

# Alarm Management and Operator Graphics

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Honeywell Process Solutions

for

Institution of Chemical Engineers  
Southampton, May 2005

**Honeywell**

- **Alarm Management**
  - **Awareness: “The Alarm Management Problem”**
  - **Progress to Date**
  - **What Next?**
  
- **Operator Graphics**
  - **Experience**
  - **ASM Guidance**
  - **Applications**
  
- **Summary**

# Problem Awareness ...



# More recently ...



**Honeywell**

**ChevronTexaco**

 **Celanese**

**ExxonMobil**

  
**ConocoPhillips**

  
**Shell**

**UCLA**



Performance Systems, Inc.

**TTS**  
**USER CENTERED DESIGN SERVICES**  
*Achieving Excellence in Control Room Operations*

 **BAW**  
Architecture

- **Charter:**
  - Research the causes of abnormal situations and create technologies to address this problem
- **Deliverables:**
  - Technology, best practices, application knowledge, prototypes, metrics
- **History:**
  - Started in 1994
  - Co-funded by US Govt (NIST)
  - Budget: +\$16M USD
- **Current Status:**
  - Honeywell leadership
  - Expanding membership

Customer Driven Solution Drives 3-8% Additional Capacity

# Experience from Projects

No plant-wide philosophy and guidelines for alarms

Major operating upsets generate alarm “floods”

Alarm configuration management is poor

Alarm Prioritization is inconsistent

Minor operating upsets generate significant numbers of alarms

Some alarms “stand” for long periods of time

Documentation and graphics support varies widely

When nothing is wrong, there are active alarms

Alarm activations occur without need for operator action

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# Forces Driving Honeywell Alarm Solutions

- **ASM Consortium**

- “Effective Alarm Management Practices” document

- **Honeywell Customers**

- Shell ESP

- ◆ “We know our limits and we operate within those limits all the time.”

- ExxonMobil

- ◆ Mutual Development Funding

- Others...

- **EEMUA 191**

- “The de facto standard”

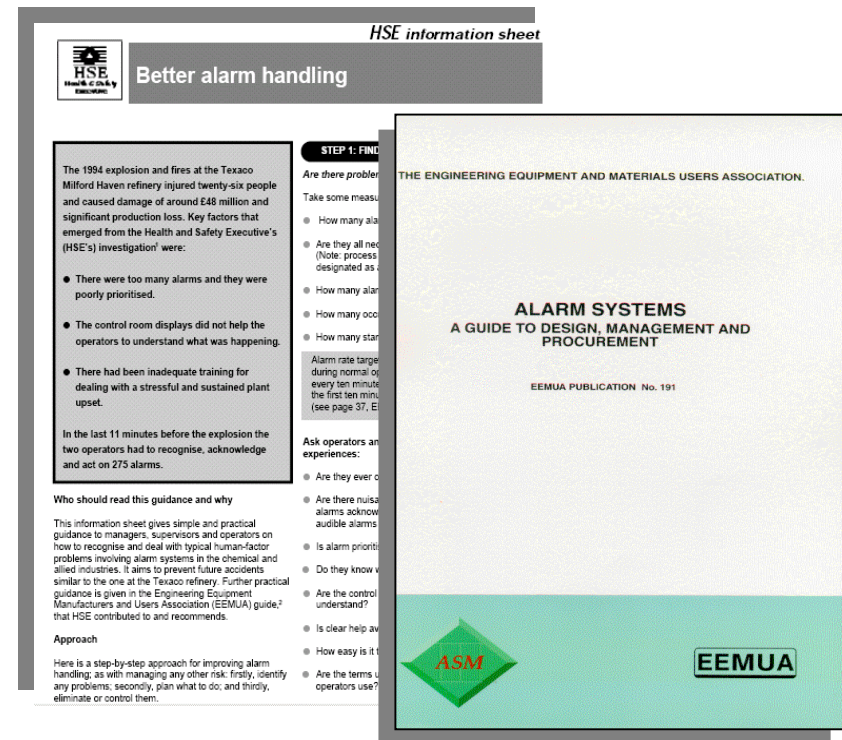
- **Standards**

- IEC 61508/61511

- UK HSE Document

- OSHA 1910.119

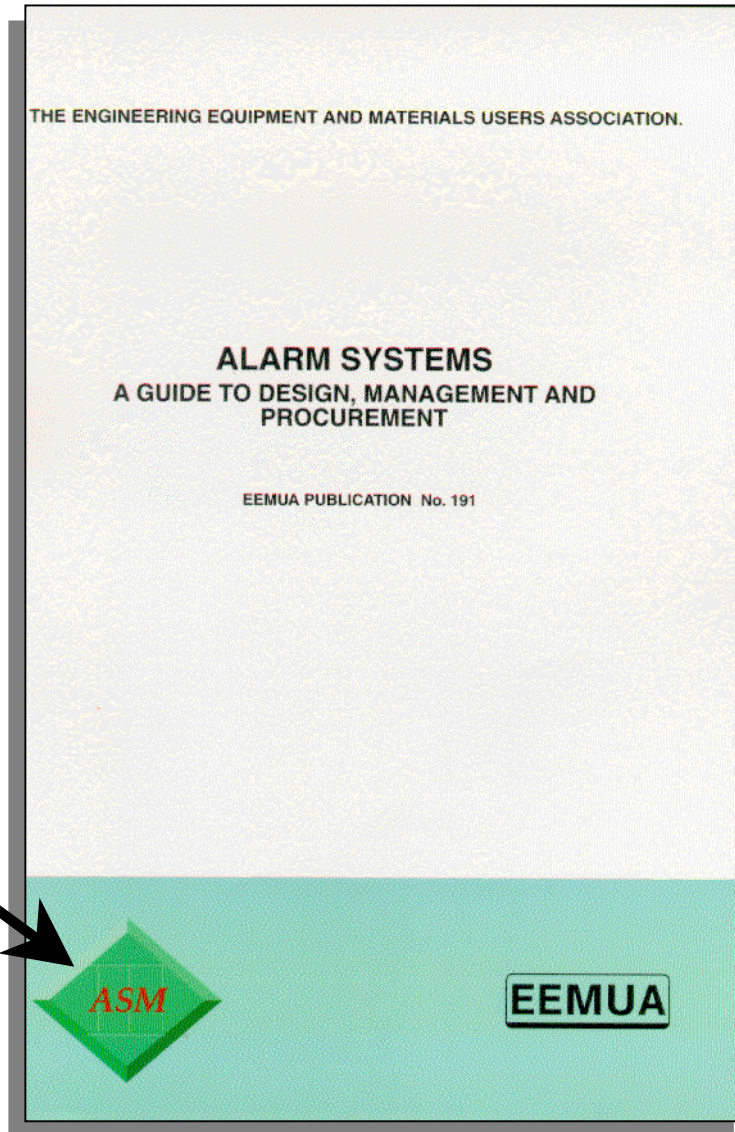
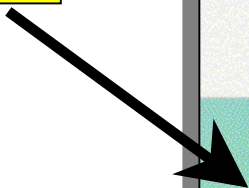
- Etc.





# EEMUA ... “the de-facto standard”

**The ASMC is very much concerned with Alarm Systems**



- **A huge step forward!**
- **Heavy focus on redesign (“rationalisation”):**
  - **Removal of meaningless “alarms”**
  - **Better use of priorities (e.g. for use during floods):**
    - ◆ ~ 5% URGENT
    - ◆ ~ 10% HIGH
    - ◆ ~ 85% LOW
  - **Wider limits – “alarms” not useful for minor deviations**
  - **More effective use of existing alarm configuration parameters**
- **Targets for activation frequency**
- **EEMUA also calls for other improvements which are often neglected (MOC, alarm suppression etc.)**

# The Three Common Problems

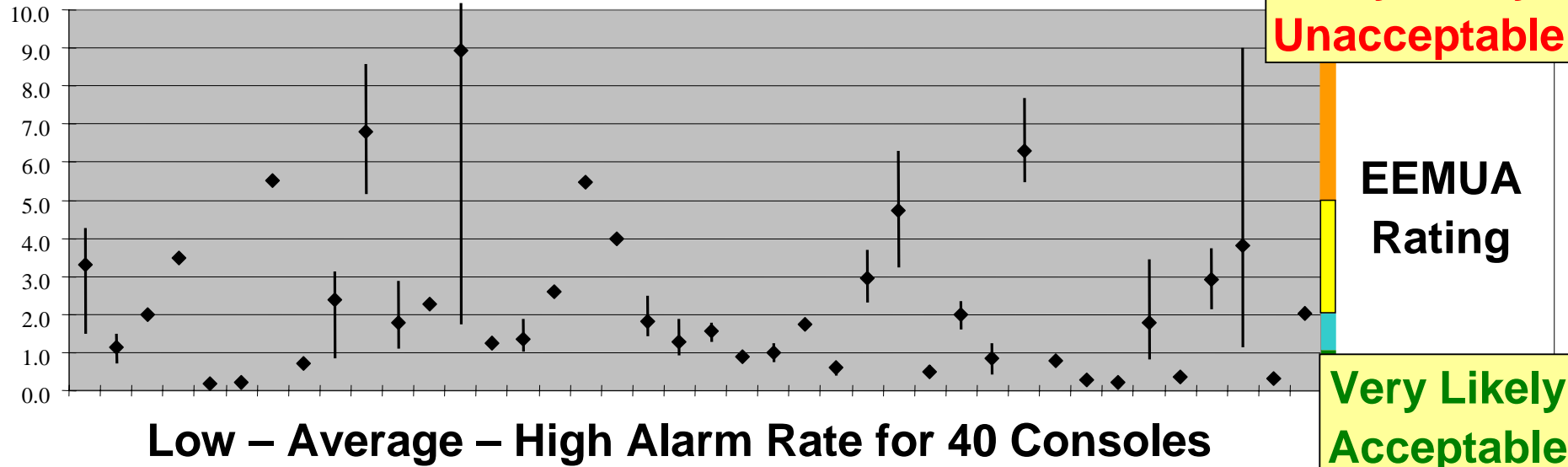
<b>Problem Type</b>	<b>Solution Approach</b>	<b>Target (e.g. from EEMUA) (one operator)</b>
<b>Standing alarms</b>	<b>Mode-based alarming. Shelving.</b>	<b>&lt; 10</b>
<b>Background alarms</b>	<b>Alarm rationalisation (just “Bad Actors” ?)</b>	<b>&lt; 10 per hour</b>
<b>Alarm floods</b>	<b>Full alarm rationalisation. Enhanced processing.</b>	<b>&lt; 10 in first 10 minutes of upset</b>

**ASM Consortium  
Alarm System Performance  
Metrics Benchmarking  
Project**

**Honeywell**

# Alarms/10 mins (ASM<sup>®</sup> Consortium Data)

Honeywell

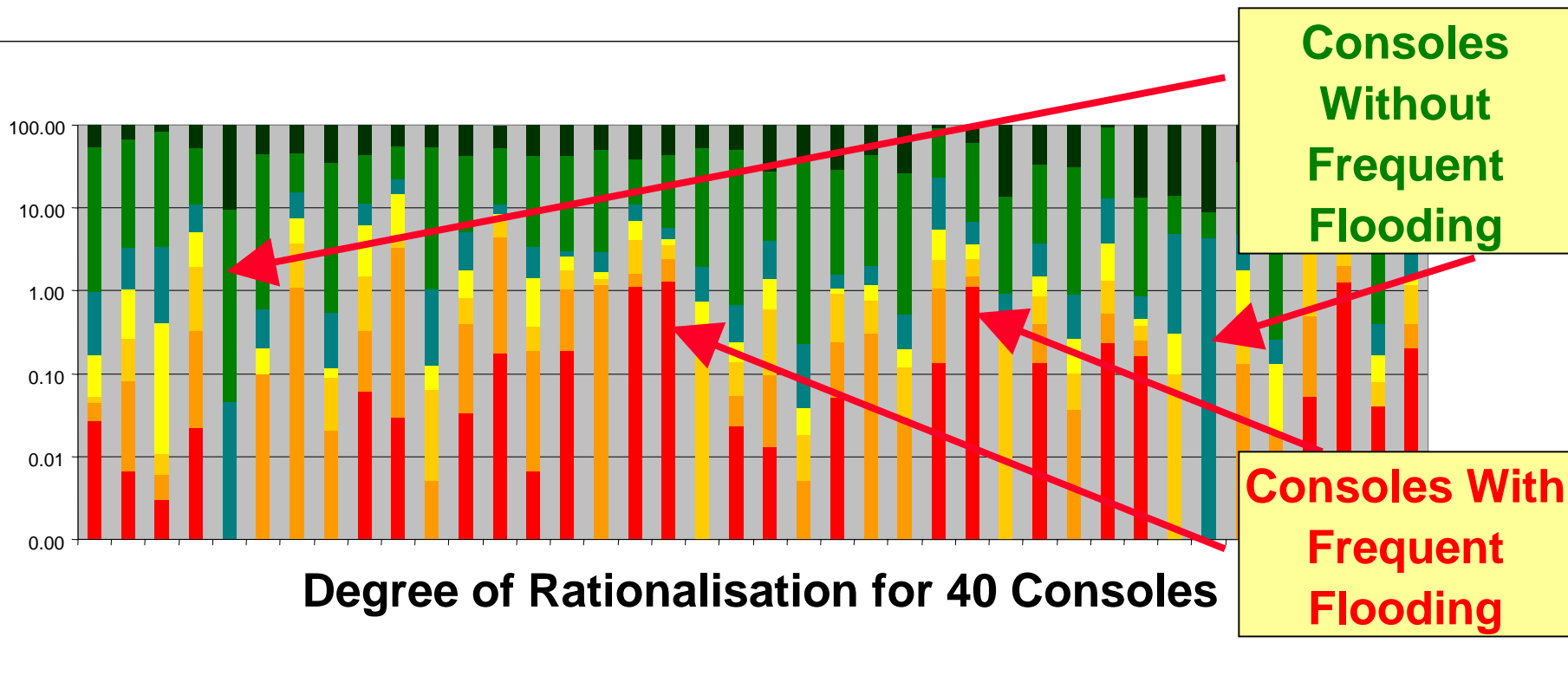


- Average alarm rates (the “background” rate) have improved
- Sites can meet and sustain the EEMUA targets (“Manageable” or “Very Likely Acceptable”)

ASM is a registered US trademark of Honeywell Inc.

# Peak Alarm Rates (ASM Consortium Data)

Honeywell



- The peak alarm rate is not closely correlated with the degree of rationalization
- Peak alarm rates exceeding 100 alarms per 10 minute window were experienced at least once by 60% of the consoles

# Three Problems Summary

**Tools and progress**

Problem Type	Approach	Target (e.g. from EEMUA) (one operator)
Standing alarms	Mode-based alarming. Shelving	< 10
Background alarms	Alarm "Bad Actors ...)	< 10 per hour
Alarm floods	Full alarm rationalisation. Enhanced processing.	< 10 in first 10 minutes of upset

**Considerable progress**

**The most difficult problem**

- **As noted in the EEMUA Guide:**
- **Most process plant alarms are DCS-based and are covered by the International Standard IEC 61508.**
- **Many countries expect compliance with IEC 61508.**
- **According to the standard, an alarm system is safety-related if:**
  - **It is a claimed part of the facilities for reducing risks from hazards to people to a tolerable level**
  - **AND ... the claimed reduction in risk provided by the alarm system is “significant”**
- **“Significant” means a claimed Average Probability of Failure on Demand of less than 0.1/demand**
- **Terminology!!!**



- If an alarm system is considered as a safety-related system then:
  - It should be designed, operated and maintained in accordance with IEC 61508.
  - It should be independent and separate from the process control system (unless the process control system is itself safety-related and conforms to IEC 61508).
- Many plants use (or claim to use!) a separate, high-reliability system for safety-related alarms.
- The traditional DCS (including Honeywell ones) are NOT engineered to IEC 61508 specifications and should NOT be used for safety-related alarms.

# IEC 61511

**... generally reinforces the generic requirements of IEC 61508 as far as process industry alarms are concerned**

**Honeywell**

- **“It should be noted that a risk reduction of up to a factor of 10 might be claimed without the need to comply with IEC 61511. Where such claims are made, the human factor issues will need to be carefully considered”**
- **“Any claims for risk reduction from an alarm should be supported by a documented description of the necessary response for the alarm and that there is sufficient time for the operator to take the corrective action and assurance that the operator will be trained to take the preventive actions”**

- **An alarm system can be used as a method of risk reduction by reducing the demand rate on the SIS providing:**
  - **the sensor used for the alarm system is not used for control purposes where loss of control would lead to a demand on the SIF.**
  - **the sensor used for the alarm system is not used as part of the SIS.**
  - **limitations have been taken into account with respect to risk reduction that can be claimed for the BPCS and common cause issues.**
- **Some plants seem to be unaware of the IEC 61508/61511 guidance or mistakenly believe that they are following it**

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# More Work Required?

- **So ... some incidents have raised awareness and EEMUA has given us a framework to move forward**
- **A lot of work has been done ...**
- **... but significant problems remain:**
  - **Many plants have considerably improved their performance ... but large variations between the best and the worst (even within the same site and/or company)**
  - **The ASMC study (and anecdotal evidence) has shown that alarm floods are still a major problem**
  - **Rationalisation can be time-consuming and expensive ... lots of interest in better techniques/tools**
  - **Safety-Related alarms are a source of real concern**
- **Need for effective tools (not just analysis tools) and the work-process**

## Operations Management Pro is the Productization of Shell ESP

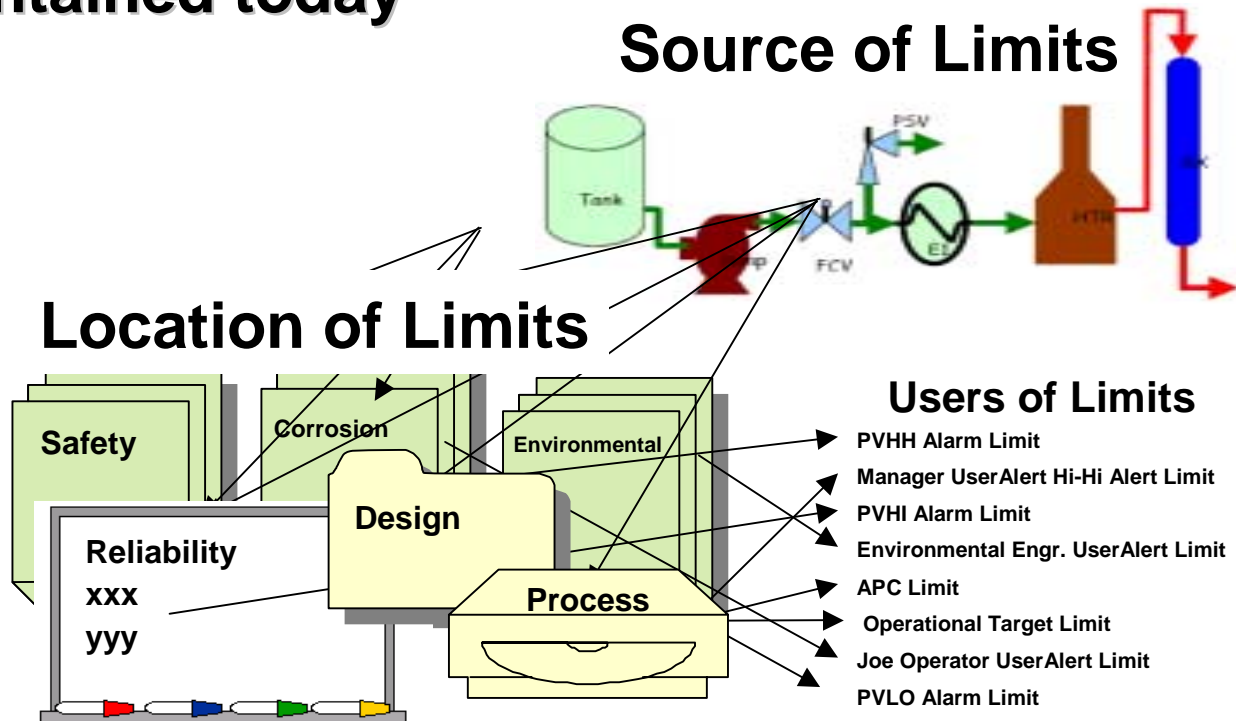
- **Ensure Safe Production is a Shell Global Solutions initiative to establish work processes to...**
  - **Establish Limits for plant operations -- based on equipment, health, safety, and environmental concerns/regulations**
    - ◆ assure consistency across application disciplines
  - **Validate daily operating targets against these limits**
  - **Monitor and control deviations**
    - ◆ monitor and report deviations
    - ◆ common approaches for notifying appropriate plant personnel
  - **Learn and Improve -- assess plant performance**
    - ◆ common end of shift logs
    - ◆ drill-down plant level access
    - ◆ deviation and alarm system metrics
- **Joint Shell / Honeywell development**
- **Currently being installed at the 9 US Shell refineries**



**Major commitment by Shell - \$11M**

# Safe Operating Boundaries

- Operating within safe operating boundaries is key to safety. Many major incidents have been attributed to operations unknowingly or knowingly running outside safe operating boundary
- Boundaries are often not well documented and maintained today



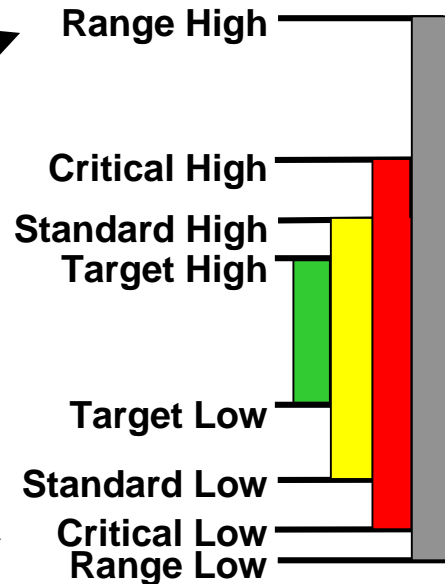


# Boundary Management

## Equipment Constraints



## Operating Boundaries



## Application Limits

- PVHH Alarm Limit
- Manager UserAlert Hi-Hi Alert Limit
- PVHI Alarm Limit
- Environmental Engr. UserAlert Limit
- APC Limit
- Operational Target Limit
- Joe Operator UserAlert Limit
- PVLO Alarm Limit

- **Consistent reference point based on facts, documented and available to the entire operating team and other applications**
- **Thorough PHA, HAZOP, and alarm system design with cross functional team**
  - **Clear definition of safe upper and lower limits (OSHA 1910.119)**
  - **Identify what to monitor (alarms, alerts, production targets)**
  - **Capture and make available knowledge from PHA, HAZOP, AOA, other processes**

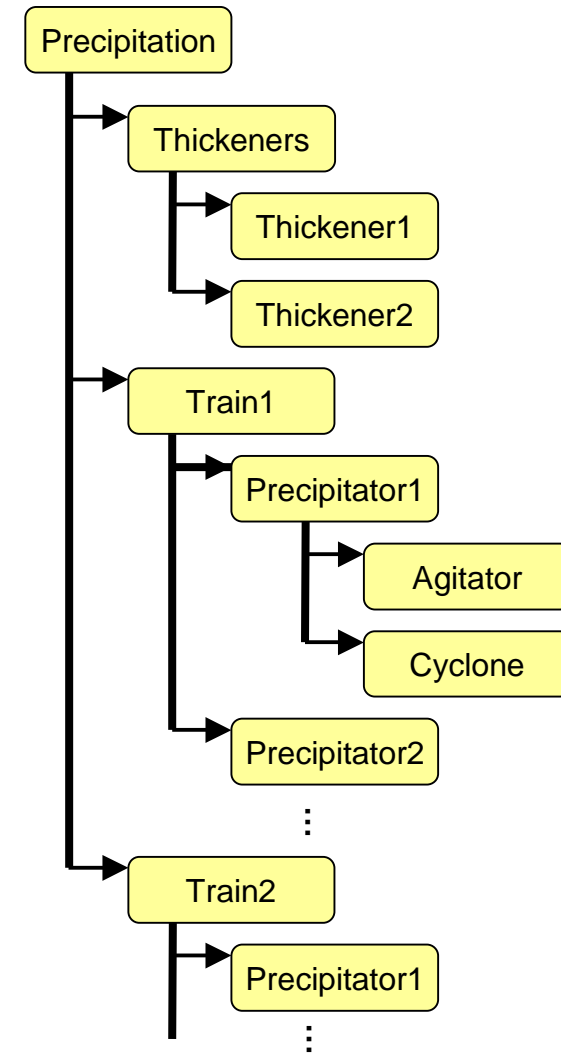
# Experion Enterprise Model

- **What is the Enterprise Model?**

- Allows organization of Experion platform to reflect structure of the plant including assets and boundaries
- Will become the basis for other models/views that reflect other aspects of the enterprise

- **Applications organized around the hierarchical asset model**

- Existing area-based mechanisms enhanced to work with more richly structured asset model
- More effective integration since application parameters are based on the same core enterprise model



Equipment Tree

- Distillation
  - Debutanizer (R=Debut\_OpMode.PV, L=...)
    - C3 Product Cooler
    - D-100
    - Debutanizer Feed
    - E-100 Reboiler
    - E-110 Reboiler
    - T-100**
  - Depropanizer
    - D-200
    - E-210 Condensor
    - E-220 Reboiler
    - E-240 C4 Cooler
    - T-200
    - T-200 Feed

Define Equipment

Available Constraints not associated with 11TC10

Equipment	Subassembly	Monitored Prop...	Boundary Name	Cor
T-100	Vessel Body	Temperature	Design High	Maxi
T-100	Tray 2 Temperature	Temperature	Standard High	Maxi
T-100	Vessel Body	Pressure	Design High	Maxi

Define Constraints

Map Constraints To Tags

Constraints Associated with 11TC10

Equipment	Subassembly	Monitored Prop...	Boundary Name	Constraint Reas...	Value	Units	Use
T-100	Vessel Body	Temperature	Design High	Maximum Desig...	300	DEGC	JOE
T-100	Tray 2 Temperature	Temperature	Standard High	Maximum opera...	185	DEGC	JOE
T-100	Vessel Body	Pressure	Design High	Maximum Desig...	1500	KPA	

# Map Boundaries to Alarm & Alerts

Management of Change (MOC) for all changes – intended for offline use

- Manage multiple types
- Design
  - Environmental
  - Safe operating limits
  - Environmental
  - Corrosion
  - (etc.)

Equipment constraints

Variable boundaries

Boundary Reference Documentation Link

The screenshot shows the 'Alarm Manager - Distillation' software interface. It includes a menu bar (File, Edit, View, Tools, Reports, Help) and several configuration panels. The 'VARIABLE ENTITY' panel shows '20F0502 data' selected. The 'PHD TAG' panel shows '20F0502.DACA'. The 'ALARM TAG' panel shows '20F0502'. Below these are fields for 'Engineering Units', 'Equipment', 'Variable Entity Type', and 'Configuration State'. A 'Piping & Instrumentation Diagram' section is also visible.

Two tables are displayed at the bottom of the interface:

Equipment Name	Subassembly	Monitored Property	Boundary Name	Constraint Reason	Value	Unit	Owner	Role	Document Link
T-100	Vessel Body	Temperature	Design High	Maximum Design te...	300	DEGC	JOEUSER	PROCE...	c:\Unit1\Constrai...
T-100	Tray 2 Temperature	Temperature	Standard High	Maximum operating ...	185	DEGC	JOEUSER	PROCE...	c:\Unit1\Standard...
T-100	Vessel Body	Pressure	Design High	Maximum Design Ph...	1500	KPA	JOEUSER	PROCE...	

Boundary Name	Alarm Type	Alarm Priority	Value	Reason for Value	Potential Impact	Monitor	History
Critical Hi	Bad PV	EMERGENCY		MAXIMUM TEMPERATURE RATING FROM MANUFACTURER	DAMAGE TO THE PHYSICAL INTEGRITY OF THE TOWER	<input type="checkbox"/>	<input type="checkbox"/>
Standard Hi	PV High	HIGH	210	TEMPERATURE AT TRAY 2 TOO HIGH	RESULTS IN EXCESS BUTANE DOWNSTREAM OF T100	<input type="checkbox"/>	<input type="checkbox"/>
Safety Hi	PV High High	LOW	185	TEMPERATURE AT TRAY 2 TOO HIGH		<input type="checkbox"/>	<input type="checkbox"/>
Safety Lo						<input type="checkbox"/>	<input type="checkbox"/>
Standard Lo						<input type="checkbox"/>	<input type="checkbox"/>
Critical Lo						<input type="checkbox"/>	<input type="checkbox"/>

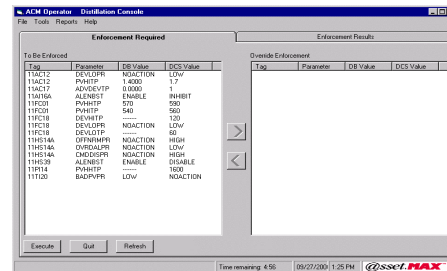
- Applications use boundaries
- Production monitoring
  - Process monitoring (alarm & alerts)
  - Exposed via OPC

- **ACM Information exposed:**
  - **Boundary Values and Alarm Limits (operating mode aware)**
  - **Alarm Help**
  - **Alarm Documentation**
- **Uses:**
  - **GUS & HMI Web Displays**
  - **OI/OM Integration**
  - **UserAlert – boundary alerts**
  - **APC – model constraints**
  - **Etc**

# Common Database for Managing Limits

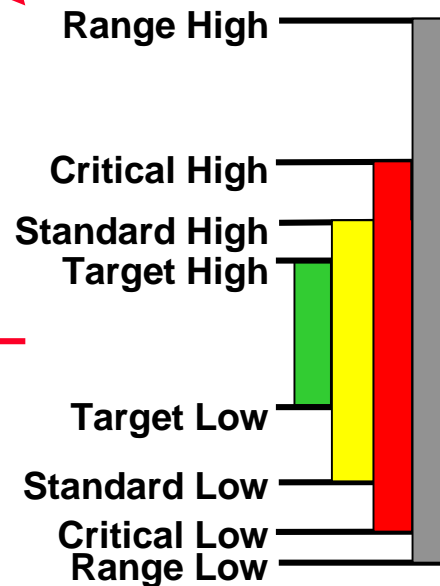
Common configuration management

- Cross-checking
- Audit tracking
- Enforcement
- Mode change management



Operating limits established by Operating Instructions

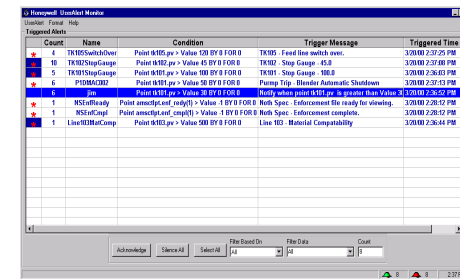
## Operating Boundaries



Operating limits used by Operations Monitoring



Process alarm trip-points



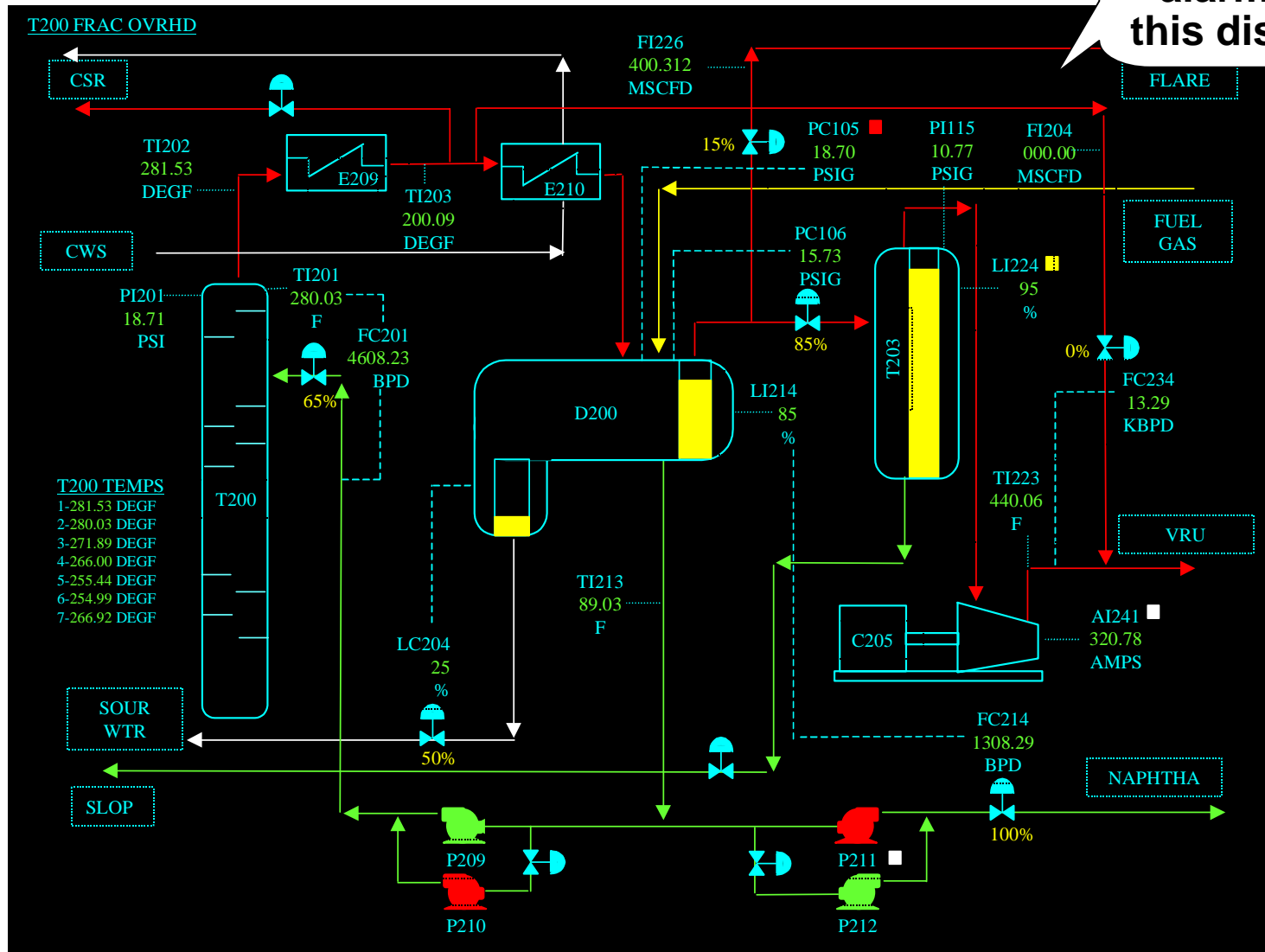
UserAlert limits

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# An "effective" graphic?

Honeywell

Pick out the alarms in this display.







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# **ASM Consortium Guidelines “Effective Operator Display Design”**

**(Version 4.00 19/June/2002)**

**Honeywell**

- **The detailed guidance is only available to ASM Consortium members**
- **Honeywell project teams can also use the guidance on non-ASM Consortium projects**
- **But some parts derive from public-domain information ...**

# Level 1: Process Area Overview Displays

- **Level 1 graphics show the broadest available view of the facilities under the operator's control.**
- **Primary purpose is to provide situational awareness of the operators entire span of control**
- **Summarized on a limited number of displays.**
- **Contains multiple units, with the process values or safety signals being read-only from a control perspective.**
- **The operator is not allowed to execute any control from this display.**
- **Simplified process flow diagrams of a whole plant area.**
- **Often a combination of KPI values, trends and alarms**

# Level 2: Process Unit Overview Displays

- **Main control interface for performing routine operational tasks**
- **One for every major process unit**
- **Enough information to control plant under normal conditions**
- **Allows operators to perform common tasks without changing graphics**
- **Used to provide information regarding key elements of the process unit**

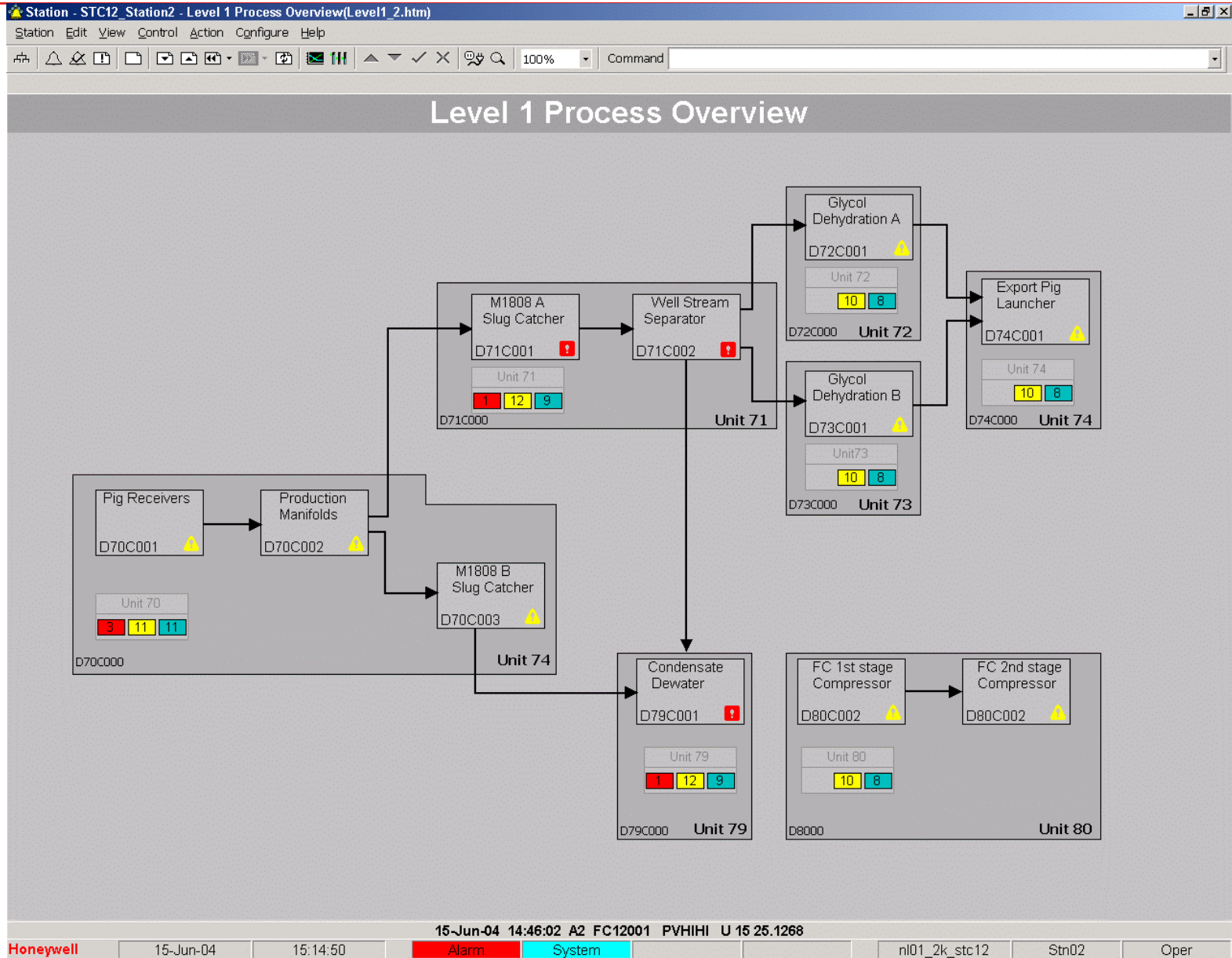
# Level 3: Detailed Displays

- **Exhaustive in their detail and contain all available information of smaller pieces of the process unit.**
- **All control loops (?) and indicators are shown on the Level 3 displays.**
- **Used for detailed investigations and interventions that are not time-critical.**
- **May also be used to show detailed alarm information (e.g. PVLL)**

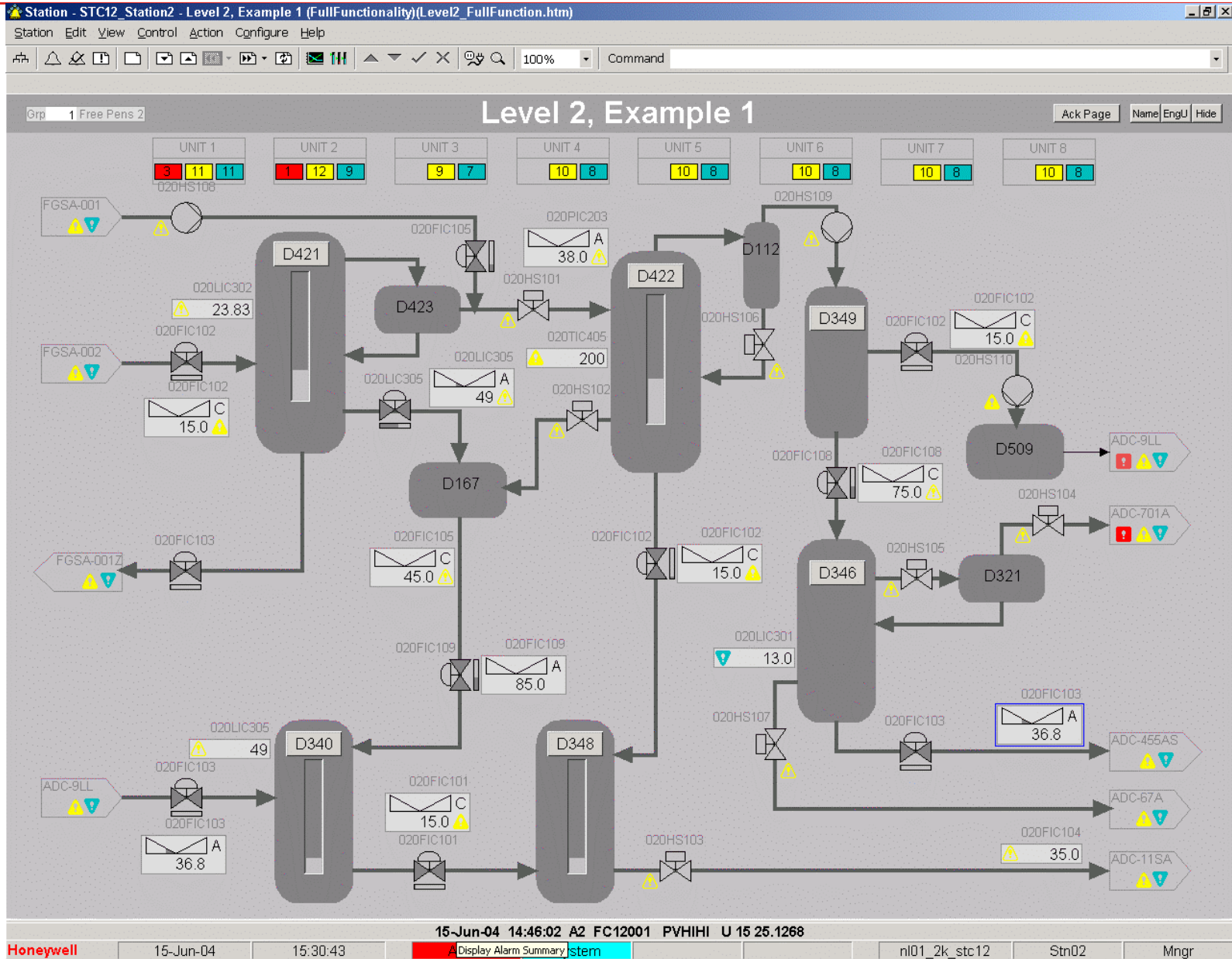
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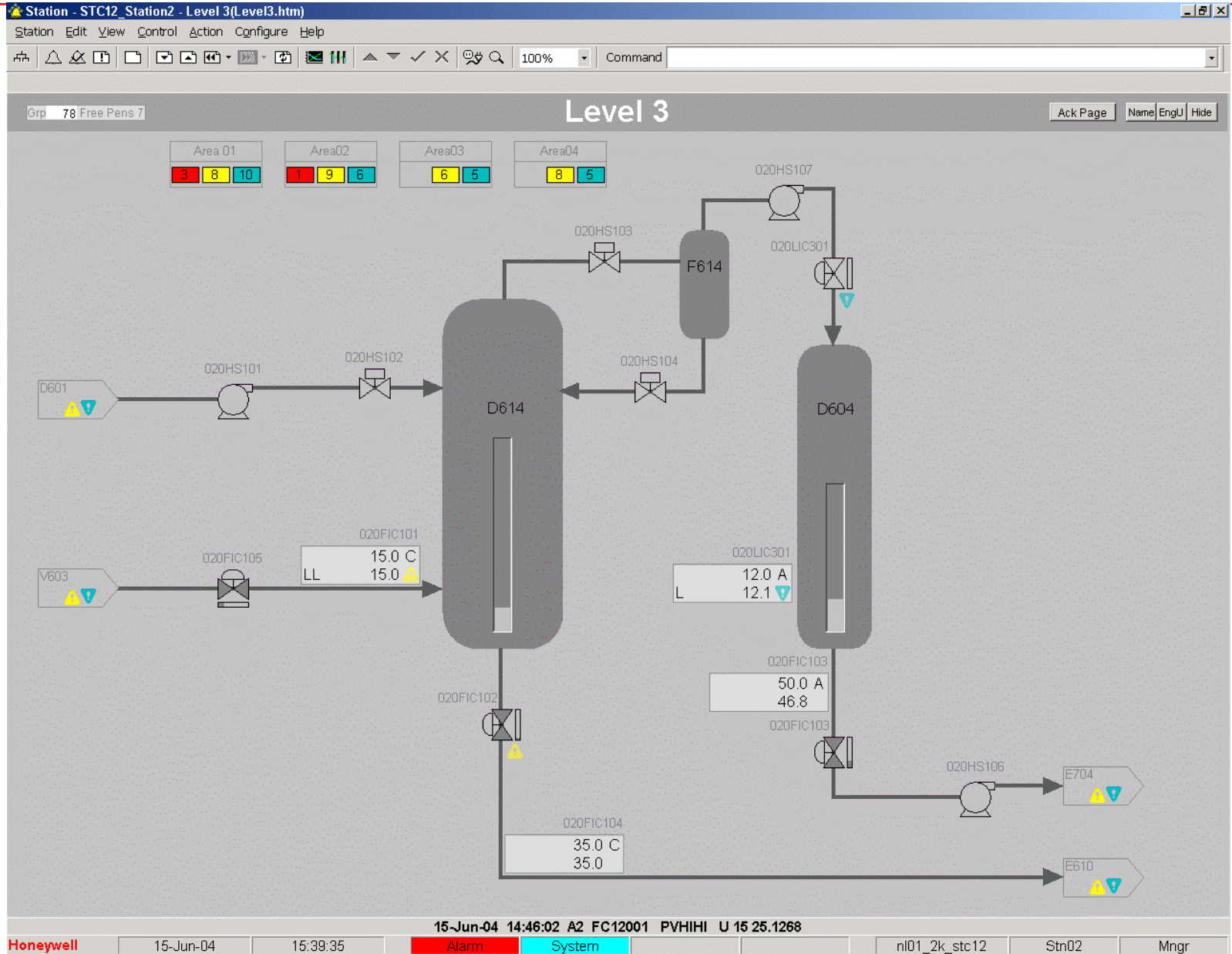
# Level 1 example



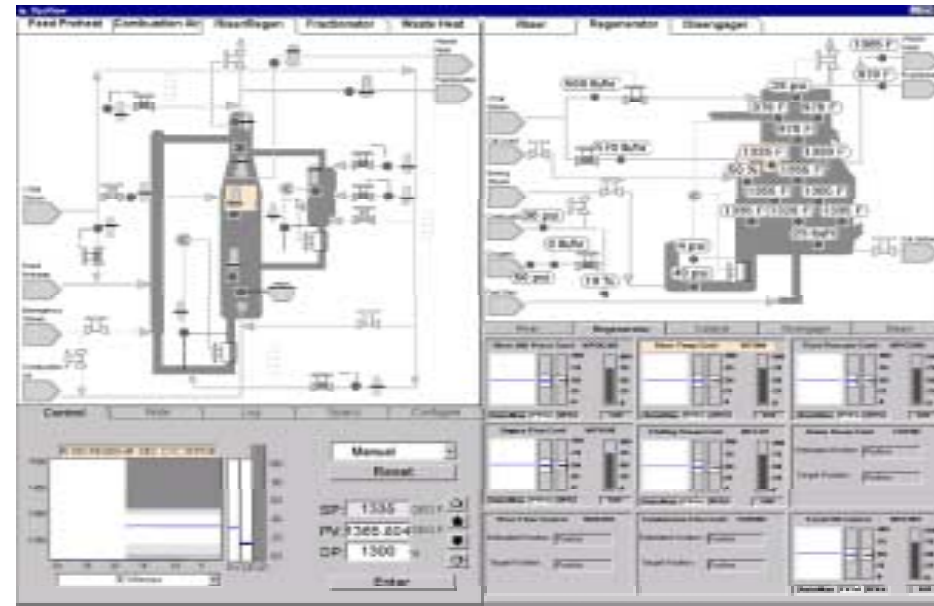
# Level 2 Example



# Level 3 Example



- By using the ASM concepts in one of their process units
  - ASM graphics
  - Alarm management
  - Etc ...
- >35% improvement in recognizing process deviations before an alarm
- 25% improvement in their ability to solve the problem
- 35-48% improvement in operator response time to deviations
- As compared to other units that were using US station type technologies as their control room environment, operators were able to orient to problems faster, more completely resolve the problems, and generally deal with abnormal situations faster



*~ C\$1M per year in savings*

**Honeywell is also applying the EEMUA guidance and ASM Graphics guidance to its Alarm Summary as well as in the HMIWeb Solution Pack**

**Honeywell**



# Experion PKS Alarm Summary

**Alarms**

**All areas**

- All areas
- S1 - System Area
- Generator
- Wet Ends
- Cooling Tower
- Auxiliary

**User view**

Time	Area	Source	Condition	Priority	Description	Value
18-Feb-2000 10:44:43 PM	Gene	FIC2001	HI_HI	Urgent	FIC2001 is above HiHi Limit	177.35 m
18-Feb-2000 10:44:43 PM	Wet	LIC3001	HI_HI	High	LIC3001 is above HiHi Limit	56.19 m3
18-Feb-2000 10:44:45 PM	Coolin	FIC3777	LO	Low	FIC3777 is below Lo Limit	12.33 m/s
18-Feb-2000 10:45:06 PM	Coolin	LIC8034	HI	Urgent	LVL8034 is above Hi Limit	99.45 m3
18-Feb-2000 10:45:12 PM	Gene	FIC1001	HI_HI	High	FIC1001 is above HiHi Limit	45.35 m/s
18-Feb-2000 10:46:12 PM	Auxil:	TIC3215	DEV_HI	Urgent	TIC3215 Hi Deviation Limit	12.00 Dev
18-Feb-2000 10:46:13 PM	Wet	FIC1001	HI	Low	FIC1001 is above Hi Limit	40.35 m/s
18-Feb-2000 10:46:13 PM	Gene	Valve4005	OPEN	High	Main Output Valve is OPEN	OPEN
18-Feb-2000 10:47:13 PM	Wet	LI4006	HI	Urgent	LI4006 is above Hi Limit	129.03 m
18-Feb-2000 10:48:13 PM	Auxil:	TIC3215	HI	Urgent	TIC3215	
18-Feb-2000 10:49:14 PM	Gene	LIC3005	LO_LO	High	LIC3005	
18-Feb-2000 10:55:14 PM	Wet	FIC2001	HI	High	FIC2001 is above Hi Limit	140.35 m
18-Feb-2000 10:55:15 PM	Gene	FIC1001	HI	Low	FIC1001 is above Hi Limit	35.35 m/s
18-Feb-2000 10:55:18 PM	Gene	FIC1001	HI_HI	High	FIC1001 is above HiHi Limit	45.35 m/s
18-Feb-2000 10:55:18 PM	Gene	FIC1004	LO	High	FIC1004 is below Lo Limit	15.67 m/s
18-Feb-2000 10:56:10 PM	Auxil:	TIC3215	LO	Urgent	TIC3215 is below Lo Limit	41.00 Dev

**Details**

**General** | **Instructions** | **Comments**

**Time:** 18 Feb 2000, 10:01:22 PM  
**Area:** Generator  
**Source:** FIC2001  
**Condition:** HI\_HI  
**Priority:** Urgent  
**Description:** FIC2001 is above HiHi limit  
**Value:** 6.19m

**Previous:** 5.93m  
**Parameter Name:** PV  
**Help Text:** See OP6.1.3  
**Help File:**  
**OPC Severity:** 500

**Enter comments on alarms for later analysis!**

**Present instructions for each alarm**

**One-click sorting!**

**Create and store "views" of areas, filters, and sorting**

Total alarms: 41    Total unacknowledged: 2

Pause    Resume

# Alarm Summary

The screenshot displays the 'Station - Default - Alarms Summary' window. The interface includes a menu bar (Station, Edit, View, Control, Action, Configure, Help), a toolbar with various icons, and a 'Message Summary' button. The main area is divided into a left-hand 'Assets' tree and a central table of alarms.

**Assets Hierarchy:**

- Assets (3)
  - RawMaterials
  - Digestion
  - Precipitation (3)
    - Thickeners (1)
    - Train1 (2)
      - Precipitator1 (1)
        - Cyclone1 (1)
        - Cyclone2
        - Cyclone3
      - Precipitator2 (1)
        - Train2
  - Recipes
  - System

**Alarm Table:**

View: (all alarms) ^	Date & Time	Location	Source	Condi	Priority	Description	Value	U...
Show All Alarms	28/11/2002 6:00:00	Assets./Precipitation/Precipitator1/Cyclone1	FI111	PVHI	H 00	Cyclone Flow Rate		
Alarm Groups	28/11/2002 5:00:00	Assets./Precipitation/Precipitator2/Cyclone3	FI222	PVHI	H 00	Cyclone Flow Rate		
Assets (3)	28/11/2002 5:00:00	Assets./Precipitation/Thickeners/Thickener1	MI456	PVLO	H 00	Rake Motor Amps		

At the bottom of the interface, it shows 'Unacknowledged alarms: 3' and 'Acknowledged alarms: 0'. A status bar at the very bottom displays the date '23-Nov-02 00:00:14' and the event 'System Event Archiving EVTARC U 00 Time to initiate event archive'. The Honeywell logo and version '13-Mar-03' are visible in the bottom left corner.

Asset Model shows alarm counts per 'asset' in the hierarchy

# Alarm Summary Filtering

The screenshot shows the 'Station - Default - Alarm Summary(sysAlarmSummary.htm)' window. The interface includes a menu bar (Station, Edit, View, Control, Action, Configure, Help), a toolbar with various icons, and a main display area. The main display area is titled 'Alarms' and shows a table of alarms. The table has columns for Date & Time, Location, Source, Condi..., Priority, Description, Value, and U... The first row of the table shows an alarm with a yellow warning icon, dated 28/11/2002 6:00:00, located at Assets./Precipitation/Precipitator1/Cyclone1, with a source of Ft111, condition PVHI, priority H 00, and description Cyclone Flow Rate. The left sidebar contains a tree view of assets, with 'Precipitator1 (1)' selected. A callout box points to this selection with the text 'Filter alarm display based on 'asset' selected'. The bottom status bar shows 'Unacknowledged alarms: 1', 'Acknowledged alarms: 0', and a system event archiving message: '23-Nov-02 00:00:14 System Event Archiving EVTARC U 00 Time to initiate event archive'. The bottom-most bar shows the Honeywell logo, date '13-Mar-03', time '20:45:27', and other system information.

Date & Time	Location	Source	Condi...	Priority	Description	Value	U...
28/11/2002 6:00:00	Assets./Precipitation/Precipitator1/Cyclone1	Ft111	PVHI	H 00	Cyclone Flow Rate		

Filter alarm display based on 'asset' selected



# Repeated Alarm Handling

The screenshot shows an 'Alarms' window with a table of active alarms. The table has columns for Date & Time, Area, Source, Condition, Priority, Description, Trip Value, and Live Value. The second row is highlighted in blue and has a red arrow pointing to its 'Date & Time' field. Below the table is an 'Alarm Details' panel with a 'General' tab. Red arrows point from the table to the 'Count' field in the details panel and from the 'Host Time' field in the details panel back to the table's second row.

Date & Time	Area	Source	Condition	Priority	Description	Trip Value	Live Value
8/19/2003 20:10:44	Col_Scada	sinewave	PVHH	H 00	Sine wave testing	9,002.00	3,324.00
8/19/2003 20:10:31	Col_Scada	sinewave	PVHI	H 00	Sine wave testing	8,049.00	3,324.00
8/19/2003 20:00:00	ColnagoSys	Testing license		H 00	License for internal testing - 19-Aug-03 20:00	8,049.00	
8/19/2003 18:59:59	ColnagoSys	Testing license		H 00	License for internal testing - 19-Aug-03 19:00		
8/19/2003 18:51:47	Col_C200	NUM_DACA	PVHIGH	H 00		86	86.00
8/19/2003 18:51:47	Col_C200	NUM_DACA	PVHIHI	U 00		86	86.00
8/19/2003 15:54:00	Col_Scada	Col_Status_Evt01	ALARM	H 00	For 15 Events per second	Off	0

**Initial time the alarm was raised** (points to 8/19/2003 20:10:31)

**Most recent time the alarm was raised** (points to 8/19/2003 8:10:31 PM)

**Number of times the alarm has occurred** (points to Count: 19)

Field	Value
Acknowledged:	False
Alarm Limit:	8000
Area Name:	Col_Scada
Category Name:	Process Alarm
Changed Time:	8/19/2003 8:12:01 PM
Condition:	PVHI
Count:	19
Host Time:	8/19/2003 8:10:31 PM
Live Value:	3324
Oldest Time:	8/19/2003 6:40:31 PM
Priority:	H 00
Quality:	192
Returned to normal:	True
Source:	sinewave

- **Considerable progress has been made in Alarm Management, particularly since the publication of the EEMUA 191 guidance.**
- **Safety Regulators and Insurers are also giving added momentum throughout the world.**
- **But much remains to be done, particularly in the area of “alarm floods”.**
- **The use of an Asset Model and associated work processes gives a promising way forward.**
- **Operator Graphics vary enormously in effectiveness. Good graphics give real benefits.**
- **The ASM Consortium has it’s own guidance in both areas – being applied extensively in Experion PKS.**

# Contact Information

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