0.96717703	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:38	Limit	MIXTURE	Channel_0_User_Defi...	29.449152	Critical	192	lohi message limit Mixture	JAVED
2009-06-02 09:22:38	Limit	SULPHURIC	Channel_0_User_Defi...	0.66381353	Critical	192	lohi message sul	JAVED
2009-06-02 09:22:38	Deviation	TEST	Channel_0_User_Defi...	28.0	Catastrophic	192	hihi deviation message test	JAVED
2009-06-02 09:22:38	Limit	TEST	Channel_0_User_Defi...	32.0	Critical	192	lohi limit message test	JAVED
2009-06-02 09:22:34	Limit	HCL	Channel_0_User_Defi...	0.2701796	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:34	Limit	MIXTURE	Channel_0_User_Defi...	8.772794	Medium	192	lo message limit Mixture	JAVED
2009-06-02 09:22:33	Limit	SULPHURIC	Channel_0_User_Defi...	0.18136518	Critical	192	lohi message sul	JAVED
2009-06-02 09:22:33	Deviation	TEST	Channel_0_User_Defi...	830.0	Catastrophic	192	hihi deviation message test	JAVED
2009-06-02 09:22:33	Limit	TEST	Channel_0_User_Defi...	30.0	Critical	192	lohi limit message test	JAVED
2009-06-02 09:22:29	Limit	HCL	Channel_0_User_Defi...	0.06492469	Catastrophic	192	hihi message hcl	JAVED
2009-06-02 09:22:29	Limit	MIXTURE	Channel_0_User_Defi...	3.1376188	Low	192	lolo message limit Mix	JAVED

HMI: Alarm Summary Display Columns

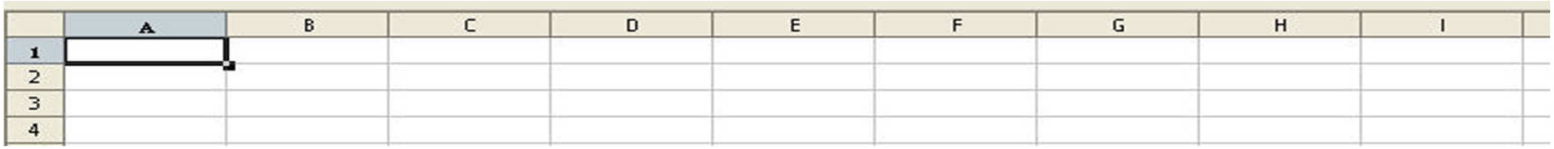
- Recommended Minimum Columns
  - Alarm Priority
  - Full Alarm Tag
  - Alarm Description
  - Current Status of Alarm: Active, RTN, Ack/Non-Ack
  - Date/Time of Trigger
  - Date/Time of RTN (return to normal)
  - Date/Time of Ack
- Others
  - Alarm Area/Group (in large systems)
  - Alarm Class (e.g., identify EPA alarms)
  - Operator Response Information



HMI: Alarm Sorting, Filtering, Routing

- Alarm Summary Display
  - Sort alarms by date/time, priority, area
  - Enough columns to see alarm context and information
  - Ability to show second filtered alarm display – to investigate an issue
  - Nice to Have – Click on alarm, user goes to relevant process screen

- Large Systems
  - Route alarms to the specific operator for that area
  - Ability to change routing of alarms depending who is on shift
  - Automatic alarm routing based on time of day: day vs. night.
  - Additional filtered alarm displays to show alarms specific to an area



HMI: Alarm Priorities

- Alarm priorities help operators prioritize when multiple alarms are active

- Commonly Used Alarm Priority Schemes:
  - Low, Medium, High
  - Low, Medium, High, Critical
  - Info, Low, Medium, High, Critical

	Urgent	Not urgent
Important	Urgent and important	Important but not urgent
Not important	Urgent but not important	Not urgent and not important

- Do not include non-urgent messages in the alarm display (e.g. maintenance alerts, operator prompts, logged events, etc.)

- ISA-18.2 suggests an alarm distribution of:
  - LOW 80%, MEDIUM 15%, HIGH 5%, CRITICAL <1%

HMI: Alarm Shelving & Alarm Out of Service

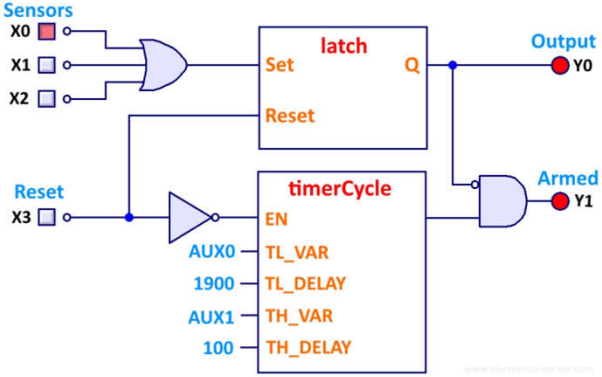
- Alarm Shelving
  - Core feature of ISA-18.2 alarm management
  - Controlled way for an Operator to temporarily disable an alarm
  - Temporary means alarm will auto-re-enable after delay (e.g., 8 hrs)
  - Should be software support for doing this with user permissions
  - For “Highly Managed Alarms” you may want to disallow shelving

- Historically SCADA support for alarm shelving is very poor to non-existent. You will often have to write custom code to do this.

- Use “Out of Service” for long-term disabling of alarms
- Make sure all Alarm Shelving and Out of Service actions are logged!

PLC: Standardized Alarm Blocks

- Use a standardized function block in your PLC for all alarms
- Key Features:
  - Raw Status vs. Alarm Bit
  - Condition Inversion
  - Logic-Based Suppression
  - ON-Delay
  - OFF-Delay
  - Shelving / Out of Service support (if required at PLC-level)
- Additional Features for Analog/Value Alarms
  - Deadband
  - Alarm Masking if Signal is Bad
  - Masking of Lesser Alarms (L vs. LL)
  - Rate of Change

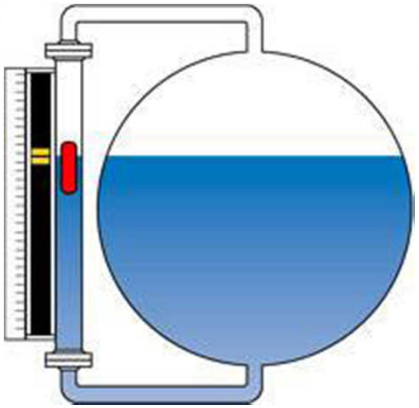


PLC: ON-Delay and OFF-Delay

- ON-Delay
  - Time that “condition” must be true before alarm triggers
  - Alarm Condition vs. Alarm Triggering
  - Example
    - High level in a wet well where a pump will come on to pump it out
    - On high level, only alarm if high level is sustained for 60 seconds
    - Don’t alarm if high level true for 30 seconds and then resolves itself

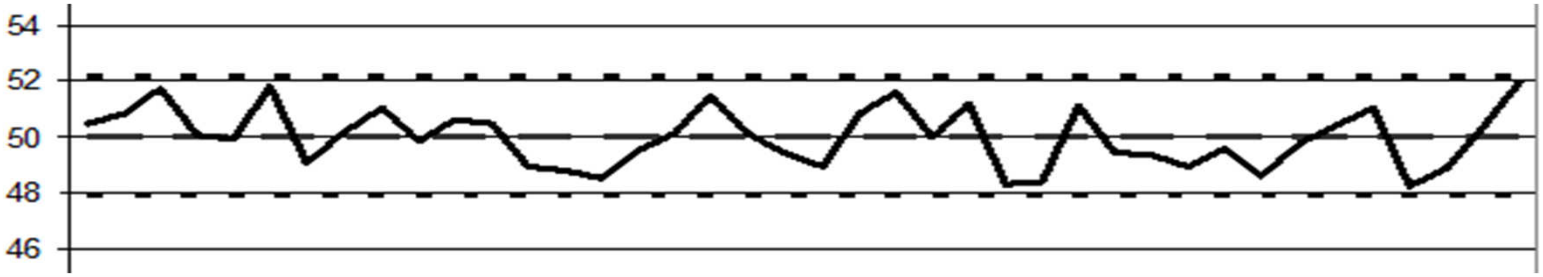
- OFF-Delay
  - Time that “alarm stays active” before it returns to normal
  - Think: minimum time alarm bit stays active
  - Helps avoid “flicker alarms” that trigger to fast to see
  - Useful for alarm dialers so dialer will detect the alarm

PLC: Deadband for Analog Value Alarms



- Also called “Hysteresis”
- Deadband prevents chatter with analog alarms
- Defined as % of associated instrument range
- Example
  - On a 0 – 10m level transmitter
  - Configure HIGH ALARM of 8.0 m with 10% deadband
  - Means: Alarm triggers at > 8.0 m, and alarm returns to normal at < 7.9 m

- When combined with ON-Delay and OFF-delay can be powerful tool !



PLC & HMI: Change Control & Permissions

- SCADA Systems must have user accounts and permissions
- Do not run a system where all users have configuration access

- Recommended minimum levels:
  - **Engineer** – configuration/programming access
  - **Administrator** – can add/delete accounts
  - **Supervisor** – can change setpoints
  - **Operator** – only operate, not change setpoints
  - **Guest** – view only, default access

- Any changes to the SCADA system should be logged

Final Words

- Alarm Management offer significant operational improvements
- Deploying Alarm Management in SCADA systems can be challenging
- Key software features are often missing in SCADA systems

- Carefully look at which functionality is important to your needs
- Document what you need, and then put in a plan to implement it
- When considering customization, consider the effort to maintain it
- Focus on implementing what will deliver maximum operational benefit

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