

# Control System Studio Training - Alarm System Usage

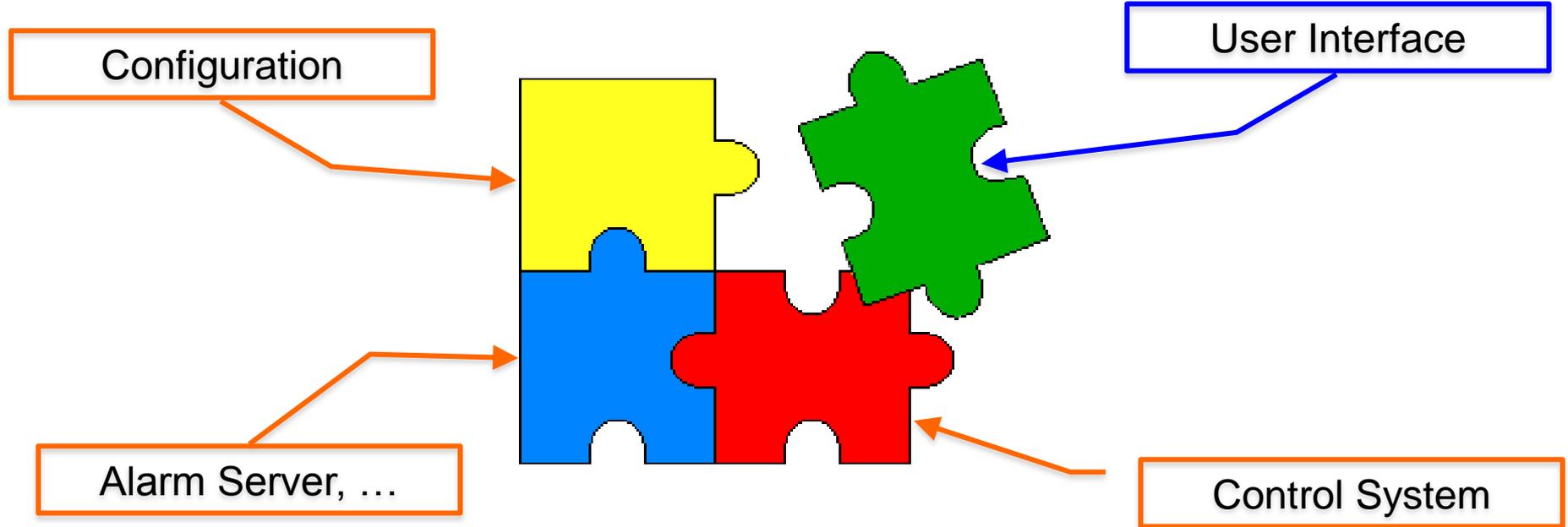
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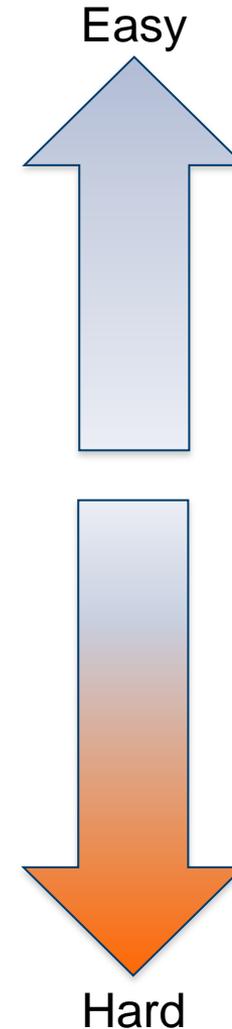
**Oct. 2012 EPICS Meeting, PAL, Korea**

# Alarm System Components



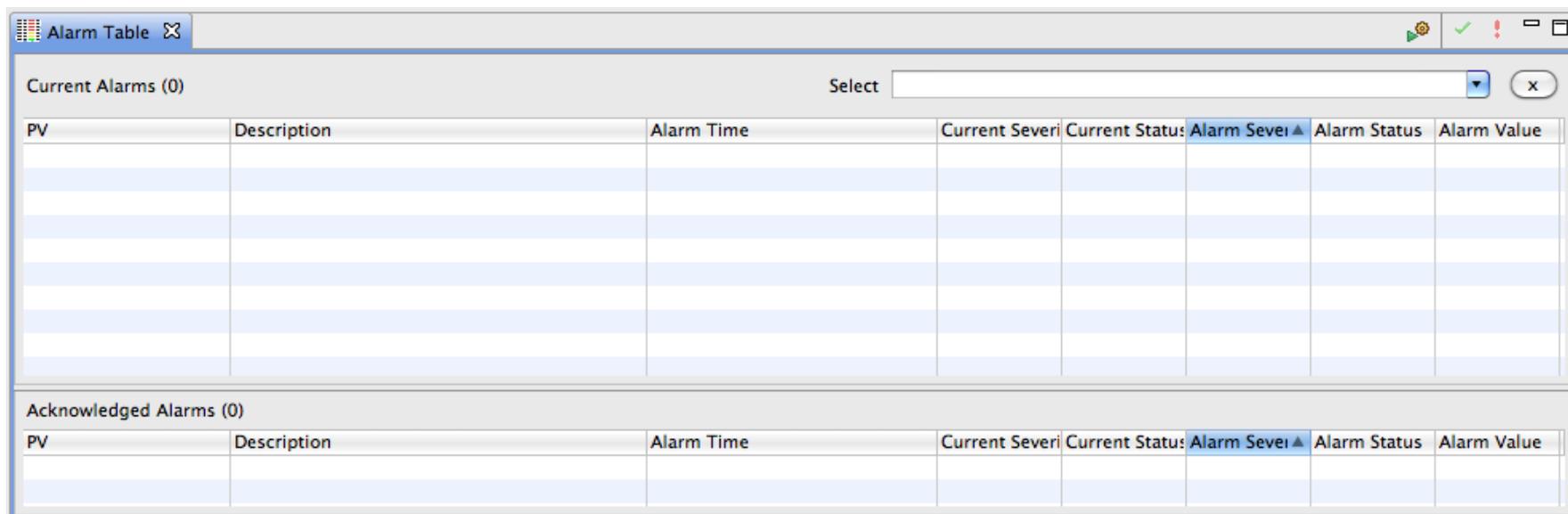
# Levels Of Complexity

- **Use the Alarm System**
  - Control Room operator
- **Configure the Alarm System**
  - Certain operators, IOC engineers
- **Alarm System Setup**
  - CSS maintainer for site
- **Coming up with a good configuration**
  - Everybody



# Operator Using the Alarm System

- Menu *CSS, Alarm, Alarm Table*
- Ideally: no alarms



The screenshot displays a software window titled "Alarm Table". At the top, there is a search bar labeled "Select" and a close button (X). Below the search bar, there are two sections, each with a table header and an empty table body.

**Current Alarms (0)**

PV	Description	Alarm Time	Current Severi	Current Status	Alarm Severi ▲	Alarm Status	Alarm Value

**Acknowledged Alarms (0)**

PV	Description	Alarm Time	Current Severi	Current Status	Alarm Severi ▲	Alarm Status	Alarm Value

# Operator Looking at Alarm User Interface

- Other Alarm Views (Context Menu Alarm Perspective)
  - Alarm Tree displays items monitored by the alarm server
  - Area Panel displays state of areas
- Still, all OK

The screenshot displays the Alarm User Interface with three main components:

- Alarm Area Panel:** Shows two green panels labeled "Ion Source" and "Linac", indicating that all monitored areas are in an OK state.
- Alarm Tree:** A hierarchical tree view showing the structure of monitored items. The tree is expanded to show:
  - Area: Ion Source
    - System: RF
    - System: Vacuum
    - PV: demo.temp
  - Area: Linac
- Alarm Table:** A table showing the status of current and acknowledged alarms. Both tables are currently empty, indicating no active or acknowledged alarms.

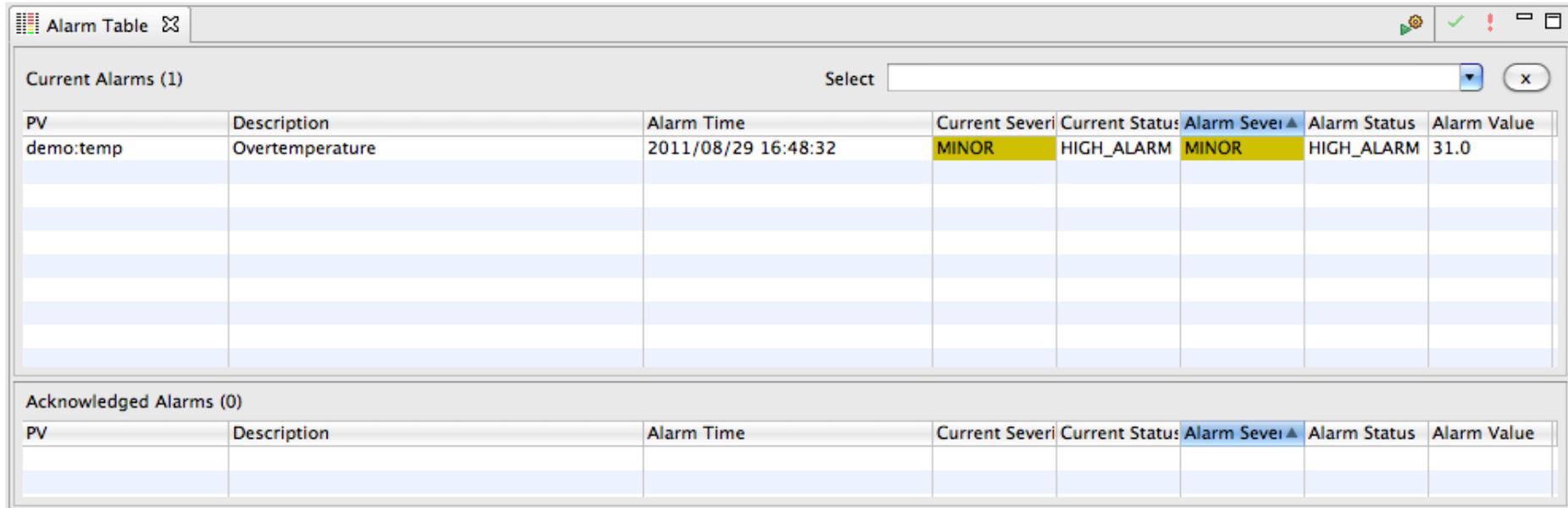
Current Alarms (0)							
PV	Description	Alarm Time	Current Severi	Current Status	Alarm Severi	Alarm Status	Alarm Value

Acknowledged Alarms (0)							
PV	Description	Alarm Time	Current Severi	Current Status	Alarm Severi	Alarm Status	Alarm Value

# An Alarm Triggers!

Table shows what, when, ...



The screenshot shows a software window titled "Alarm Table" with a search icon. It contains two sections: "Current Alarms (1)" and "Acknowledged Alarms (0)". The "Current Alarms" section has a "Select" dropdown menu and a table with the following data:

PV	Description	Alarm Time	Current Severity	Current Status	Alarm Severity	Alarm Status	Alarm Value
demo:temp	Overtemperature	2011/08/29 16:48:32	MINOR	HIGH_ALARM	MINOR	HIGH_ALARM	31.0

The "Acknowledged Alarms" section is currently empty, showing only the column headers: PV, Description, Alarm Time, Current Severity, Current Status, Alarm Severity, Alarm Status, and Alarm Value.

Annunciator would say:

***“Minor alarm: Overtemperature”***

# An Alarm Triggers...

Some operators prefer just the Alarm Table, others also like to look at Area Panel or Tree View

The screenshot displays a control room interface with three main panels:

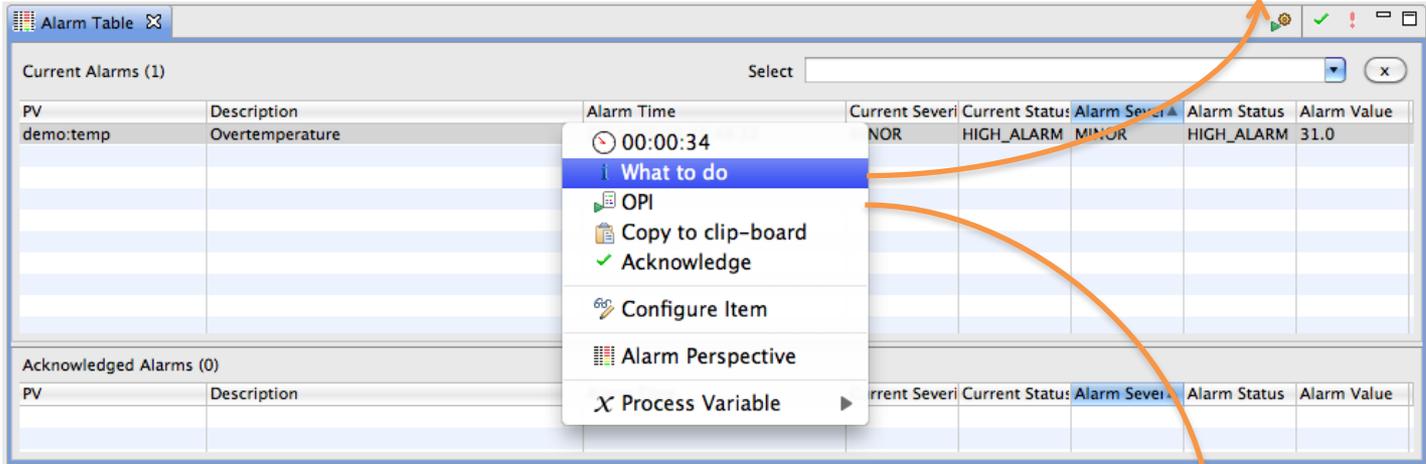
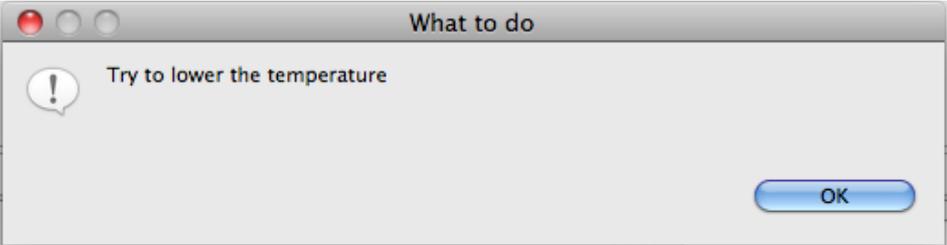
- Alarm Area Panel:** Contains two large colored rectangles labeled "Ion Source" (yellow) and "Linac" (green).
- Alarm Tree:** A hierarchical tree view showing the following structure:
  - Area: Ion Source (MINOR/HIGH\_ALARM)
  - System: RF
  - System: Vacuum (MINOR/HIGH\_ALARM)
    - PV: demo:temp (MINOR/HIGH\_ALARM, MINOR/HIGH\_ALARM)
  - Area: Linac
- Alarm Table:** A table showing current and acknowledged alarms.

Current Alarms (1)								
PV	Description	Alarm Time	Current Severi	Current Status	Alarm Seve	Alarm Status	Alarm Value	
demo:temp	Overtemperature	2011/08/29 16:48:32	MINOR	HIGH_ALARM	MINOR	HIGH_ALARM	31.0	
Acknowledged Alarms (0)								
PV	Description	Alarm Time	Current Severi	Current Status	Alarm Seve	Alarm Status	Alarm Value	

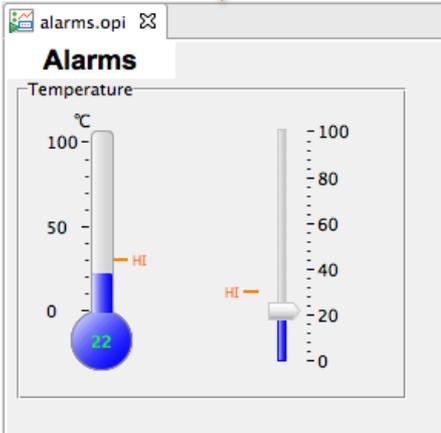
So there is a problem in the Ion Source Vacuum...

# Context menu of Alarm

- **Guidance**



- **Links to related OPIs**



# The Problem is fixed, Alarm clears

The screenshot displays a software interface for alarm management. On the left, there are two panels: 'Alarm Area Panel' with 'Ion Source' and 'Linac' buttons, and 'Alarm Tree' showing a hierarchy of areas and systems. The 'Alarms' panel shows two temperature gauges. The 'Alarm Table' is the central focus, showing a table of current alarms.

PV	Description	Alarm Time	Current Seve	Current Statu	Alarm Seve	Alarm Status	Alarm Value
demo:temp	Overtemperature	2011/08/29 16:48:32	OK	OK	MINOR	HIGH_ALARM	31.0

Below the current alarms table is a section for 'Acknowledged Alarms (0)' with a similar header and empty table.

- By default, the alarm system latches alarms
  - “Current” severity of PV is **OK**, but **MINOR** alarm is remembered until alarm is **✓ Acknowledged**

# Guidance, Related Displays, Commands

Alarm Tree

- Area: BeamPermit (OK/OK/OK)
- Area: CF (OK/MINOR/HIGH\_ALARM)
  - System: Cooling\_Tower (OK/OK/OK)
    - System: Cooling Tower Fans (OK/OK/OK)
    - System: Cooling\_Tower\_Pumps (OK/OK/OK)
    - PV: CF\_CU:TWR2\_TW\_Trouble:Sts (OK/OK/OK)
    - PV: CF\_CU:TWR\_FT4017:Flw (OK/OK/OK)
    - PV: CF\_CU:TWR\_TT4016:T (OK/OK/OK)
    - PV: CF\_CU:TWR\_TT4017:T (OK/OK/OK)
    - PV: CF\_CU:TWR\_TT4018:T (OK/OK/OK)
  - System: Klystron\_Gallery\_Temp (OK/OK/OK)
  - System: Potable\_Water\_Tank (OK/OK/OK)
  - System: Site\_Power\_Other\_UPS (OK/OK/OK)
- Area: Diagnostics (OK/OK/OK)
- Area: HP\_Mod\_Smoke (OK/OK/OK)
- Area: HP\_Mod\_V\_Mon (OK/OK/OK)
- Area: HPRF\_PLC\_Check (OK/OK/OK)
- Area: HPRF\_Rack\_Sts (OK/OK/OK)
- Area: ICS (OK/OK/OK)
- Area: MPS (OK/OK/OK)
- Area: PPS (OK/OK/OK)
- Area: Timing (OK/OK/OK)
- Area: Tunnels (OK/OK/OK)
- Area: Water\_Pump (OK/OK/OK)
- Area: IonSource (OK/OK/OK)

Check tower water pump

Look at tower water pump screen. Three pumps should be running. If not, attempt to turn on via operator screen. If that fails, turn them on manually at CUB.

OK

- ✓ Basic Text
- ✓ Open EDM/OPI screen
- ✓ Open web page
- ✓ Run ext. command

**Hierarchical:**  
Including info of parent entries

**Merges Guidance etc. from all selected alarms**

## Alarm PV: CF\_CU:TWR2\_TW\_Trouble:Sts

### Purpose of Alarm

Indicates insufficient tower water problem, either flow or elevated temperature or pump failure. Flow (5500gpm) and temperature limits are fixed in the PLC. For changes see contacts listed below.

### Operator Guidance

Look at tower water pump screen. There should be 3 pumps running. If not, attempt turn-on via operator screen.

If that fails, turn them on manually at CUB. If all fails, call contacts listed below.

### Failure Consequence

MAJOR consequence: Beam will be off for 12 hours, cold box will trip, ...

TODO: List the top 3 critical items and response times in each case to avoid shutdown.

### Operator Response Time Available

Usually less than 5 minutes in order to prevent further temperature increase.

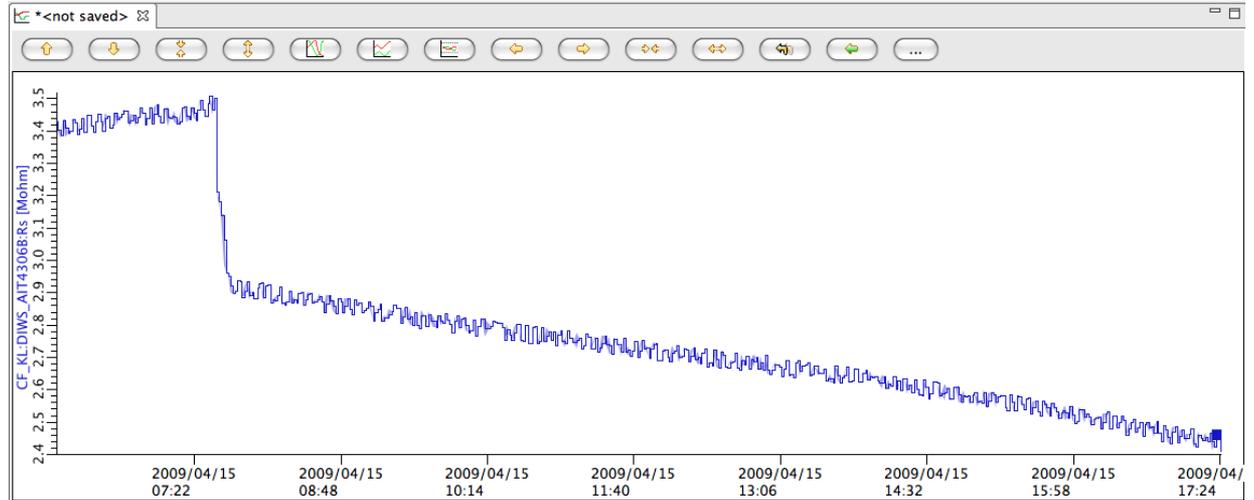
TODO: Response time depends on beam power. How should this be factored into response?

### Contacts

Water System Mechanical Engineers: Greg Irby, Jerry Ferguson Control System Contact: Frank Brantley

# CSS Context Menus Connect the Tools

Send alarm  
PV to any  
other CSS  
PV tool



PV	Description	Time	Current Severity	Severity	Status	Value
CF_KL-DIWS_AIT4306B:Rs	Check polishing loop	2009/04/15 01:33:32	OK	MINOR	HIGH_ALARM	2.5

PV	Description	Time	Current Severity	Severity	Status	Value
TMod-Summary_MPS:Alarm	Moderator System M			invalid-ack'ed	READ_ALARM	Ready
HEBT_Coll:CT2:Cond	Hebbit collimator outlet flow conductivity alarm			major-ack'ed	LOLO_ALARM	0.016

- 01:33:32
  - Check polishing loop resistivi...
  - CF Overview
  - Klystron Gallery Overview
  - Logbook...
  - Acknowledge
  - Copy Pv Name to Clipboard
  - CSS**
  - Configure Item
  - Auto-size Columns
  - Alarm Perspective
- Data Browser
  - Data Browser View
  - Open in display
  - PV Table
  - Rack View
  - PV Utility
  - PV Fields Viewer
  - Probe
  - EPICS PV Tree

Field	DBD Type	Value in File	Live Value
HHSV	DBF_MENU	MAJOR	MAJOR
HIGH	DBF_DOUBLE	2.5	2.5
HHI	DBF_DOUBLE	3.0	3.0
HSV	DBF_MENU	MINOR	MINOR

# E-Log Entries

PV	Description	Time
CF_KL:DIWS_AIT4306B:Rs	Check polishing loop	01:33:32

- 01:33:32
- Check polishing loop resistivi...
- CF Overview
- Klystron Gallery Overview
- Logbook...
- Acknowledge

- **“Logbook”** from context menu creates text w/ basic info about selected alarms. Edit, submit.

**Create electronic logbook entry**  
Enter name, password, maybe edit the alarm information

User name:

Password:

Logbook:

Title:

Text:  
Received this alarm while turning the puple thingy on.  
Fixed it by turning the second valve from the left three clicks clockwise.

Check polishing loop resistivity for KL4  
PV: CF\_KL:DIWS\_AIT4306B:Rs  
Time: 2009/04/15 15:50:58.735057000 (Duration 01:14:23)  
Severity/Message: MINOR/HIGH\_ALARM  
Value: 2.5  
Current Severity: OK

- **Pluggable implementation**

- **Similar: EMail**

# Alarm System Setup

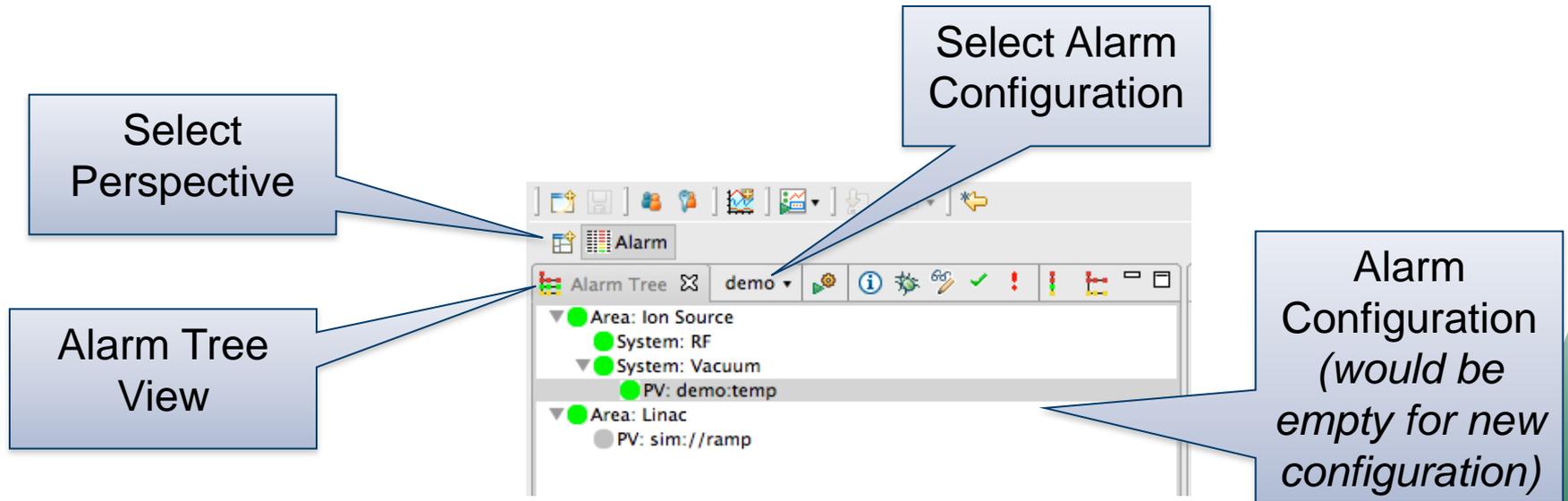
- Infrastructure
  - Separate talks:  
RDB, JMS, AlarmServer, AlarmConfigTool
  - Assume there is an Alarm Server running
- Machine, Control System,  
or at least soft IOC with alarm trigger PVs:

```
# EPICS (Soft) IOC Database
# for alarm system demo
#
# Execute with
# softIoc -s -d alarm.db
```

```
record(ai, "demo:temp")
{
  field(INP, "20")
  field(EGU, "C")
  field(HIGH, "30")
  field(HSV, "MINOR")
  field(PINI, "YES")
  field(HOPR, "100")
}
```

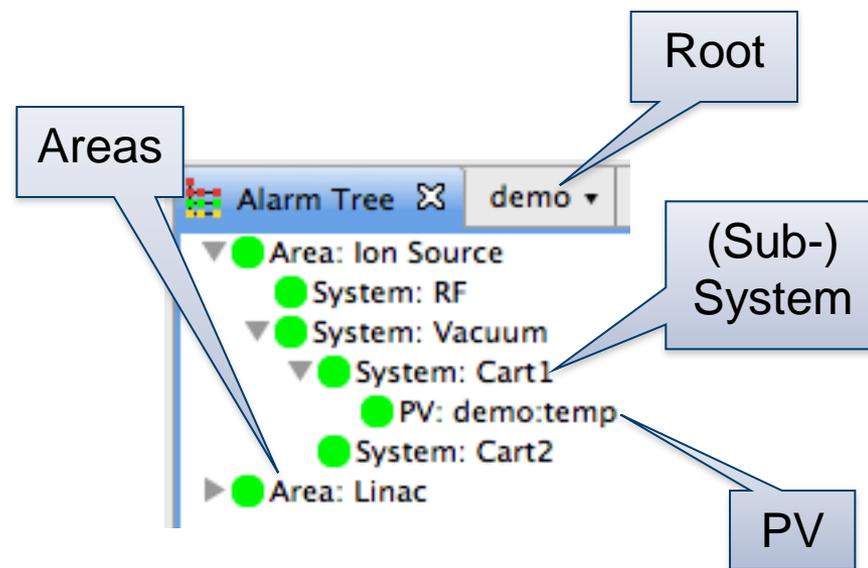
# Configuring the Alarm System

- Open Alarm Tree
  - a) Menu *CSS/Alarm/Alarm Tree*
  - b) Use *Alarm Perspective*
- Select alarm configuration

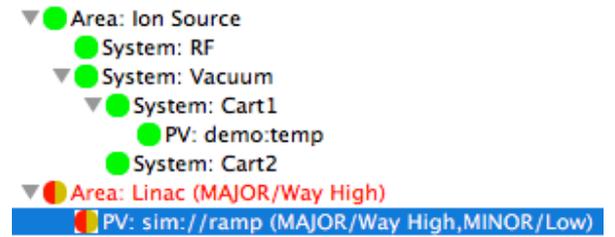


# Alarm Configuration Hierarchy

- **Root**
  - Name of the alarm configuration
- **Area**
  - Top-level elements
- **System**
  - Anything below ‘Area’
  - Can have (Sub-)System below other System
- **PV**
  - Alarm trigger PV
  - Can be below Area or System



# Why Hierarchy?



## 1. Organization

- Easier to maintain than plain list of PVs

## 2. Help Operators Locate Alarm

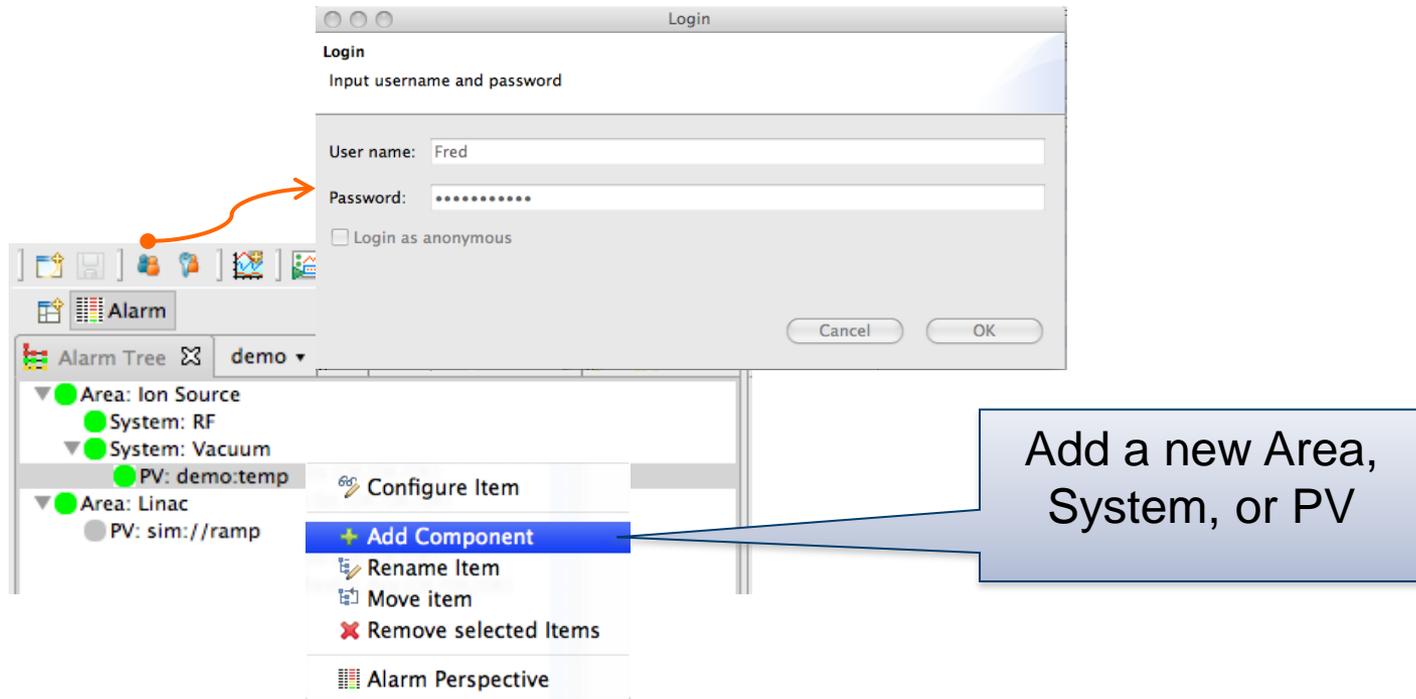
- Especially when there are many alarms, it can be useful to know **where** they are
- Use physical “Areas”, i.e. location along the machine!

## 3. Guidance, Related Displays

- Guidance for an Area or System will be displayed for **all Subsystems and PVs below that point** in the alarm configuration tree
- **Examples:**
  - General Ion Source contact information (phone numbers, ...)
  - Linac Overview display link

# Editing the Alarm Configuration

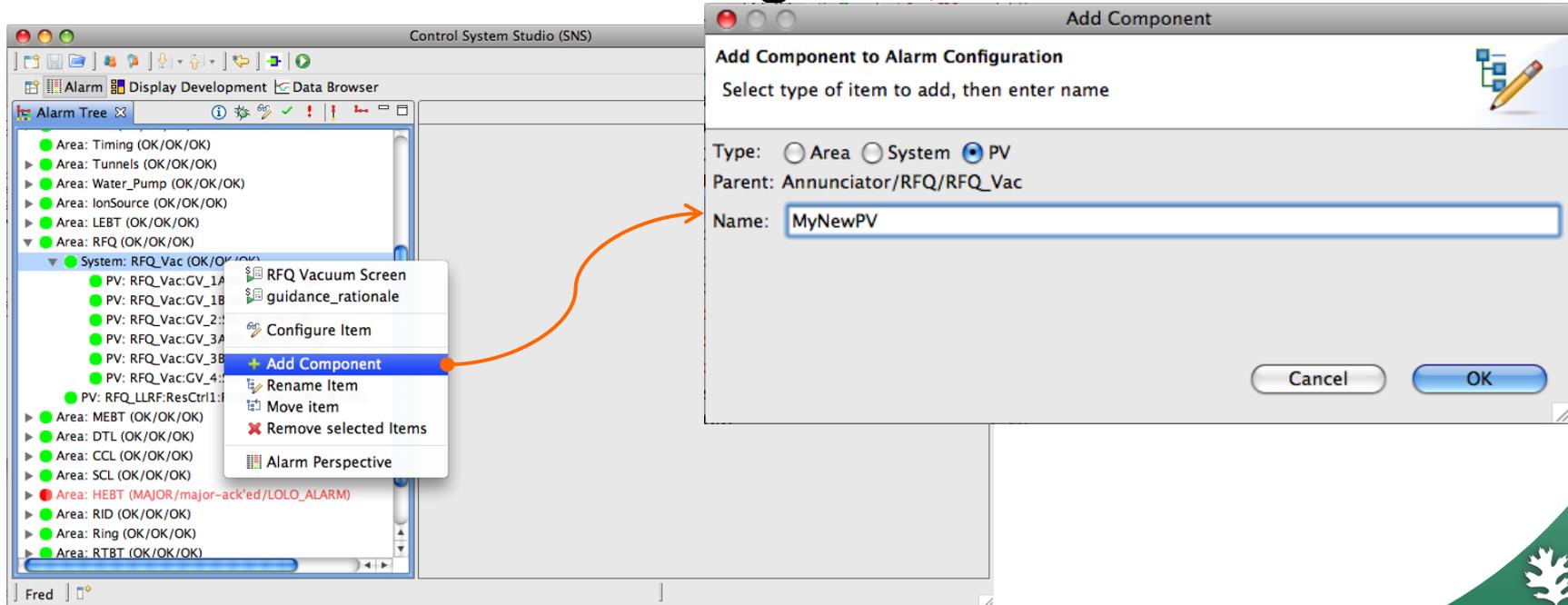
- Open Alarm Tree
- Log in
- Use Context Menu to add, edit, remove, ...



# Add PV or Subsystem

1. Right-click on 'parent'
2. "Add ..."
3. Check either Area, System or PV
4. Enter name

Online. No search for config files, no restarts.



# Configure PV

- Again online
- Especially useful for operators to update guidance and related screens.

Alarm Item Configuration

Item: Annunciator/RFQ/RFQ\_LLRF:ResCtrl1:ResErr\_Avg  
Configure guidance, related displays, ...

Description: Elevated R F Q resonance error

Alarm Delay [seconds]: 0

Alarm Count [within delay]: 0

Behavior:  Enabled  Latch  Annunciate

Enabling Filter:

Guidance:

Title	Detail
Check and fix resonance error	Check LLRF measurement of cavity residency error.
<Add>	<Add>

Displays:

Title	Command
RFQ LLRF	startedm -m S=RFQ,N=1,TN=...
RFQ Chiller	startedm Cool
Rationalization	https://ics-web.sns.ornl.gov/...
<Add>	<Add>

Commands:

Title	Command
<Add>	<Add>

ID: 621 Last configured: 2009/04/14 16:46:17

Area: RFQ (OK/OK/OK)

System: RFQ\_Vac (OK/OK/OK)

- PV: RFQ\_Vac:GV\_1A
- PV: RFQ\_Vac:GV\_1B
- PV: RFQ\_Vac:GV\_2:...
- PV: RFQ\_Vac:GV\_3A

RFQ Vacuum Screen

guidance\_rationale

Configure Item

# PV Configuration

Full Path to PV in Alarm Tree

Description:  
Also used for  
Annunciation

Guidance:  
Simple Title &  
Detail that should  
help operators  
handle the alarm

Display Link Options:  
/CSS/path/to/display.opi  
<http://www.google.com>  
<https://some.host.org>  
scriptname arg1 arg2

Alarm Item Configuration

Item: Annunciator/RFQ/RFQ\_LLRF:ResCtrl1:ResErr\_Avg  
Configure guidance, related displays, ...

Description: Elevated R F Q resonance error

Alarm Delay [seconds]: 0

Alarm Count [within delay]: 0

Behavior:  Enabled  Latch  Annunciate

Enabling Filter:

Guidance:

Title	Detail
Check and fix resonance error	Check LLRF measurement of cavity residency error.
<Add>	<Add>

Displays:

Title	Command
RFQ LLRF	startedm -m S=RFQ,N=1,TN=1 FCM-RFQ
RFQ Chiller	startedm Cool
Rationalization	<a href="https://ics-web.sns.ornl.gov/wiki/AlarmHa">https://ics-web.sns.ornl.gov/wiki/AlarmHa</a>
<Add>	<Add>

Commands:

Title	Command
<Add>	<Add>

ID: 621 Last configured: 2009/04/14 16:46:17

Cancel OK

Details:

Title: Check an

Details: Check LLRF error. Try to rec width as

## See online help for more details

# Exercise: Edit Alarm Configuration

- **Open Alarm Tree View**
- **Select the Alarm Configuration ( ‘root’ ) assigned to your team**
- **Add areas like “Front End”, “Linac”, “Target”**
- **Add Systems like “Vacuum”, “Cooling”**
- **Create simple BOY display that shows alarm trigger PVs and allows you to control them**
- **Add alarm trigger PVs to alarm configuration**
  - **Add some simple guidance like “Fix it”**
  - **Use path to your BOY \*.opi as Display Link**

# Exercise: Use Alarm Configuration

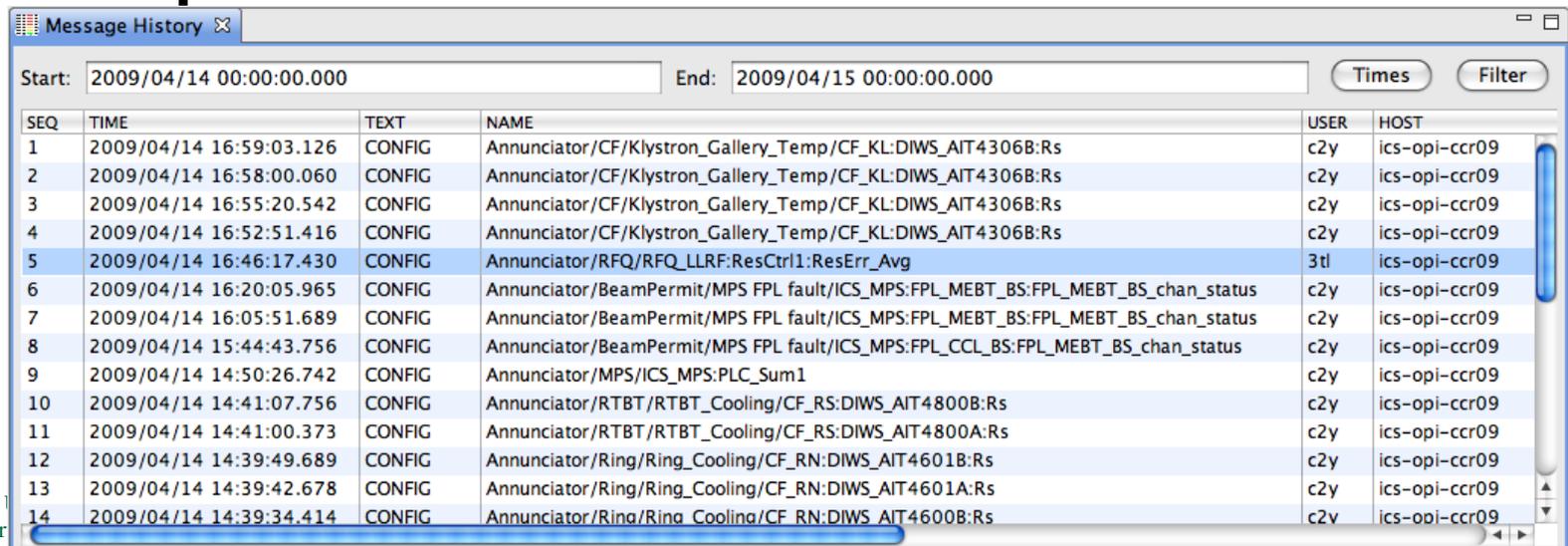
- **Switch to the Alarm Perspective**
  - Can do that from context menu of alarm tree
- **Use the display to trigger an alarm**
- **See how alarm is indicated in the table, tree, area panel**
  - Open the guidance, related display
  - Cause the alarm PV to stop alarming
  - Acknowledge the alarm

# General Alarm Server Behavior

- **Latch highest severity, or non-latching**
  - like ALH “ack. transient”
- **Annunciate**
- **Chatter filter ala ALH**
  - Alarm only if severity persists some minimum time
  - .. or alarm happens  $\geq N$  times within period
- **Optional formula-based alarm enablement:**
  - Enable if “(pv\_x > 5 && pv\_y < 7) || pv\_z==1”
  - ... but we prefer to move that logic into IOC
- **When acknowledging MAJOR alarm, subsequent MINOR alarms not annunciated**
  - ALH would again blink/require ack’

# Logging

- ..into generic CSS log also used for error/warn/info/debug messages
- Alarm Server: State transitions, Annunciations
- Alarm GUI: Ack/Un-Ack requests, Config changes
- Generic Message History Viewer
  - Example w/ Filter on TEXT=CONFIG



SEQ	TIME	TEXT	NAME	USER	HOST
1	2009/04/14 16:59:03.126	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
2	2009/04/14 16:58:00.060	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
3	2009/04/14 16:55:20.542	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
4	2009/04/14 16:52:51.416	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
5	2009/04/14 16:46:17.430	CONFIG	Annunciator/RFQ/RFQ_LLRF:ResCtrl1:ResErr_Avg	3tl	ics-opi-ccr09
6	2009/04/14 16:20:05.965	CONFIG	Annunciator/BeamPermit/MPS FPL fault/ICS_MPS:FPL_MEBT_BS:FPL_MEBT_BS_chan_status	c2y	ics-opi-ccr09
7	2009/04/14 16:05:51.689	CONFIG	Annunciator/BeamPermit/MPS FPL fault/ICS_MPS:FPL_MEBT_BS:FPL_MEBT_BS_chan_status	c2y	ics-opi-ccr09
8	2009/04/14 15:44:43.756	CONFIG	Annunciator/BeamPermit/MPS FPL fault/ICS_MPS:FPL_CCL_BS:FPL_MEBT_BS_chan_status	c2y	ics-opi-ccr09
9	2009/04/14 14:50:26.742	CONFIG	Annunciator/MPS/ICS_MPS:PLC_Sum1	c2y	ics-opi-ccr09
10	2009/04/14 14:41:07.756	CONFIG	Annunciator/RTBT/RTBT_Cooling/CF_RS:DIWS_AIT4800B:Rs	c2y	ics-opi-ccr09
11	2009/04/14 14:41:00.373	CONFIG	Annunciator/RTBT/RTBT_Cooling/CF_RS:DIWS_AIT4800A:Rs	c2y	ics-opi-ccr09
12	2009/04/14 14:39:49.689	CONFIG	Annunciator/Ring/Ring_Cooling/CF_RN:DIWS_AIT4601B:Rs	c2y	ics-opi-ccr09
13	2009/04/14 14:39:42.678	CONFIG	Annunciator/Ring/Ring_Cooling/CF_RN:DIWS_AIT4601A:Rs	c2y	ics-opi-ccr09
14	2009/04/14 14:39:34.414	CONFIG	Annunciator/Ring/Ring_Cooling/CF_RN:DIWS_AIT4600B:Rs	c2y	ics-opi-ccr09

# Logging: Get timeline

- Example: Filter on TYPE, PV

Select filter criteria:  
Which Property should contain what value?

Property: NAME Matching Value: %SCL\_HPRF:Mod15:V\_Mon%

... AND ...

Property: (no filter) Matching Value:

Value patterns support SQL wildcards '%', '\_'

Cancel OK

Message History

Start: 2009/04/12 07:00 End: 2009/04/12 20:31

TIME	TYPE	TEXT	SEVERITY	USER
2009/04/12 08:31:38.020	talk	MAJOR alarm: mps fault	MAJOR	alarms
2009/04/12 08:31:29.292	talk	MAJOR alarm: Check SCL 15 Modulator voltage	MAJOR	alarms
2009/04/12 08:31:38.307	talk	MAJOR alarm: SCL 15 modulator in standby	MAJOR	alarms

Message History

Start: -5 day End: now

6. All OK

Times Filter

TIME	DELTA	TYPE	TEXT	NAME	STATUS	SEVERITY	CURRENT_SEVERITY	USER	APPLI...ON-ID	HOST
2009/04/12 20:30:29.522	00:00:00.039	alarm	STATE	SCL_HPRF:Mod15:V_Mon	OK	OK	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 20:30:29.483	08:16:59	alarm	ACK	SCL_HPRF:Mod15:V_Mon				accl-oper	CSS	ics-opi-c
2009/04/12 12:13:30.319	00:01:42	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 12:11:47.332	01:03:08	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	MAJOR	alarms	AlarmServer	ics-srv-sc
2009/04/12 11:08:38.729	00:02:06	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 11:06:32.713	02:31:01	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	MAJOR	alarms	AlarmServer	ics-srv-sc
2009/04/12 08:35:31.364	00:04:02	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 08:31:29.283	01:15:20	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	MAJOR	alarms	AlarmServer	ics-srv-sc
2009/04/12 07:16:09.109	00:00:00.014	alarm	STATE	SCL_HPRF:Mod15:V_Mon	OK	OK	OK	alarms	AlarmServer	ics-srv-sc

3. Alarm Server  
annunciates

2. Alarm Server  
latches alarm

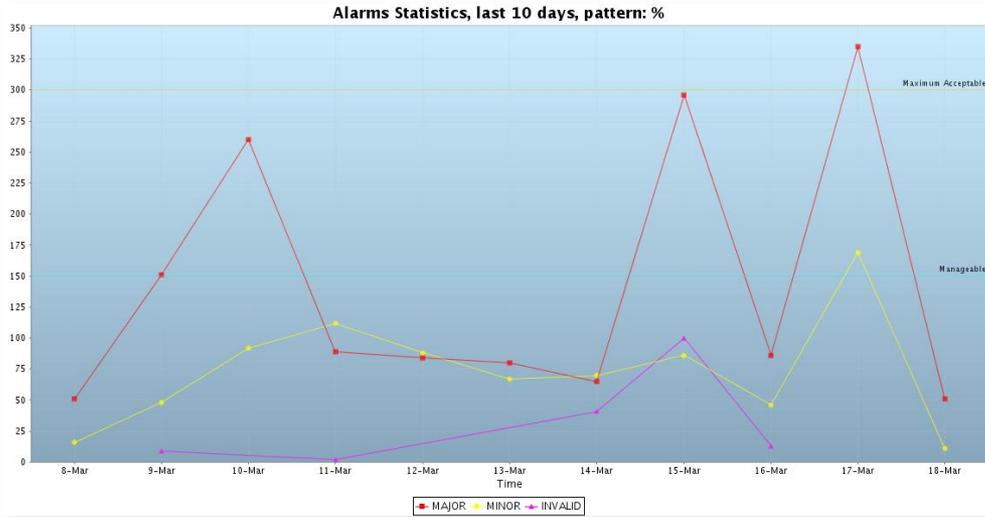
1. PV triggers,  
clears,  
triggers again

5. Ack'ed by  
operator

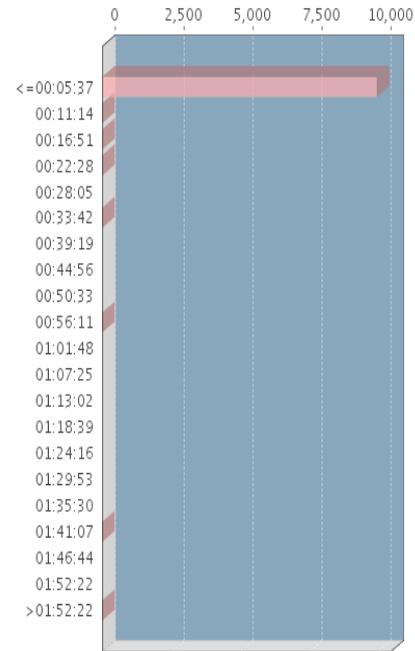
4. Problem fixed

# Web Report Examples

Statistics based on CURRENT SEVERITY:



Alarms duration frequency (hh:mm:ss)



Within selected time period:  
at start: OK  
at end: OK

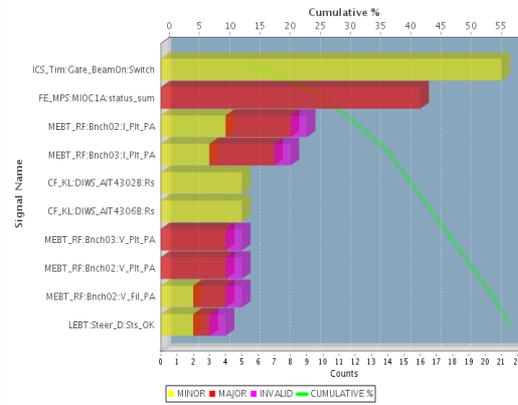
Total alarms: 9967  
Total time in alarmed state: 23:04:59

Severity counts:  
MAJOR: 9967  
MINOR: 0  
INVALID: 0  
ERROR: 0

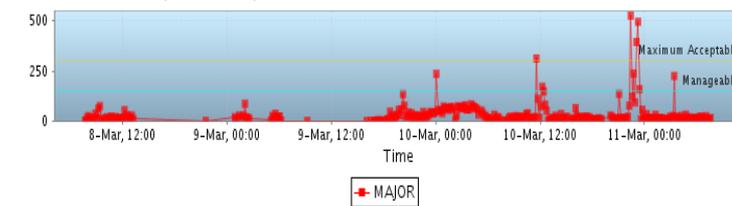
Alarm durations (hh:mm:ss):  
Minimum: 00:00:00 (less than 1 sec)  
Maximum: 06:29:55  
Average: 00:56:11  
Most frequent: 00:00:00 (less than 1 sec)

Extreme durations:  
Less than 1 sec: 5505  
More than 12 hours: 0

Pattern: %, 17-Mar-2009 00:00 for 0 days 24 hours (-)



Alarms on time line (10 min slices)



- Anything is possible

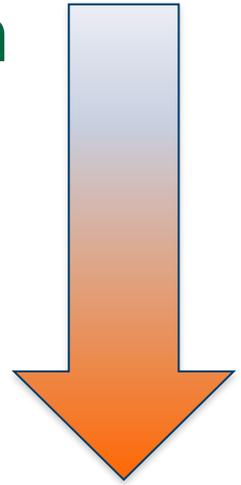
- Examples from SNS

- Code would need some rework to port to other sites

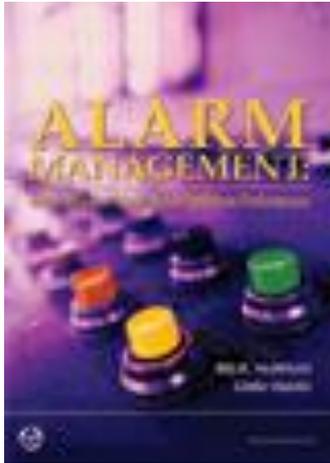
Alarms Active 24.0 h or more

#	PV Name	Description	Path	Alarm Time	--Duration [HH:MM:SS]	Severity	Alarm Message	Current Severity
1	MEBT_CHOP:PS_1:V	mebbit chopper power supply one voltage fault	/Annunciator/MEBT	2009-03-16 13:17:35	42:58:57	MAJOR_ACK	LOLO_ALARM	MAJOR
2	MEBT_CHOP:PS_2:V	mebbit chopper power supply two voltage fault	/Annunciator/MEBT	2009-03-16 13:17:35	42:58:57	MAJOR_ACK	LOLO_ALARM	MAJOR
3	HEBT_Coll:CT2:Cond	HEBT_Coll:CT2:Cond	/Annunciator/HEBT/HEBT_Cooling	2009-03-14 20:22:50	83:53:42	INVALID_ACK	READ_ALARM	MAJOR
4	TMod:Summary_MPS:Alarm	Moderator System MPS Trip	/Annunciator/Target/CMS	2009-02-07 09:25:09	934:51:23	INVALID_ACK	READ_ALARM	INVALID

# Creating a good Alarm Configuration



Hard



**B. Hollifield, E. Habibi,  
"Alarm Management:  
Seven (??) Effective Methods  
for Optimum Performance", ISA, 2007**

# Alarm Philosophy

## Goal:

### Help operators take correct actions

- Alarms with guidance, related displays
- Manageable alarm rate (<150/day)
- Operators will respond to every alarm  
(corollary to manageable rate)

# What's a valid alarm?

- **DOES IT REQUIRE IMMEDIATE OPERATOR ACTION?**
  - What action? Alarm guidance!
    - Not “make elog entry”, “tell next shift”, ...
  - Consequence of not reacting?
  - How much time to react?

# How are alarms added?

- **Alarm triggers: PVs on IOCs**
  - But more than just setting HIGH, HIHI, HSV, HHSV
  - HYST is good idea
  - Dynamic limits, enable based on machine state,...

Requires thought, communication, documentation

- **Added to alarm server with**
  - **Guidance: How to respond**
  - **Related screen: Reason for alarm (limits, ...), link to screens mentioned in guidance**
  - **Link to rationalization info (wiki)**

# Example: Elevated Temp/Press/Res.Err./...

- Immediate action required?
    - Do something to prevent interlock trip
  - Impact, Consequence?
    - Beam off: Reset & OK, 5 minutes?
    - Cryo cold box trip: Off for a day?
  - Time to respond?
    - 10 minutes to prevent interlock?
- ↓
- **MINOR? MAJOR?**
  - Guidance: “Open Valve 47 a bit, ...”
  - Related Displays: Screen that shows Temp, Valve, ...

# Avoid Multiple Alarm Levels

- **Analog PVs for Temp/Press/Res.Err./....:**
  - Easy to set LOLO, LOW, HIGH, HIHI
- **Consider:**
  - Do they require *significantly different* operator actions?
  - Will there be a lot of time after the HIGH to react before a follow-up HIHI alarm?
- **In most cases, HIGH & HIHI only double the alarm traffic**
  - Set only HSV to generate single, early alarm
  - Adding HHSV alarm assuming that the first one is ignored only worsens the problem

# Bad Example: Old SNS 'MEBT' Alarms

- Each amplifier trip:  $\geq 3$  ~identical alarms, no guidance
- Rethought w/ subsystem engineer, IOC programmer and operators: 1 better alarm

#	Date	Type	Name	Severity	TEXT
1	2009-03-16 13:46:20.255	talk		MAJOR	MAJOR alarm: MEBBIT two power amplifier trip
2	2009-03-16 13:46:19.962	talk		MINOR	MINOR alarm: MEBBIT two power amplifier trip
3	2009-03-16 13:45:56.241	talk		MAJOR	MAJOR alarm: S C L 18 modulator in standby
4	2009-03-16 13:45:25.963	talk		MAJOR	MAJOR alarm: MEBBIT two power amplifier trip
5	2009-03-16 13:45:25.891	talk		MINOR	MINOR alarm: MEBBIT two power amplifier trip
6	2009-03-16 13:45:25.884	talk		MAJOR	MAJOR alarm: MEBBIT two power amplifier trip
7	2009-03-16 13:23:09.202	talk		MINOR	MINOR alarm: DTL 3 RCCS CV one valve open limit is exceeded

MEBT_RF:Bnch02:V_Plt_PA	MEBBIT two power amplifier trip
MEBT_RF:Bnch02:V_Fil_PA	MEBBIT two power amplifier trip
MEBT_RF:Bnch02:I_Plt_PA	MEBBIT two power amplifier trip

**Alarm PV: MEBT\_RF:Bnch\*:V\_Plt\_PA**

**Purpose of Alarm**  
Indicates MEBT high power RF amplifier problem: Plate voltage dropped, so amplifier won't be able to provide sufficient RF to cavity.

**Operator Guidance**

- Verify that the plate voltage is indeed off.
- Turn OFF the plate voltage through EPICS.
- At the amplifier, observe the fuses to determine which phase/phases blew.
- Change all three fuses according to procedure.
- Turn on plate voltage.
- Ramp up RF power slowly.
- After two fuse changes, call for RF support.

**Failure Consequence**  
Minor Consequence: Beam will be off while MEBT is off, but recovery is usually quick as soon as for example the fuses are replaced.

**Operator Response Time Available**  
The sooner operators respond, the sooner beam is back up. Since this might require calling RF personnel, the sooner they're called, the better.

**Contacts**  
Mark Middendorf, Mike Clemmer for MEBT RF,  
Alan Justice for IOC.

Field	DBD Type	Value in File	Live Value
VAL			
LINR	DBF_MENU	LINEAR	LINEAR
HSV	DBF_MENU	MINOR	MINOR
HHSV	DBF_MENU	MAJOR	MAJOR
MDEL	DBF_DOUBLE	0.005	0.00
INP	DBF_INLINK	@0xe 1 3 6	@0xe 1 3 6
EGU	DBF_STRING	kV	kV
LOLO	DBF_DOUBLE	6.5	5.00
LSV	DBF_MENU	MINOR	MINOR
PREC	DBF_SHORT	2	2
LOPR	DBF_DOUBLE	0.0	0.00
DESC	DBF_STRING	PA Plate V	PA Plate V
SCAN	DBF_MENU	I/O Intr	I/O Intr
DTYP	DBF_DEVICE	Group3 C	Group3 C
HOPR	DBF_DOUBLE	10.0	10.00
EGUL	DBF_DOUBLE	-10.75	-10.75
LOW	DBF_DOUBLE	6.8	5.20
LLSV	DBF_MENU	MAJOR	MAJOR
EGUF	DBF_DOUBLE	10.75	10.75
HIHI	DBF_DOUBLE	7.5	7.50
HIGH	DBF_DOUBLE	7.2	7.20

# Alarms for Redundant Pumps

## Klystron Building Overview

Site Overview  
vxStats

Alarm Overview

Help

Close

### Power System

KL-T-SS1 WATTS **410000.00 W**  
 KL-T-SS2 WATTS **315350.00 W**  
 KL-T-SS3 WATTS **437100.00 W**  
 KL-T-SS4 WATTS **341100.00 W**

### Comp Air Hdr

**123.5 PSIG**

### Process Waste

### KL HVAC 1

KL Bldg Temp 1 **68.4 F**  
 KL Bldg Humidity 1 **45.7 % RH**  
 Smoke Detected

### KL HVAC 4

KL Bldg Temp 4 **71.7 F**  
 KL Bldg Humidity 4 **37.8 % RH**  
 Smoke Detected

### KL HVAC 2

KL Bldg Temp 2 **70.1 F**  
 KL Bldg Humidity 2 **43.7 % RH**  
 Smoke Detected

### KL HVAC 5

KL Bldg Temp 5 **68.0 F**  
 KL Bldg Humidity 5 **46.0 % RH**  
 Smoke Detected

### KL HVAC 3

KL Bldg Temp 3 **70.8 F**  
 KL Bldg Humidity 3 **34.9 % RH**  
 Smoke Detected

Bldg Press East **0.2 in H2O**

Bldg Press West **-0.0 in H2O**

RFQ, DTL  
Circulator Loads

Temp  
**86.9 F**



Heat Exchanger

1.0 % Open

Klystron Glycol

Klystrons, Circulators, Blue Box

Circulating Loop  
**1.9 Mohm**

Temp  
**87.1 F**



Heat Exchanger

24.1 % Open

DI Water P-KL-4  
FEB, KL-RFQ, KL-DTL 1-6

Klystrons, Circulators

Circulating Loop  
**2.1 Mohm**

Temp  
**92.4 F**



Heat Exchanger

23.3 % Open

DI Water P-KL-1  
KL-CCL 1-4

Klystrons, Circulators

Circulating Loop  
**1.9 Mohm**

Temp  
**91.7 F**



Heat Exchanger

18.5 % Open

DI Water P-KL-3  
KL-SCL 1-14

Klystrons, Circulators

Circulating Loop  
**2.0 Mohm**

Temp  
**85.1 F**



Heat Exchanger

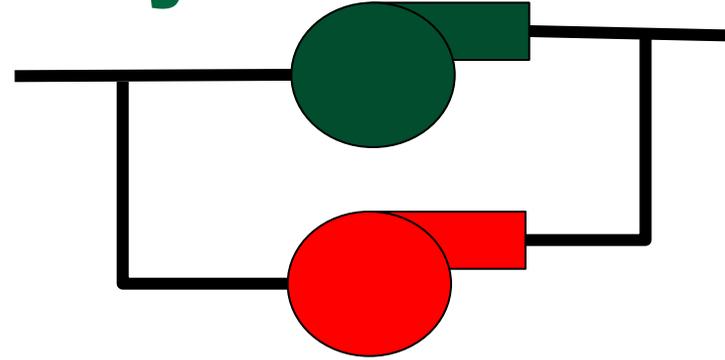
23.1 % Open

DI Water P-KL-2  
KL-SCL 8-16

Tower Water

Supply  
Return

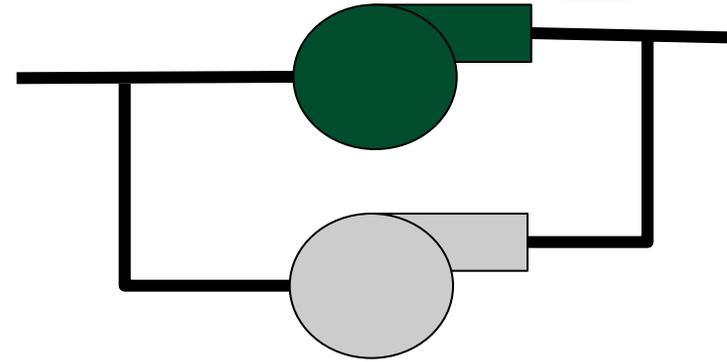
# Alarm Generation: Redundant Pumps the wrong way



- **Control System**
  - Pump1 on/off status
  - Pump2 on/off status
  
- **Simple Config setting: Pump Off => Alarm:**
  - It's normal for the 'backup' to be off
  - Both running is usually bad as well
    - Except during tests or switchover
  - During maintenance, both can be off

# Redundant Pumps

Required Pumps: 1



- **Control System**

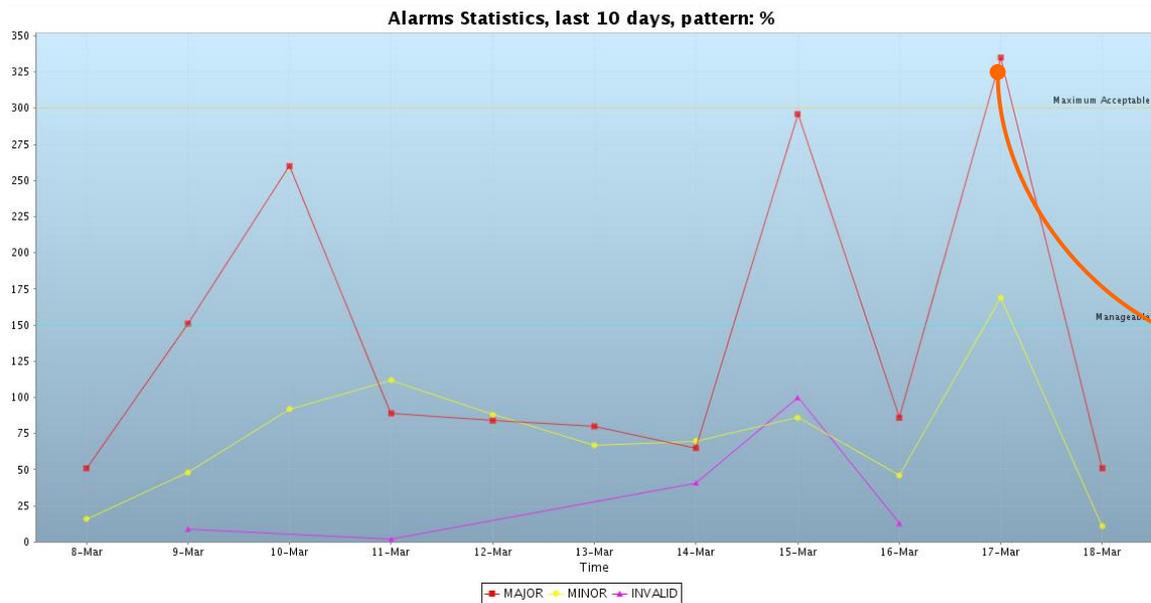
- Pump1 on/off status
- Pump2 on/off status
- Number of running pumps
- Configurable number of desired pumps

- **Alarm System: Running == Desired?**

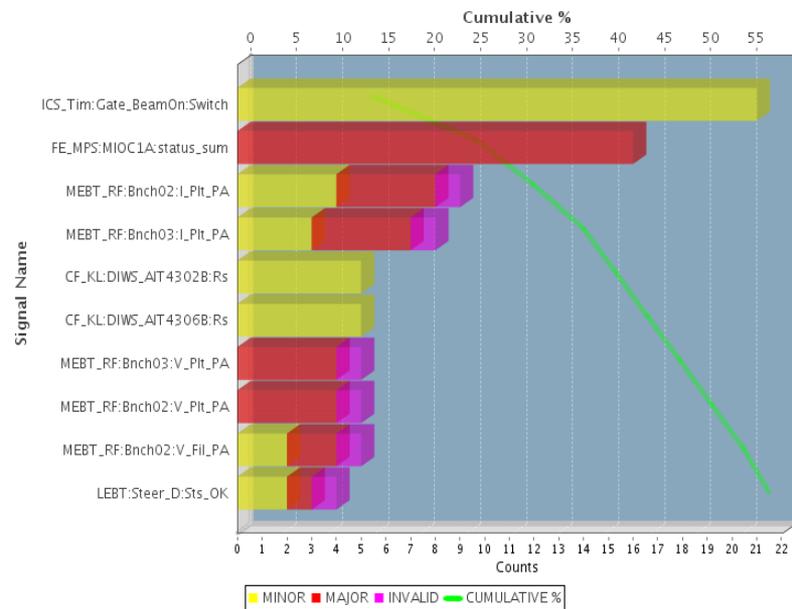
- ... with delay to handle tests, switchover

- **Same applies to devices that are only needed on-demand**

# Weekly Review: How Many? Top 10?



Pattern: %, 17-Mar-2009 00:00 for 0 days 24 hours (-)



# Summary

- **Easy to use**
  - Check alarms in Table, Tree, Panel
  - Fix it: Read Guidance, use Display Links
  - ✓ Acknowledge
- **Configuration**
  - Can be changed online
  - Operators can update guidance or add better display links
- **Alarm System Setup**
  - Somewhat Involved, but only once
- **Coming up with a good configuration**
  - **Hard**

