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NuStart's Design Standardization Initiatives and Support of HFE Program Development

EPRI I&C Workshop
March 28, 2006

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NuStart Energy Organization

- NuStart Energy Consortium
  - 10 NuStart Member companies
  - General Electric
  - Westinghouse
- "Task Teams" manage work to accomplish major project objectives
- COL Task Teams aligned with NRC's plans for "Design Centered Reviews"
  - Led to NuStart's "design standardization" initiatives
- NuStart Energy is supporting HFE Program development for AP1000 and ESBWR reactor designs

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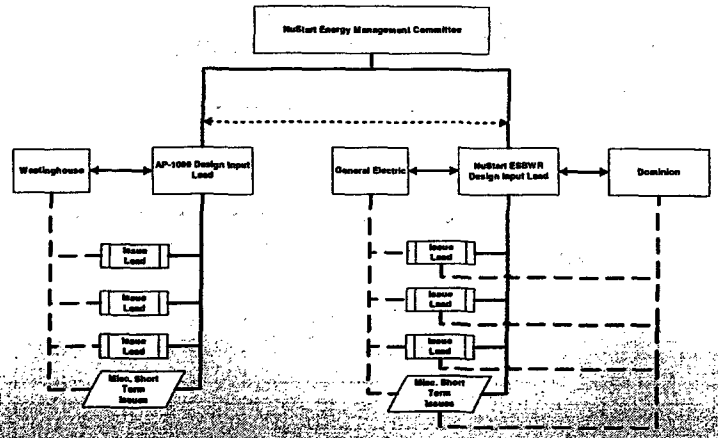
Standard Design Input Structure



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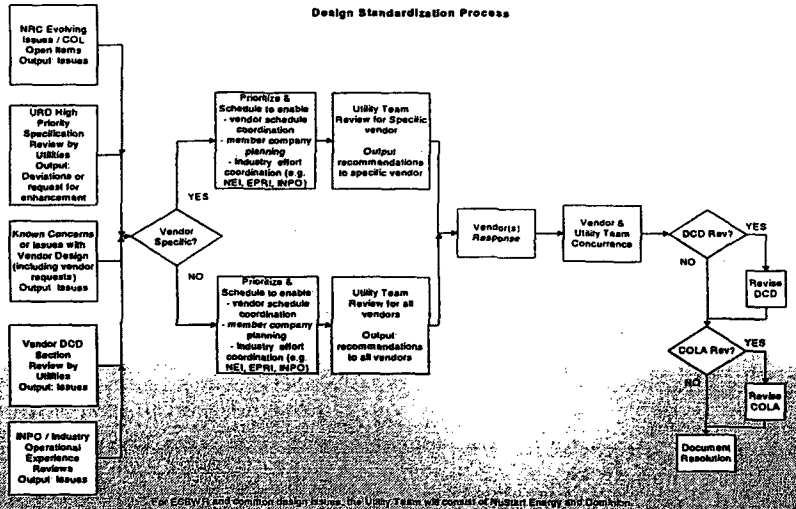
Design Standardization Process



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Inputs to Design Standardization Process

- **Evolving/ changing regulatory requirements**
  - May impact Certified Design or Combined License (COL) Application
- **Design Certification COL Action Items**
  - Need to be addressed in COL Application
- **High impact URD (Utility Requirements Document) items**
  - Based on NuStart internal review and update of URD information
- **Current industry issues (e.g. Security) need to be evaluated for impact on the plant design**
- **Design Control Document (DCD) section reviews**
  - AP1000
  - ESBWR
- **Industry Operating Experience – INPO, EPRI, other**

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Example I&C Design Issues

Priority A,B,C	Topic or Strategic Element	Existing Forum(s) or Task Force(s)	Deliverable(s)	Timing	Comments
	NRC Evolving Regulations: Reg Guide 1.152 Rev 2 (01/2006) "Criteria for Digital Computers in Safety Systems of Nuclear Power Plants"		FSAR Chapter 7 Discussion	COLA Submittal 4Q07	AP-1000 Design Certification issued prior to RG revision
	URD "AA" Item #304: Automated Test Feature for Tech Spec Requirements		Final Design	Design Finalization	Design coordination with TS development
	DCD Review Item: Acceptability of Isolation for 2-Way Communication between SR and NSR components		FSAR Chapter 7 Discussion	COLA Submittal 4Q07	Westinghouse developing Technical Report for submittal to NRC
	COL Action Item 18.2.4-1 COL Applicant will implement NRC Approved HFE Program		Final design - Operations V&V	COLA Submittal 4Q07	Westinghouse implementing HFE program as part of MCR design

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AP1000 Human Factors Engineering Program and Advanced Control Room

- AP1000 is an compact control room designed to address requirements of the EPRI's Utility Requirements Document (URD)
- AP600 USNRC Design Certification in 1999
- AP1000 USNRC Design Certification in 2005
- HFE Program and Human System Interface (HSI) design process submitted and reviewed
- Latest HSI technology being used to complete the detailed design for 1st plant construction
- Requirements of HFE Program contained in Design Certification Document (DCD) Chapter 18, "Human Factors Engineering"

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AP1000 Advanced Control Room

- Compact Control Room
  - Designed for 1 Reactor Operator and 1 Supervisor
- Displays
  - Plant status / overview via wall panel (DDS, non 1E)
  - Detail display via workstation video displays (DDS, non 1E)
  - Qualified safety displays (PMS, 1E)
  - Diverse actuation system displays (DAS, non 1E)
- Controls
  - Soft controls (DDS, non 1E and PMS, 1E)
  - Small number of dedicated switches; safety (PMS, 1E) & diverse (DAS, non 1E)
- Advanced Alarm Management
- Computer Based Procedures
  - Paper backup

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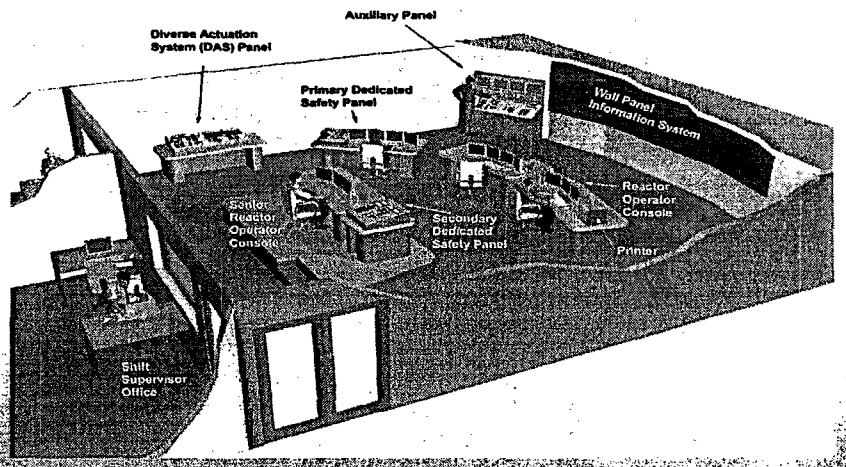
AP1000 Compact Control Room



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Human Factors Engineering Program

Planning and Analysis	Design	V&V	Implementation and Operation
HFE Program Management	Interface Design		Design Implementation
Operating Experience Review			
Function Requirements Analysis and Function Allocation	Procedure Development	Verification And Validation	
Task Analysis			
Staffing	Training Development		Human Performance Monitoring
Human Reliability Analysis			

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Task Analysis Procedure Support

- **AP1000 DCD Chapter 18, Section 5 (18.5) covers the Task Analysis Implementation Plan**
- **DCD requires a human factors Task Analysis to be performed on the following AP1000-specific operational sequences:**
  - Plant heatup and startup from post-refueling to 100% power
  - Reactor trip, turbine trip, and safety injection
  - Natural circulation cooldown (startup feedwater with steam generator)
  - Loss of reactor or secondary coolant
  - Post loss-of-coolant accident cooldown and depressurization
  - Loss of RCS inventory during shutdown
  - Loss of the normal residual heat removal system (RNS) during shutdown
  - Manual automatic depressurization system (ADS) actuation
  - Manual reactor trip via PMS, via diverse actuation system (DAS)
  - ADS valve testing during Mode 1

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Human – System Interface Design

- **AP1000 DCD Chapter 18, Section 8, "Human System Interface Design" references the "Man-in-the-Loop Test Plan", WCAP-14396**
- **WCAP-14396 specifies the requirement to perform two HSI engineering tests:**
  - Soft Control Prototypes
  - Integrated Control Room Prototypes

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HFE/HSI Testing – Scope and Schedule

Soft Control Prototypes

- Universal Soft Control test was performed in June, 2005
- Universal, non-safety soft controls were used to manually control both safety and non-safety plant components.
- Test was performed using a partial-scope AP1000 simulator
- Test was performed using ROs as test subjects, dealing with SGTL and SGTR events.
- Test results are documented, and design improvements are being implemented

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HFE/HSI Testing – Scope and Schedule

Integrated Control Room Prototypes

- Test is scheduled for May, 2006
- Control room resources will include:
  - Plant controls and displays
  - Wall Panel Information System (Large Screen Displays)
  - Partial simulation of Protection System (including CIMs)
  - Alarm System
  - Computerized Procedures System
  - Selected Nuclear Application Programs
  - Selected dedicated ("hard") controls

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HFE/HSI Testing – Scope and Schedule

Integrated Control Room Prototypes

- Test will use a partial-scope AP1000 simulator
- Test will be performed using ROs as test subjects, dealing with SGTL and SGTR events.
- Test results will be documented and design improvements will be implemented
- The need for additional HSI engineering tests will be evaluated (none currently committed)

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Human Factors Engineering Verification & Validation

Integrated System Validation (ISV)

- "Validates that HSI design can be effectively operated by personnel within all performance requirements" (WCAP-15860, referenced in DCD Chapter 18, Section 11) KS
- ISV tests the entire, completed HSI design
- ISV requires a near full scope, high-fidelity simulator
- ISV is part of COL Information Item 18.11-1
- ISV is also covered in an ITAAC (duplication of regulation)
- ISV is currently scheduled beyond COL application submittal date

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Summary

- **NuStart Energy is developing processes to:**
  - Provide customer input on design alternatives and recommended solutions to GE and Westinghouse as they refine and finalize their designs
  - Support "standardized design" initiatives
- **NuStart Energy is involved with evolving/changing regulatory requirements**
  - Development of DG-1145 (Regulatory Guide for COL Applications)
  - Revision of Standard Review Plan (including Chapter 7 on I&C)
- **NuStart Energy is supporting HFE Program development for AP1000 and ESBWR reactor designs**

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