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# AP1000 Advanced Control Room

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April 18, 2006

# AP1000 Advanced Control Room Presentation Outline

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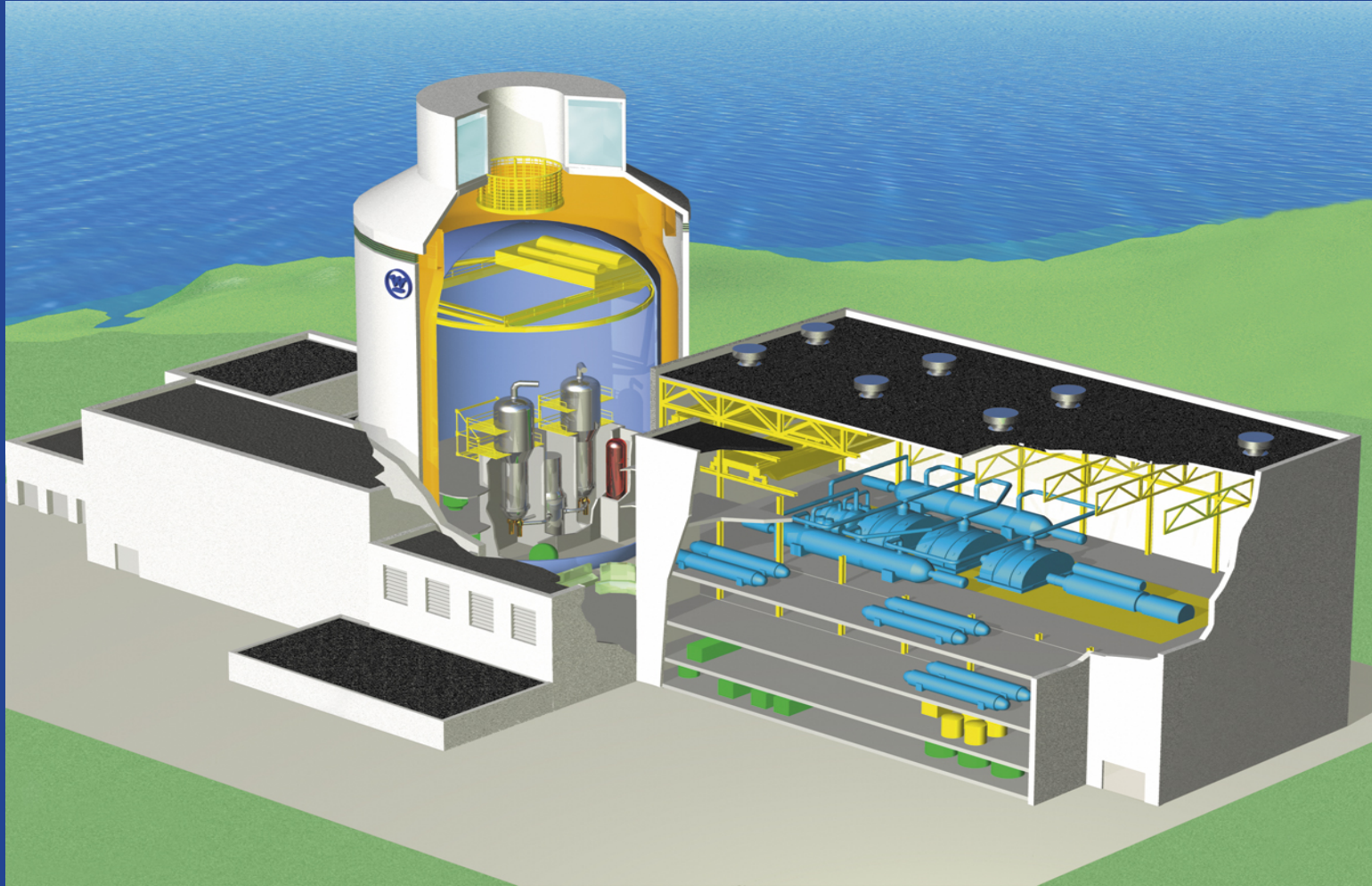
- **Background**
- **Operations and Control Centers**
- **Human-machine Interface Features**
- **Human Factors Engineering Program**
- **Conclusion**

# AP1000 Background

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- **AP1000**
  - An Advanced Light Water Reactor
  - Meets requirements of EPRI's Utility Requirements Document
  - Designed using passive safety features
- **AP600 USNRC Design Certification in 1999**
- **AP1000 USNRC Final Design Approval issued in Fall 2004**
- **HFE Program and Human Machine Interface (HMI) design process submitted and reviewed**
- **Latest HMI technology being used to complete the detailed design for 1<sup>st</sup> plant construction**

# AP1000 Passive Plant Design



# AP1000 Near-Term Opportunities

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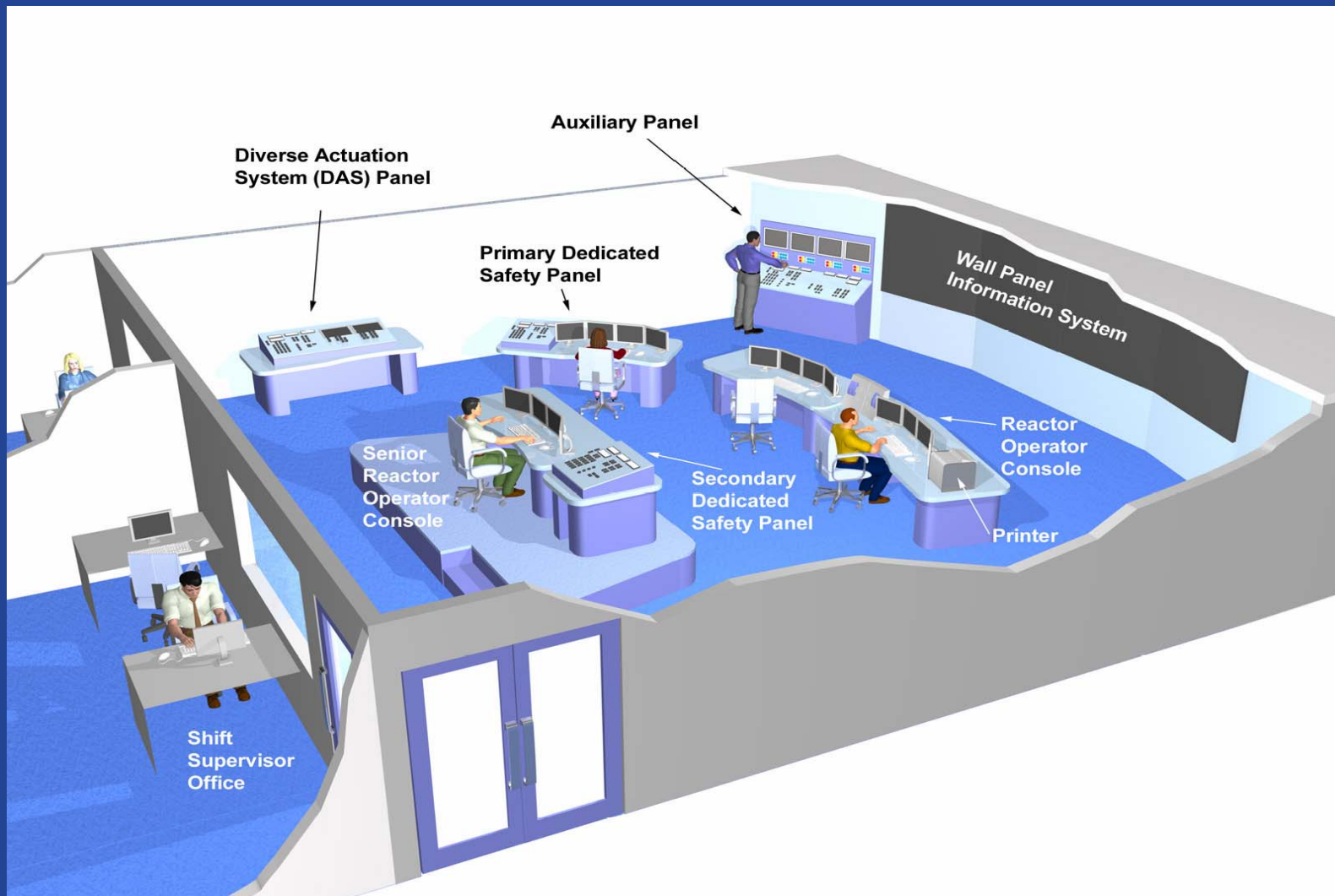
- **Westinghouse is proposing AP1000 for new units in China; proposal evaluation in progress**
  - Sanmen
  - Yangjiang
- **Westinghouse working with NuStart Energy Consortium on detailed design for new units in the US**
  - Currently performing detailed engineering
    - Control room, HMI and HFE program
    - I&C system designs
  - Combined License application to USNRC planned in 2007
- **Recent announcements by Owner/operators of intent to submit AP1000 Combined License applications**

# AP1000 Operations and Control Centers

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- **Main control room**
  - Main controlling area
  - Shift supervisor's and clerk's offices
  - Switching and tagging area
  - Kitchen/restroom facilities
- **Remote shutdown room**
- **Technical support center**
- **Operations support center**
- **Emergency operations facility**
- **Local control stations**

# AP1000 Compact Control Room



# AP1000 Control Room Features

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- **RO Console:** Four identical work positions available
  - Designed to be manned by one operator normally
- **SRO Console:** Two identical work positions available
  - Designed to be manned by one operator normally
- **Primary Dedicated Safety Panel**
  - Two Qualified Data Processing System FPDs for PAMS
  - Two associated Class 1E FPDs for safety related soft control and monitoring
  - Minimum Inventory fixed-position control switches
- **Secondary Dedicated Safety Panel**
  - Redundant switches for onerous condition actuations
- **DAS Panel:** Diverse manual actuations and monitoring



# Westinghouse Standard I&C/HMI Platforms

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- **Common Q for safety-related systems**
  - ABB's AC 160 processors
  - ABB's AF100 network and high speed link communications
  - Qualified FPDs (6" to 18" diagonal) with PC Nodebox processors
  - Class 1E power supply
  - Common Q equipment and applications to safety-related systems have been licensed by USNRC in Safety Evaluation Report
- **Ovation DCS for non-safety systems**
  - Controllers and computational servers provide processing for all control and plant computer-type functions
  - Redundant network communications with safety system gateways and datalink servers to foreign systems
  - Operator stations with full-function FPD interfaces
  - Wall Panel Information System large screen displays

# AP1000 HMI Resources

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- **Soft control**


- All non-safety components controlled through Ovation FPDs
- Safety components controlled by either:
  - Universal soft control through non-safety Ovation FPDs
  - Approved by NRC in Common Q Safety Evaluation Report
  - Manual system-level ESF actuations

- **Computerized procedures**

- DCS application program for all types of operating procedures, including Emergency Operating Procedures
- Significant operational benefit compared to paper procedures
- CPS Editor provided for procedure development, maintenance, configuration control and automatic generation of paper back-up procedures

# AP1000 HMI Resources Computerized Procedure System

**Computerized Procedures: On-Line**

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The human-computer system is more vigilant since a large amount of information is being monitored and evaluated essentially instantaneously

COMPRO performs data acquisition and step evaluation tasks, allowing the operator to judge the effectiveness of his success path and to improve his situation assessment

Procedure information is on-line and is updated periodically

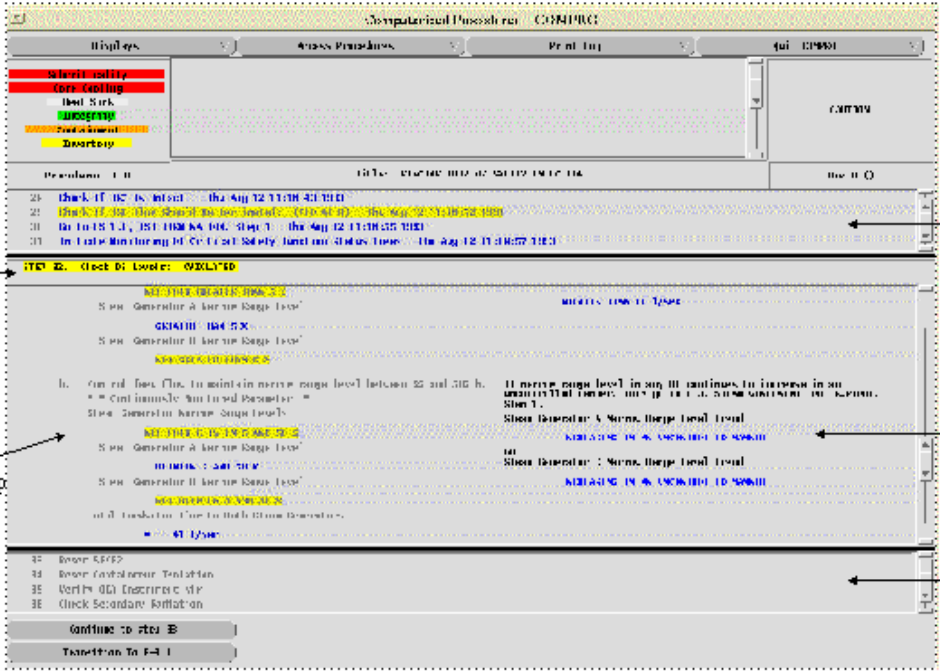
Status of previous steps provides context and continuity

Contingency actions displayed automatically when necessary

Presentation of future steps provides "sense of direction"

Status of current high level step, computed from dynamic plant data

Supporting Substep/subsubstep Information



# AP1000 HMI Resources

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- **Displays**

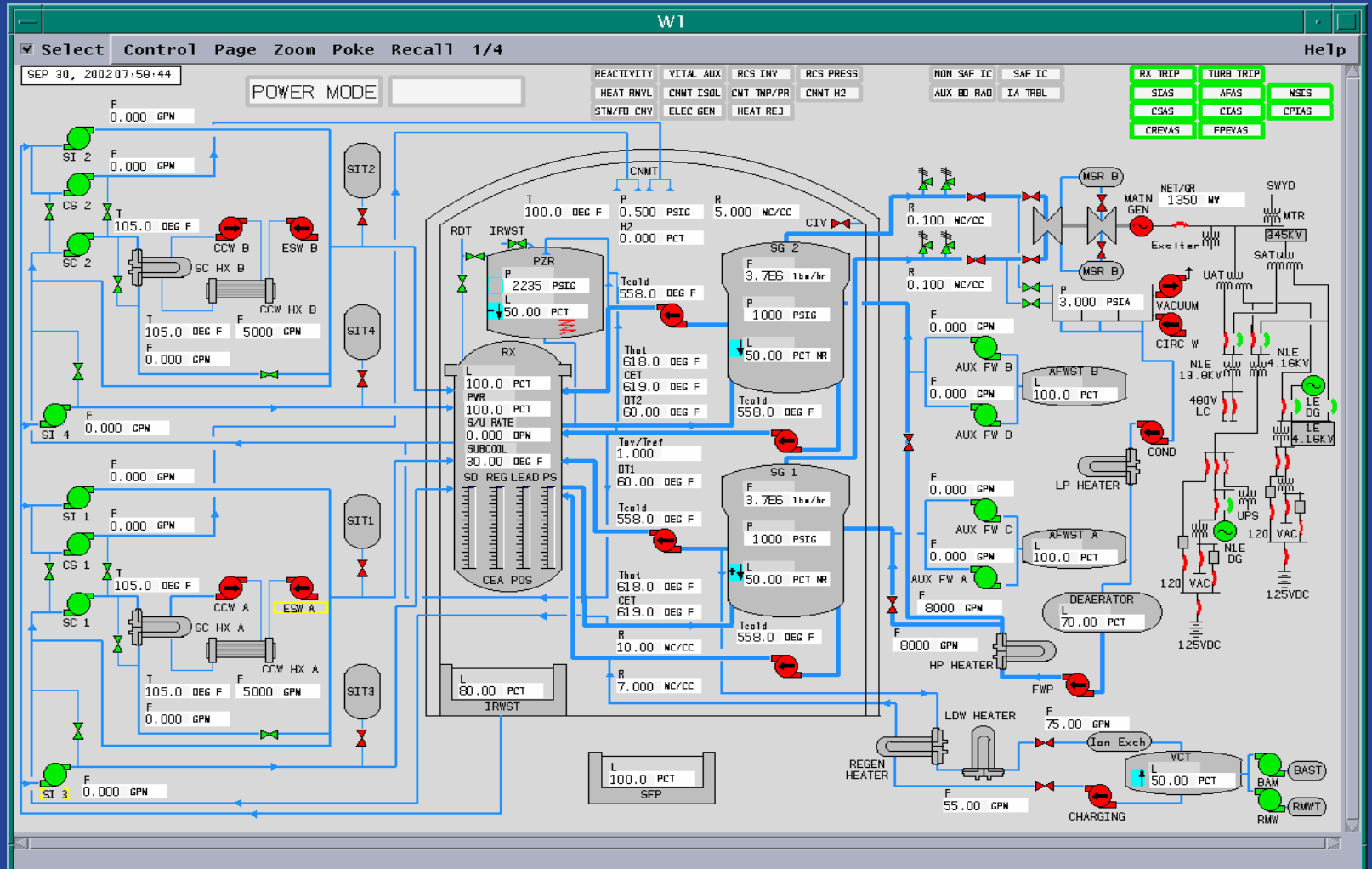
- Ovation provides capability for all types of displays
- Wall Panel Information System overview display and selectable display screens
- Limited set of safety-related displays on multi-channel FPDs and QDPS FPDs (including Reg. Guide 1.97 Category 1 PAMI)

- **Alarms**

- Primarily generated/displayed through Ovation (lists or integrated with plant mimics)
- Fixed-position alarms on either WPIS or dedicated alarm FPDs
- Multiple alarm processing techniques enhance useability
- Limited safety-related alarms on multi-channel FPDs for accident mitigation and safe shutdown

# AP1000 HMI Resources

## Example Overview Display



# Alarm Presentation System Example Overview Display

Fönsterhanterare

719 Slutet kylsystem STÖRNING	Fri	414 Kondensatsystemet STÖRNING	Fri
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414 Kondensatsystemet STÖRNING

Kvittera larmblock Visa samlingslarmet

414 Kondensatstam Tryckvakt förbikopplad	414 Kondensatstam Tryckmätning 414K119-MED XALM	414 Kondensatstam Tryckmätning 414K119-MED MRE	
414 C107, C108 Filter LTDP Diff.tryck			
414 V115 Inloppsventil LTFV E103, 5, 7 *Ställverksfel*	414 V115 Inloppsventil LTFV E103, 5, 7 *Störn CIM/Feedback*	414 V119 Bypassventil LTFV 103, 5, 7 *Ställverksfel*	414 V119 Bypassventil LTFV 103, 5, 7 *Störn CIM/Feedback*
414 V116 Inloppsventil LTFV 104, 6, 8 *Ställverksfel*	414 V116 Inloppsventil LTFV 104, 6, 8 *Störn CIM/Feedback*	414 V120 Bypassventil LTFV 104, 6, 8 *Ställverksfel*	414 V120 Bypassventil LTFV 104, 6, 8 *Störn CIM/Feedback*
414 V235 Dränageventil 413 E001 *Ställverksfel*	414 V235 Dränageventil 413 E001 *Störn CIM/Feedback*		
414 V427 Isolerventil inloppssida 332 *Ställverksfel*	414 V427 Isolerventil inloppssida 332 *Störn CIM/Feedback*	414 V428 Isolerventil utloppssida 332 *Ställverksfel*	414 V428 Isolerventil utloppssida 332 *Störn CIM/Feedback*

Bakgrundsinfo. (BIM)

- 22414V120-FB
- Larminstruktion
- Driftinstruktioner
- Trend (mini)
- Larminformation
- Point Information
- Ingen processbild
- Logikschema
- LPS HSR Larmhistorik
- Markera Larm (på/av)

719 Slutet kylsystem STÖRNING

Kvittera larmblock Visa samlingslarmet

719 Slutet kylsystem Konduktivitet Nivå	719 T001 Tryckhållningstank slutet kylsystem Hög Nivå	719 T001 Tryckhållningstank slutet kylsystem Tryck	719 T002/T003 Kvävgasbehållare till 719 T001 Tryck
719 Efter V011 L1 Temp.	719 V0011 (KS25) MRE Övergång till medelvädesreglering		
719 Slutet kylsystem 1/3-delvillkor Extremt lågt Flöde	719 Slutet kylsystem 1/3-delvillkor Extremt lågt Flöde	719 Slutet kylsystem 1/3-delvillkor Extremt lågt Flöde	

# Alarm Presentation System Example Support Display

The screenshot displays the Alarm Presentation System interface. A console window (xconsole) shows the following text:

```
Console log for xserver211  
access control disabled. clients can connect from any host  
[1] 97:  
[1] 67:  
[1] 67:  
[1] 67:  
/home/wdpf  
xserver211{wdpf31: exit
```

A trend graph (Trend) is visible on the right side of the console window, showing a vertical axis with values ranging from -1.0 to 3.0. The graph is currently empty.

A point information dialog (Point Appl) is open in the foreground, displaying the following information:

Point Name: 22414V120-FB

St+rn. CIM/Feedback, packad pk 000cH

Point Config Security Value/Status Hardware Initial Alarm Display Ancillary

Sys ID No.	ID	2147538153	8000d4e9H
Point Alias	PA		
Group Point Description	ED	St+rn. CIM/Feedback, packad pk	
Record Type Number	RT	226 (LP)	Packed Digital
Characteristics	KR	E414V120	
Originating Drop Number	DO	32	
Frequency	S		
Point Version Number	VN	7792	

Buttons: Apply, Cancel, Clear

Annotations:

- Master: Points to the Larmlistor window.
- Trend: Points to the trend graph.
- Point Information: Points to the point information dialog.

# AP1000 Human Factors Engineering Program

Planning

Analysis

Design

V&V

Operation

Operating  
Experience  
Review

Function Requirements  
Analysis and  
Function Allocation

Task Analysis

Staffing

Human  
Reliability  
Analysis

Interface  
Design

Procedure  
Development

Training  
Development

Design  
Implementation

Verification  
And  
Validation

Human  
Performance  
Monitoring

HFE  
Program  
Management



# AP1000 Human Factors Engineering Program

## Current Progress

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- **Task Analysis**
  - Function-based TA complete
  - Operational Sequence Analysis method established and being performed by a dedicated, international team
- **MCR staffing roles and responsibilities document completed and submitted to NRC**
- **Human Reliability Analysis**
  - Risk important operational tasks identified
  - Risk important maintenance, testing, inspection and surveillance task identification identified
  - Report submitted to NRC
- **Procedure development underway**

# AP1000 Human Factors Engineering Program

## Current Progress (cont.)

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- **Human Machine Interface Design**
  - Functional requirements and design specs written
  - First multi-disciplinary review completed
- **Engineering Tests**
  - Engineering test for safety soft control completed in June 2005; Report complete
  - Engineering test for HMI integration will start May 15<sup>th</sup>
  - Simulation test facility development supports tests
  - HMI resource implementation supports tests

# Westinghouse AP1000 Control Room Development Facility



# Conclusion

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- **Near term opportunities to deploy AP1000 exist in both China and the US**
- **AP1000's compact control room is being implemented with Common Q and Ovation video-based HMI**
- **A comprehensive human factors engineering program is being conducted to support COL applications**
- **Detailed engineering for the complete HMI is well underway**