

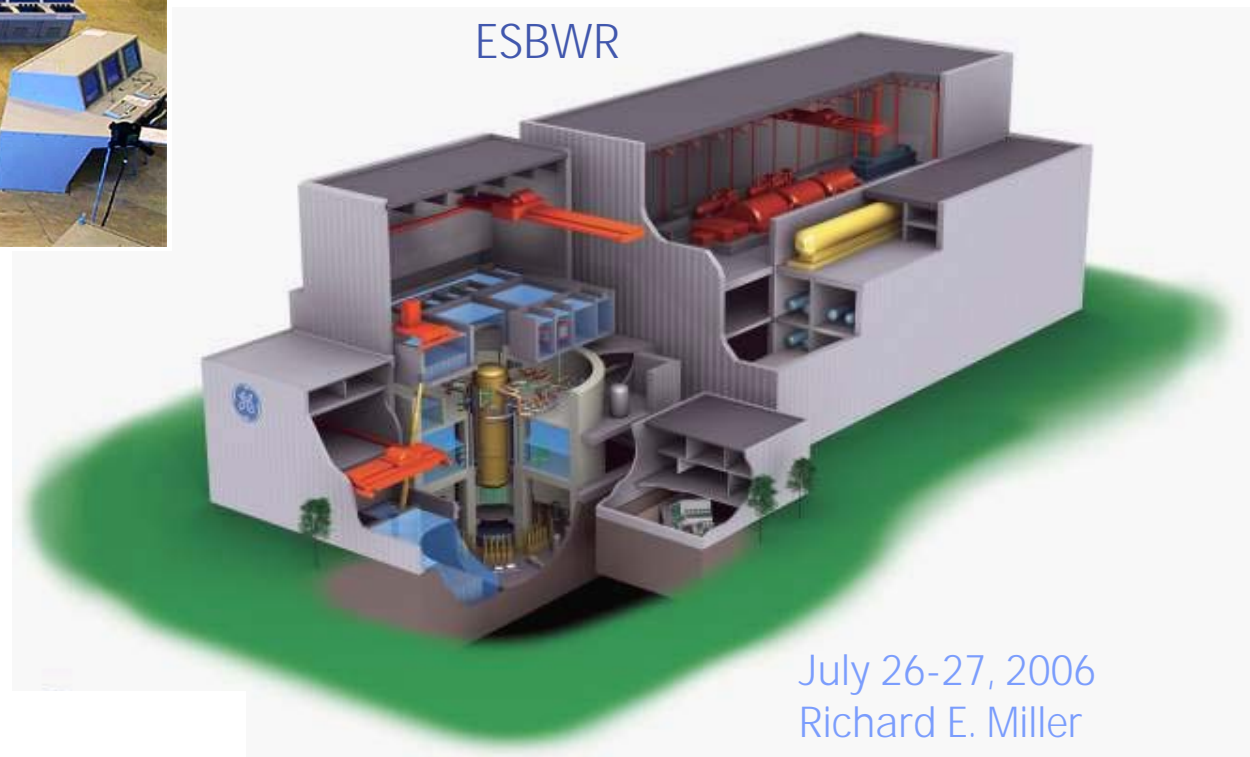
ESBWR Instrumentation & Controls Systems

Distributed Control and Information Systems (DCIS)

JULY 26-27, 2006



Lungmen Digital Control
Room Simulator



July 26-27, 2006
Richard E. Miller



imagination at work

ESBWR I&C SYSTEMS

Agenda

- Wednesday, July 26
 - > 0800 – GE - Check-In
 - > 0830 – GE - Internal Discussions
 - > 0900 – Entrance Meeting – Introductions
 - > 0915 – Agenda Overview
 - > 0930 – Software Plans Overview
 - > 1400 – Proprietary Discussions – Software Management Plans
- Thursday, July 27
 - > 0800 – GE - Check-In
 - > 0830 – GE - Internal Discussions
 - > 0900 – Entrance Meeting – Introductions
 - Distributed Control & Information Systems (DCIS)
 - DCIS Platform Families

ESBWR I&C SYSTEMS

Agenda (Continued)

- Thursday, July 27 (cont.)
 - > 0930 – DCIS Agenda (cont.)
 - Commercial Grade Dedication for DCIS
 - I&C Systems Factory Test Program and Interface with COL Applicant's Acceptance Test Program
 - Fault Tolerant Digital Control System – Mark VIe
 - RAI 7.0-2 Discussion
 - RAI 14.3-4 Discussion
 - N-2 Design Discussion
 - > 1400 – Proprietary Discussions
 - DCIS Platform Families
 - Software Plans
 - > 1700 – Exit Site (Day 2 of 2)

ESBWR I&C SYSTEMS - DCIS

- DCIS Platform Families

Safety Category	Safety-Related		Nonsafety-Related				
	E - DCIS		NE - DCIS				
System Families	RPS NMS	ECCS ESF	DPS	NUCLEAR CONTROL SYSTEMS	Balance of any NE-DCIS Systems	PCF	Severe Accident
Architecture	NUMAC Derived	Redundant	Triple Redundant	Triple Redundant	Dual Redundant	Workstations **	PLCs
Systems/ Subsystems	RPS LD&IS (MSIV) NMS ATWS/SLCS*	ICS SRV/DPV GDCS SLCS LD&IS (Non-MSIV)	RPS ECCS Backup	FWC, PAS (Automation SB&PC, T/G Control)	PIP A, PIP B Balance Of Plant (Power Generation)	HMI, Alarms, SPDF, Historian, 3D-Monitore	Deluge System (GDCS Subsystem)

* Non -Microprocessor based

** Dual redundant as necessary

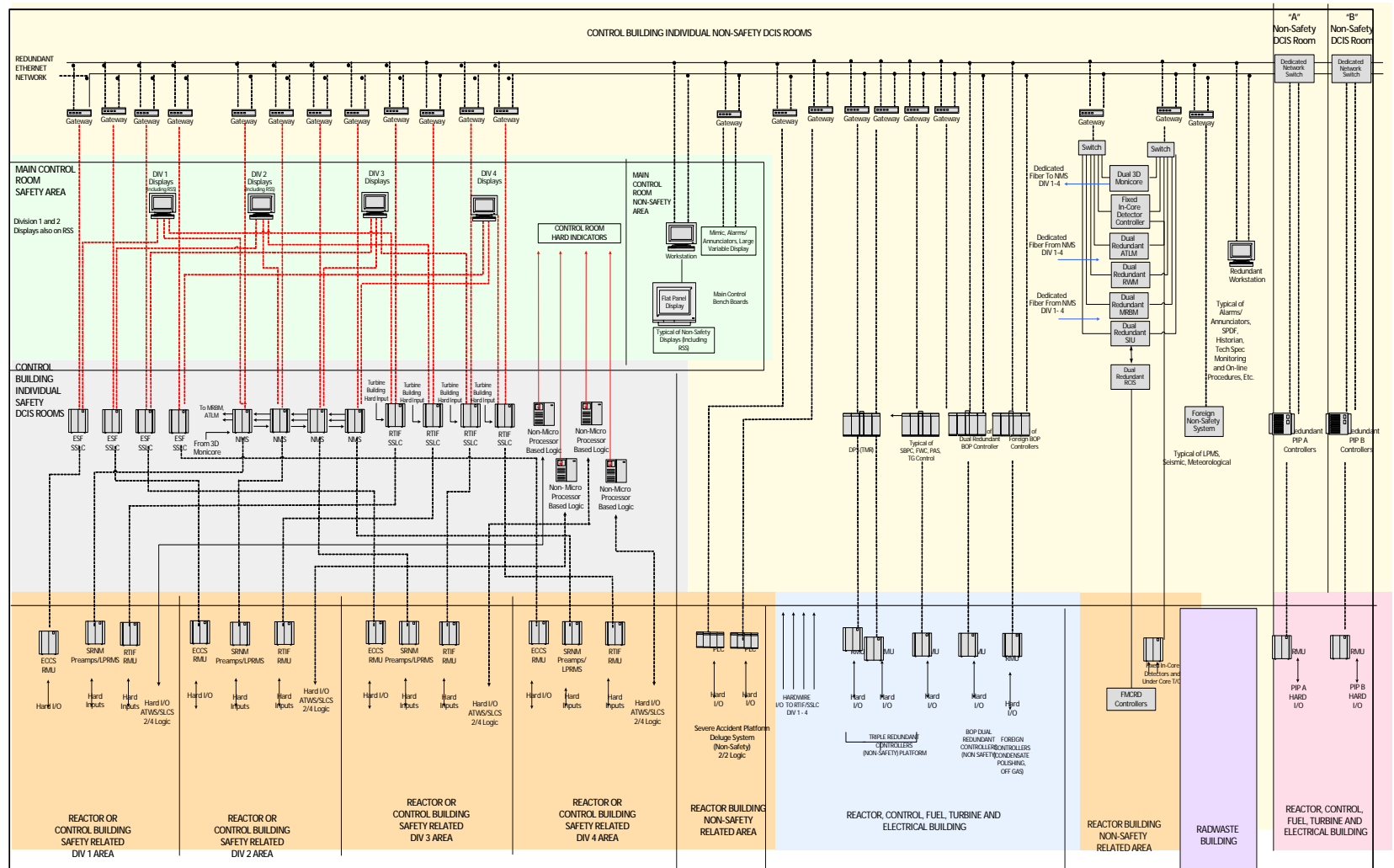
Diversity Strategy

Within Essential Controls (NRC)	
Essential -vs- DPS (NRC)	
Essential -vs- Non-E (GE DCD PRA)	

ESBWR I&C SYSTEMS - DCIS

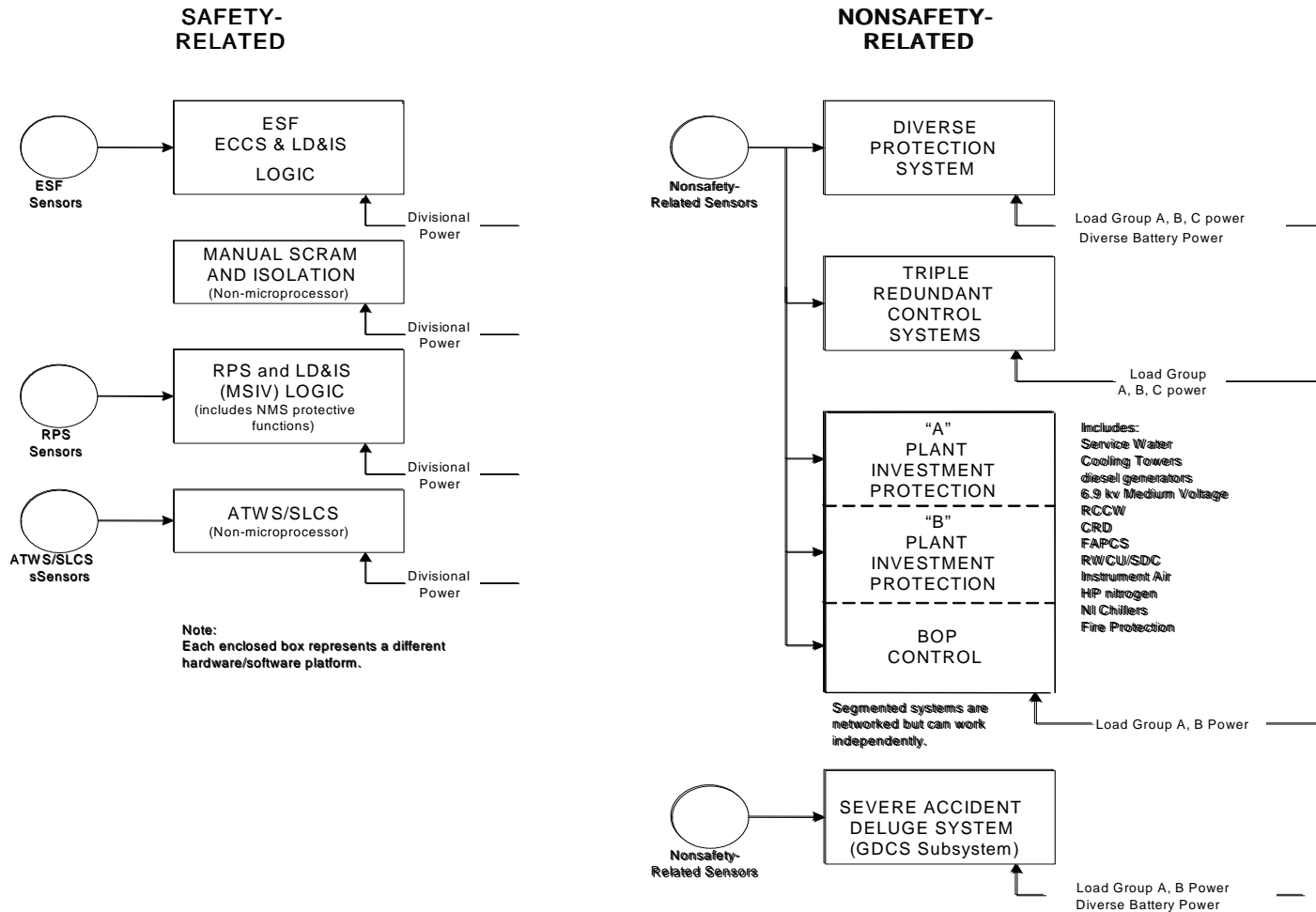


ESBWR NETWORK DIAGRAM (PROPOSED)



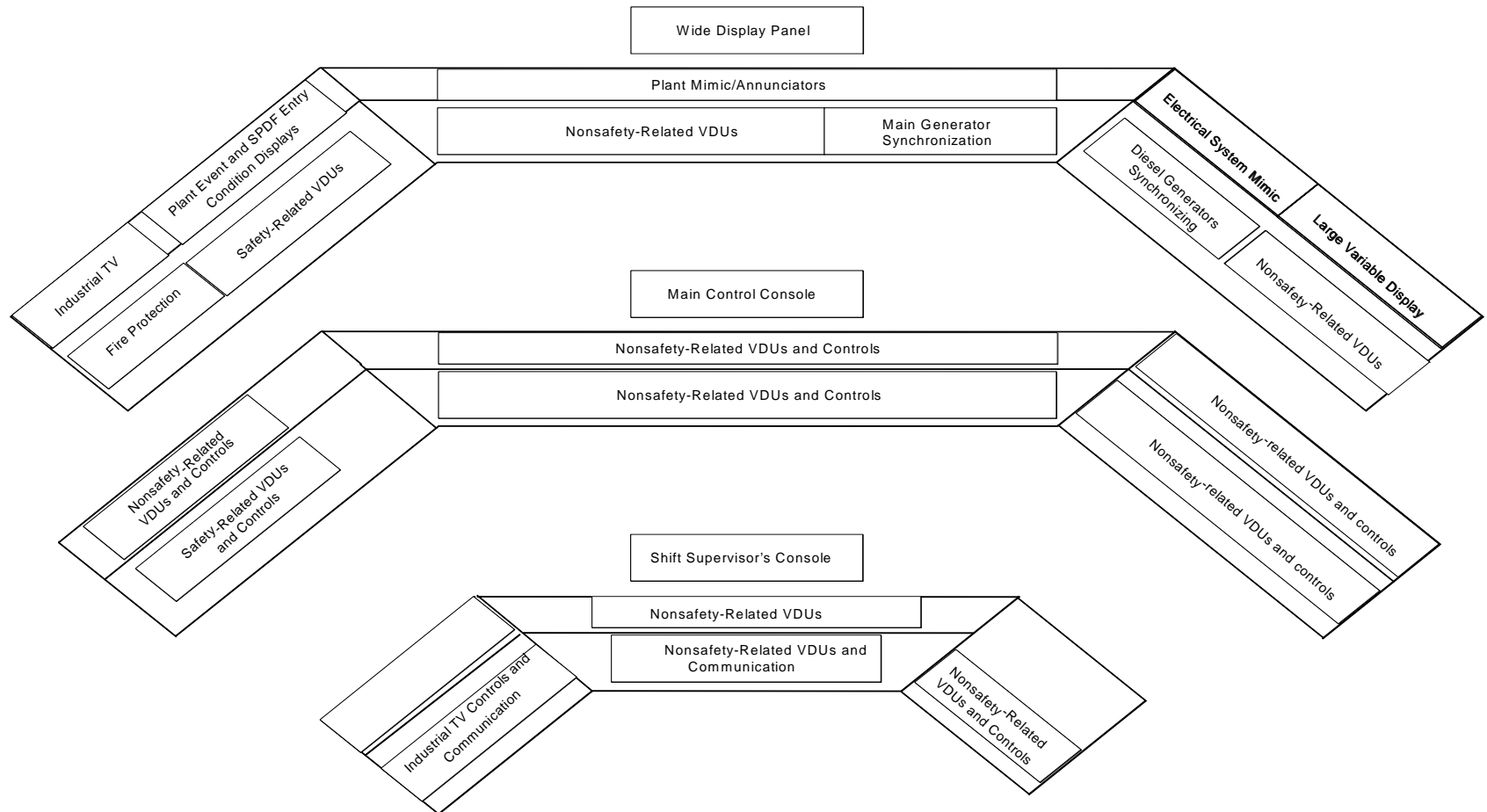
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- DCIS Power & Sensor Diversity



ESBWR I&C SYSTEMS - DCIS

- DCIS Control Room (Pending HFE Design Process)



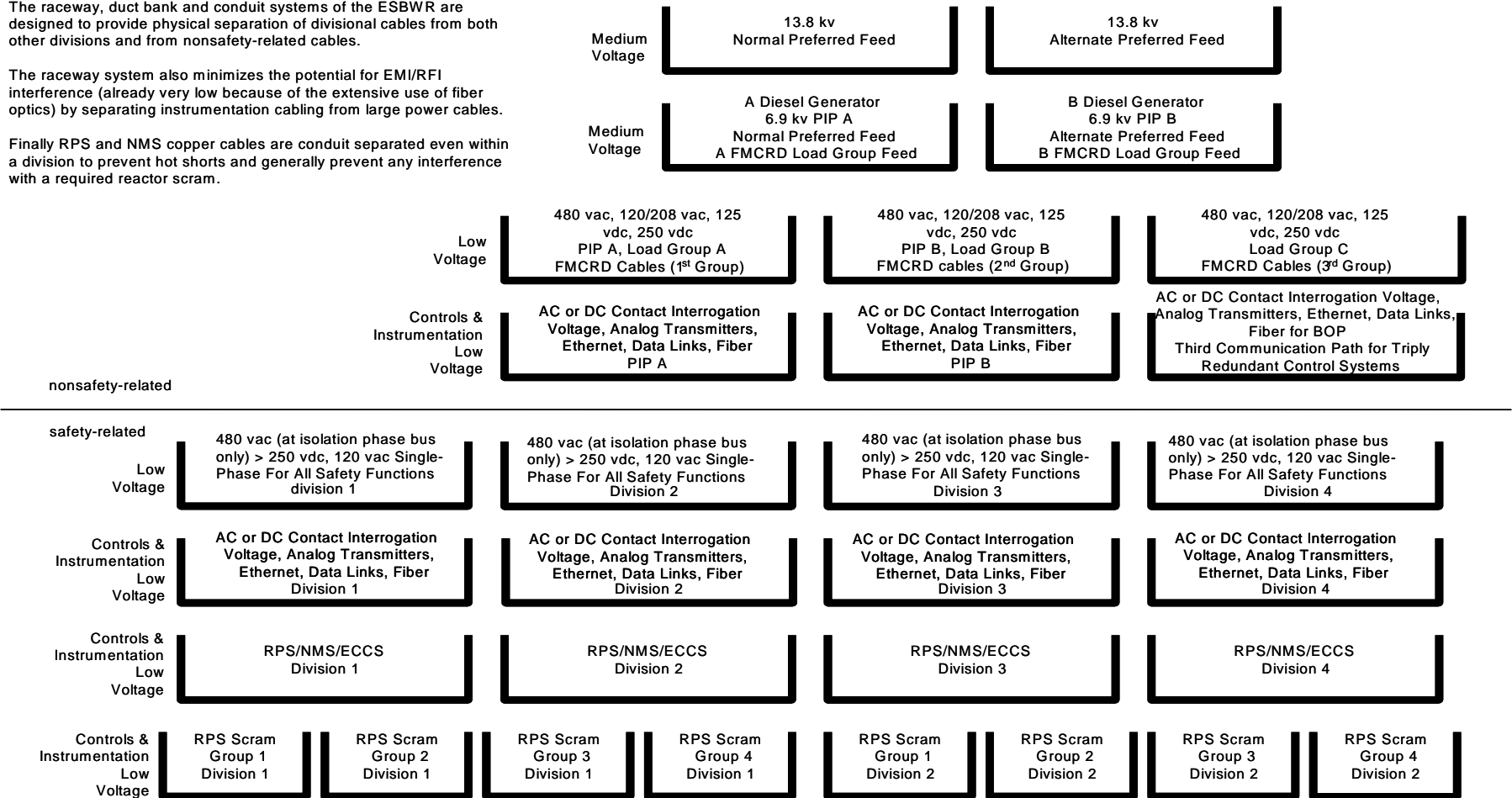
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• DCIS and Power Separation

The raceway, duct bank and conduit systems of the ESBWR are designed to provide physical separation of divisional cables from both other divisions and from nonsafety-related cables.

The raceway system also minimizes the potential for EMI/RFI interference (already very low because of the extensive use of fiber optics) by separating instrumentation cabling from large power cables.

Finally RPS and NMS copper cables are conduit separated even within a division to prevent hot shorts and generally prevent any interference with a required reactor scram.



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Proposed Suppliers for Primary DCIS Families

- NMS/RPS > GE (NUMAC)
- ECCS/ESF > GE/DS-S (Spinline 3), DRS (Performnet), HF-C (6000 Series), or Invensys (Triconex)
- DPS > GE (Mark VIe)
- Nuclear Control Systems > GE (Mark VIe)
- Balance of Any Nonsafety-Related Systems > GE (Mark VIe) or Invensys (Foxboro)
- Plant Computer Functions > (GE-Mark VIe / DS-S (SAIPMS/Win)
- Severe Accident > Quality Diverse PLC Supplier
- 3rd Party DCIS Suppliers > Various

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Open DCIS Discussion

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- **Commercial Grade Dedication for DCIS**
 - DCD Chapter 7, Appendix 7B.2 Software Management Plan, Paragraph (2)e and DCD Chapter 7, Appendix 7B.4 Software Configuration Management Plan, Paragraph (3) h reference:
 - CR-G421, "A Proposed Acceptance Process for Commercial Off-the-shelf (COTS) Software in Reactor Applications"
 - EPRI TR-106439, Guidelines on Evaluation and Acceptance of Commercial Grade Digital Equipment in Nuclear Safety Applications

ESBWR I&C SYSTEMS - DCIS

- **Commercial Grade Dedication for DCIS (cont.)**
 - DCD Chapter 7, Section 7.2, Reactor Trip System and Neutron Monitoring System, BTP HICB-18, Guidance on Use of Commercial Grade Industrial Computers) in Digital Computer-based Instrumentation and Control systems
 - Any portions of RPS, NMS and SSLC/ESF design that will use Commercial Grade Industrial Computers for safety-related functions conform to this BTP (and to BTPs 14, 17, and 21). Such commercial grade industrial computers will be qualified to a level commensurate with safety requirements.

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Break

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- I&C Systems Factory Test Program and Interface with COL Applicant's Acceptance Test Program
 - Discussion

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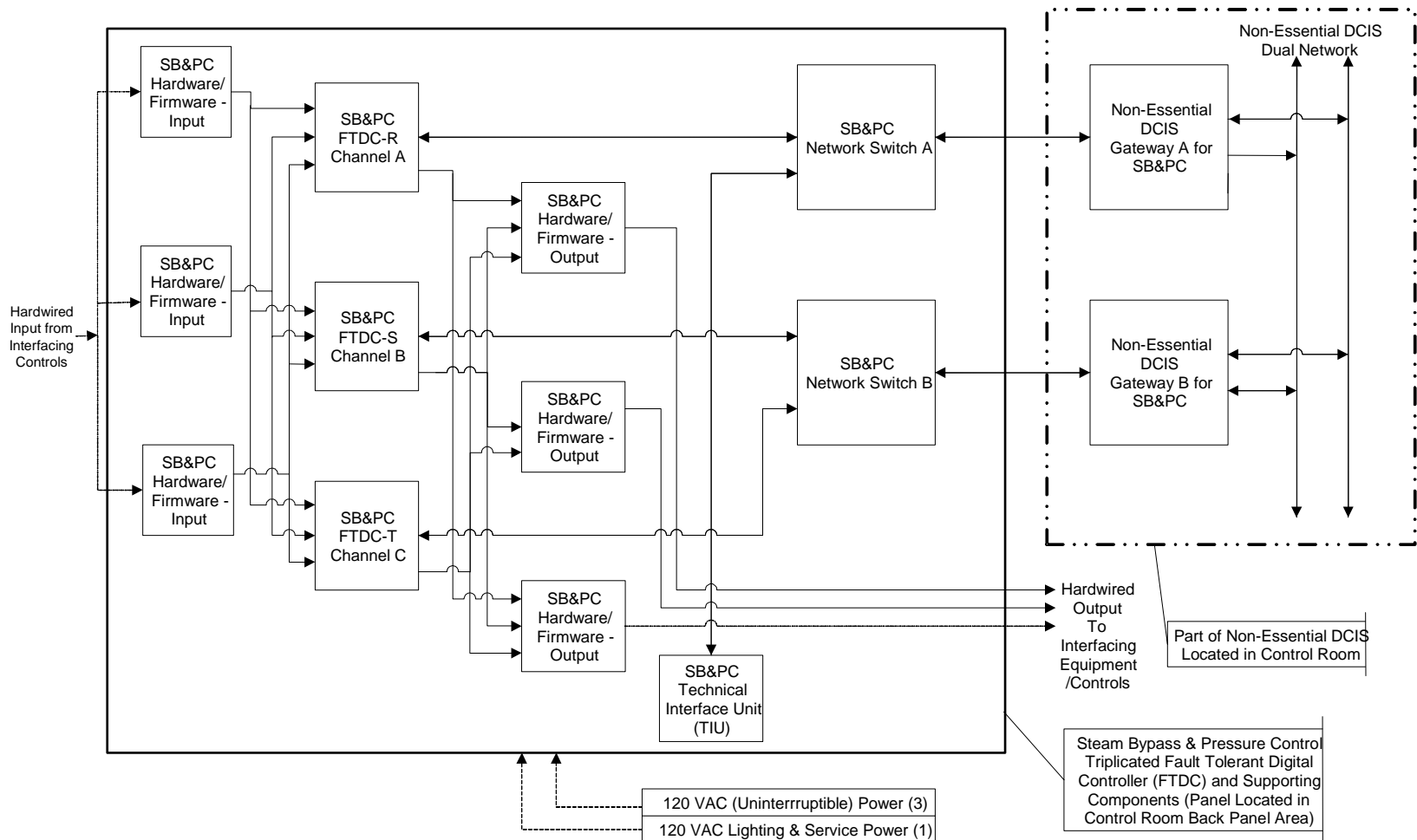
Break

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- Fault Tolerant Digital Control System – Mark VIe
 - DCD Figure
 - Discussion

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- Fault Tolerant Digital Control System – Mark VIe



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- RAI 7.0-2 Discussion

- *NRC RAI 7.0-2*
- *10 CFR 52.47(a)(2) requires that the information submitted for a design certification must include performance requirements and design information sufficiently detailed to permit the preparation of acceptance and inspection requirements by the NRC, and procurement specifications and construction and installation specifications by an applicant. For any ESBWR application software developed by GE, and described in DCD Appendix 7B, please provide the following software life-cycle documents:*
 - *- Requirements Definition*
 - *- Integration Plan*
 - *- Test Plan*

ESBWR I&C SYSTEMS - DCIS

- RAI 7.0-2 Discussion (cont.)
 - GE Draft Response to RAI 7.0-2
 - Establishing performance requirements and specifying design information are part of the software life cycle process and are discussed in DCD Tier 2, section 7B.2 (3), "Software Management Plan". This process is further described in NEDE-33226, "ESBWR I&C Software Management Plan".
 - The detailed ESBWR software life cycle process design output documents, which are created and reviewed during the life-cycle phases referred to in the RAI and as reflected in Section 2.1 of the HICB-14, will be developed and available for NRC audit and inspection during the software life cycle process.
 - Specifically DG-1145, "Combined License Applications for Nuclear Power Plants" Section C.II.2, Attachment A, Software Requirements Specifications states "The ITACC should require verification that each of the functional characteristics shown in SRP Chapter 7, BTP 7-14, has been addressed, and specifically require a verification that each individual requirement is traceable to a digital system requirement, and that there are no added functions or requirements which are not traceable to the system requirement." DCD, Section 7B.2(3)b, "Design Definition Requirements Phase," provides for the output documents that will document system requirement specifications.

ESBWR I&C SYSTEMS - DCIS

- RAI 7.0-2 Discussion (cont.)
 - GE Draft Response to RAI 7.0-2 (cont.)
 - DG-1145 Section C.II.2, Attachment A, also states that the ITACC for software life cycle process output documents should demonstrate that “The system test procedures and test results (validation tests, site acceptance tests, pre-operational and start-up tests) provide assurance that the system functions as intended.” DCD Section 7B.2(3)e “Integration Test Phase” provides for the output documents that will provide the required assurance.
 - DG-1145 was recently issued in draft form. Attachment A of Section C.II.2 provides general development guidance on ITACC related to the subject software life cycle process design output documents. GE is currently evaluating that additional guidance and will incorporate any changes to the ESBWR ITACC for software related activities as warranted.

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- RAI 14.3-4 Discussion

- *NRC RAI 14.3-4 Requirements to be addressed by DCD Tier 1, Section 2.2.7, Reactor protection System (RPS).*
- *The RPS can withstand seismic design basis loads without loss of safety function.*
- *The RPS has electrical surge withstand capability (SWC), and can withstand electromagnetic interface (EMI), radio frequency interface (RFI), and electrostatic discharge (ESD) conditions that would exist before, during, and following a design basis accident without loss of safety function.*
- *The RPS can withstand the room ambient temperature, humidity, pressure, and mechanical vibration conditions that would exist before, during, and following a design basis accident without loss of safety function.*
- *The RPS is powered from Class 1E division.*

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- RAI 14.3-4 Discussion (cont.)

- *NRC RAI 14.3-4 Requirements to be addressed by DCD Tier 1, Section 2.2.7, Reactor protection System (RPS). (cont.)*
- *The RPS provides process signals to the Essential Distributed Control and Information System (E-DCIS) through isolation devices. Data Communication between safety and non safety systems does not inhibit the performance of the safety function.*
- *The RPS provides the transfer of control capability from the main control room to the remote shutdown panel.*
- *The RPS trip setpoints are determined using a methodology which accounts for loop accuracies, and accommodates response time testing.*
- *The RPS hardware and software is developed using a planned life cycle process.*

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Break

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- N-2 Design Discussion
 - Problem Statement
 - Design Change
 - Impacts

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Break

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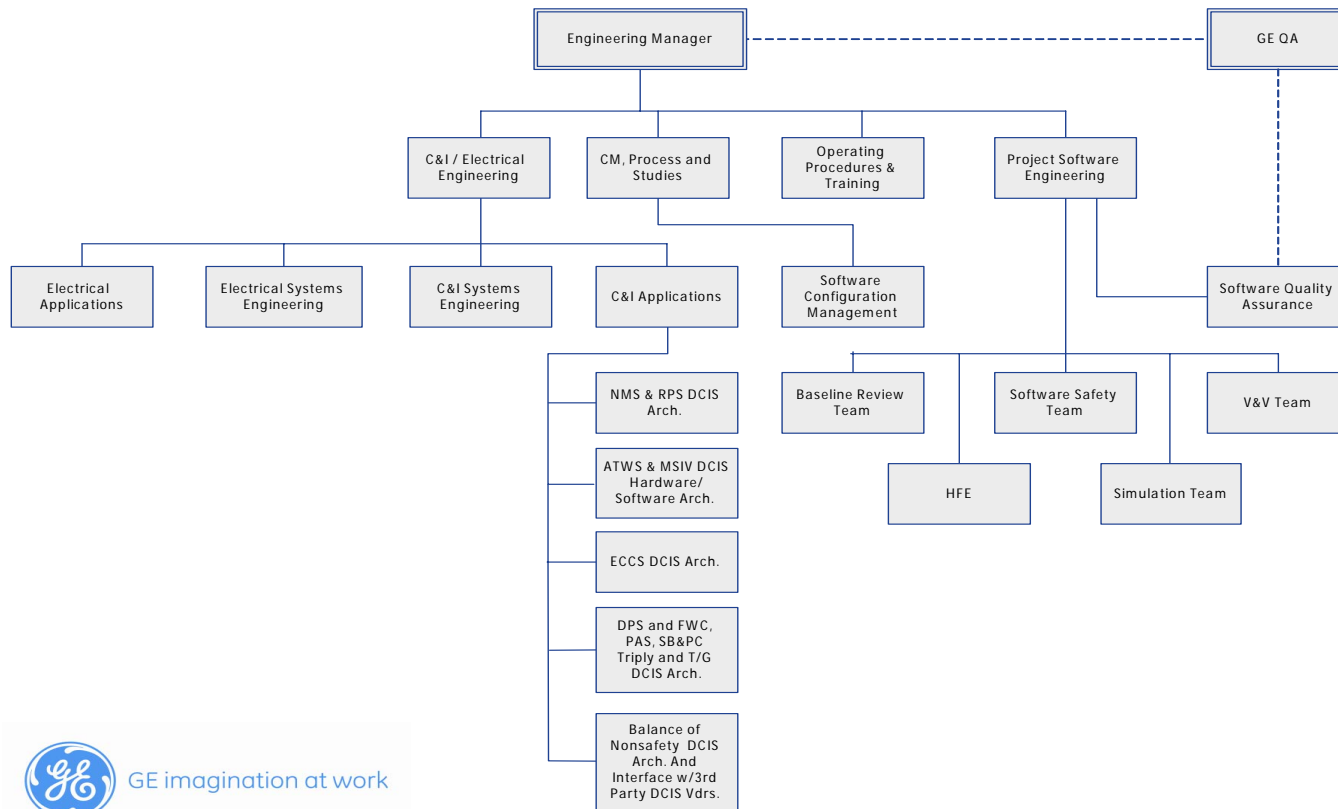
- Proprietary Discussions
 - DCIS
 - Software

N-2 Problem Statement

Currently all ESF/ECCS valves that are solenoid, AOV/NOV, or squib operated receive two sources of 250VDC 1E divisional power (Figures 1 and 3). This power is normally supplied via battery chargers with 250VDC 1E battery backup. All ESF/ECCS and containment isolation valves that are motor operated are powered from the same battery backed chargers through inverters. Each MOV, by its inherent design, only can be powered by one source of power. In this current configuration, the plant must enter a Technical Specification Action Statement (TSAS) to perform 1E battery maintenance or surveillance on line. It is not possible to perform the requisite surveillances on the batteries, on line, within the LCO time window, thereby forcing the plant to perform these functions during outages. Customers have expressed their displeasure with this configuration.

ESBWR I&C SYSTEMS

ESBWR C&I and Electrical and Software Project Engineering



GE imagination at work



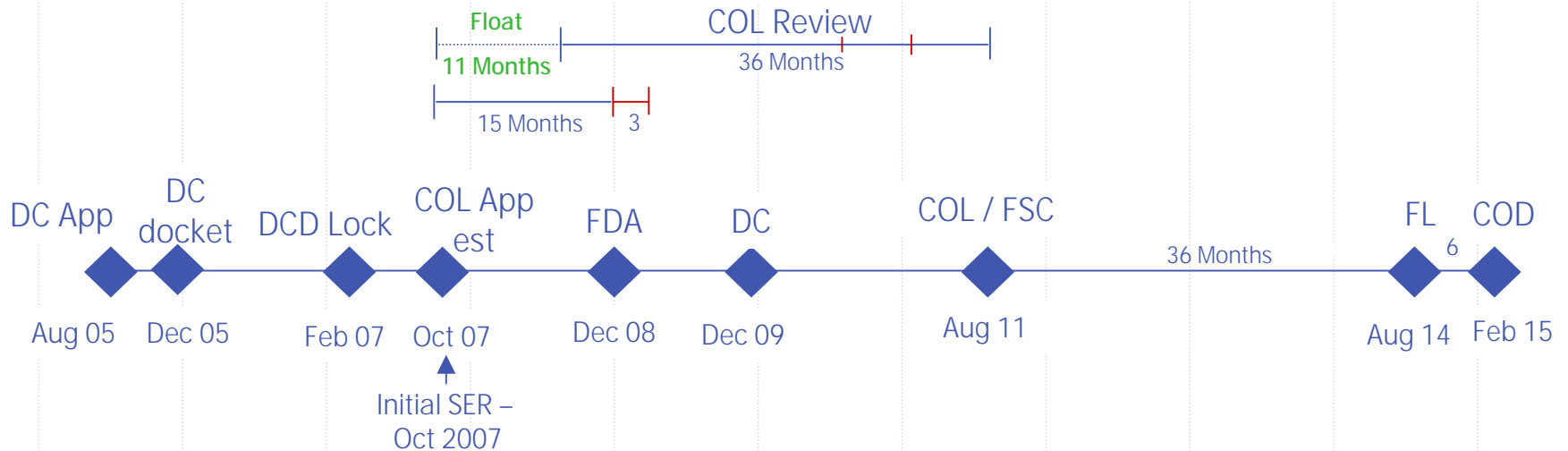
imagination at work

Backup

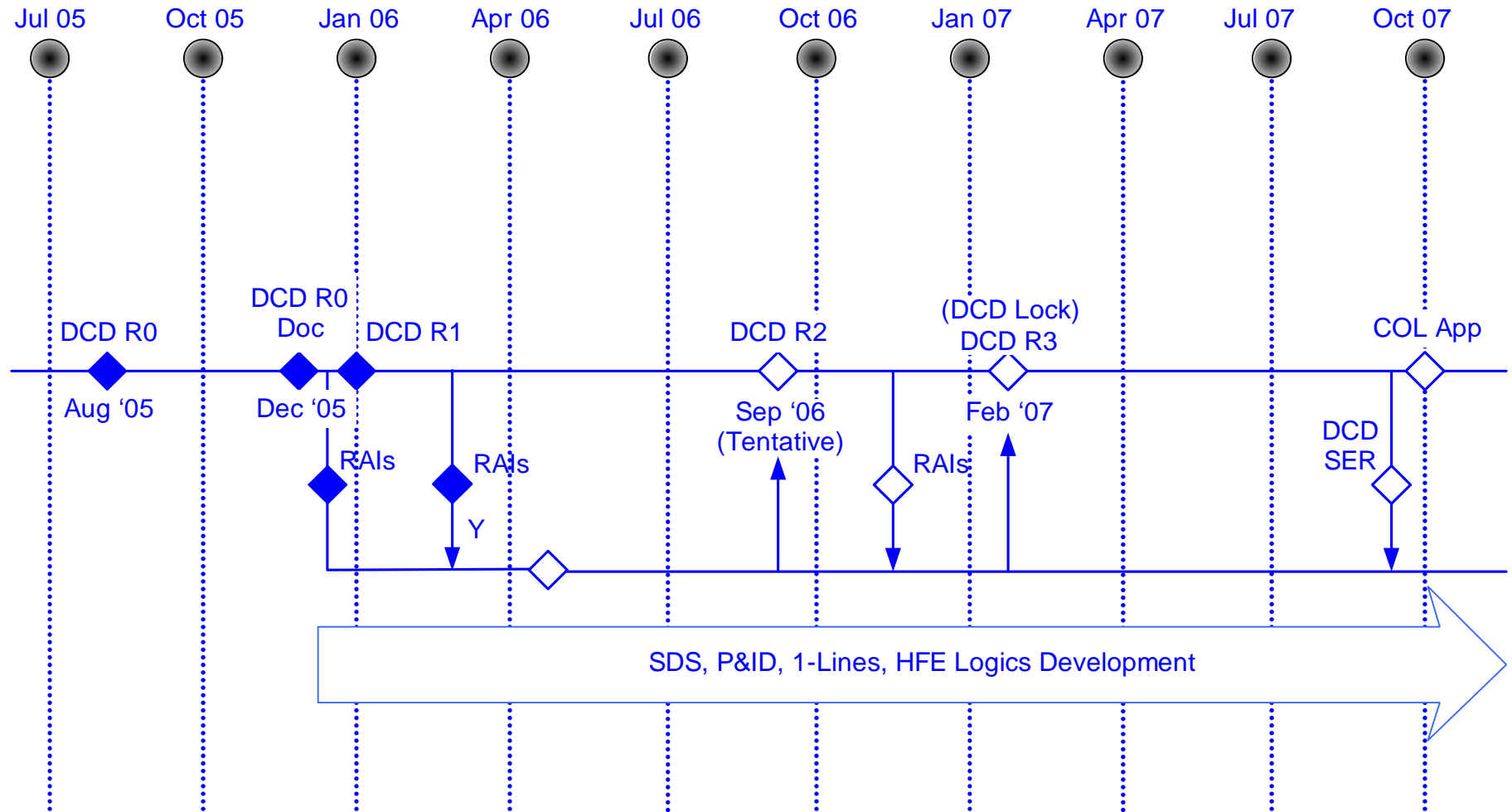
ESBWR Schedule



Schedule with 36 mo ESBWR FDA NRC Review



ESBWR Certification Schedule



Regulatory Interactions

Regulatory Interactions

- RAIs Topics Currently Open
 - > 7.0-2
 - > D3 Report

C & I Open RAIs

RAI Number	Summary	Resolution	Schedule
7.0-2	For any ESBWR application software developed by GE please provide the following software life-cycle documents: <ul style="list-style-type: none">- Requirements Definition- Integration Plan- Test Plan	To be discussed at NRC Meeting on July 27, 2006	TBD
7.8-1	In DCD section 7.8, describe the diverse I&C system characteristics. The DCD also should identify which accidents are covered by the diverse I&C systems.	RAI 7.8-1 submitted with reference to D3 Report forthcoming.	D3 Report – July 2006

C & I Open RAIs cont'd

RAI Number	Summary	Resolution	Schedule

HFE Open RAIs

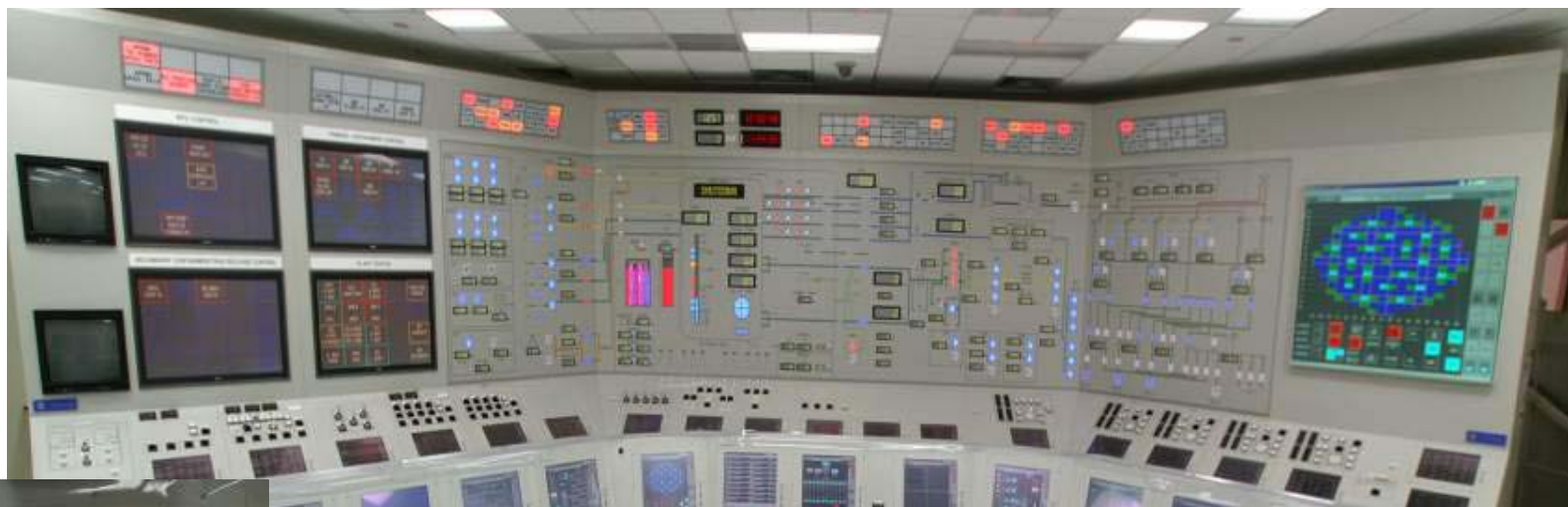
RAI Number	Summary	Resolution	Schedule

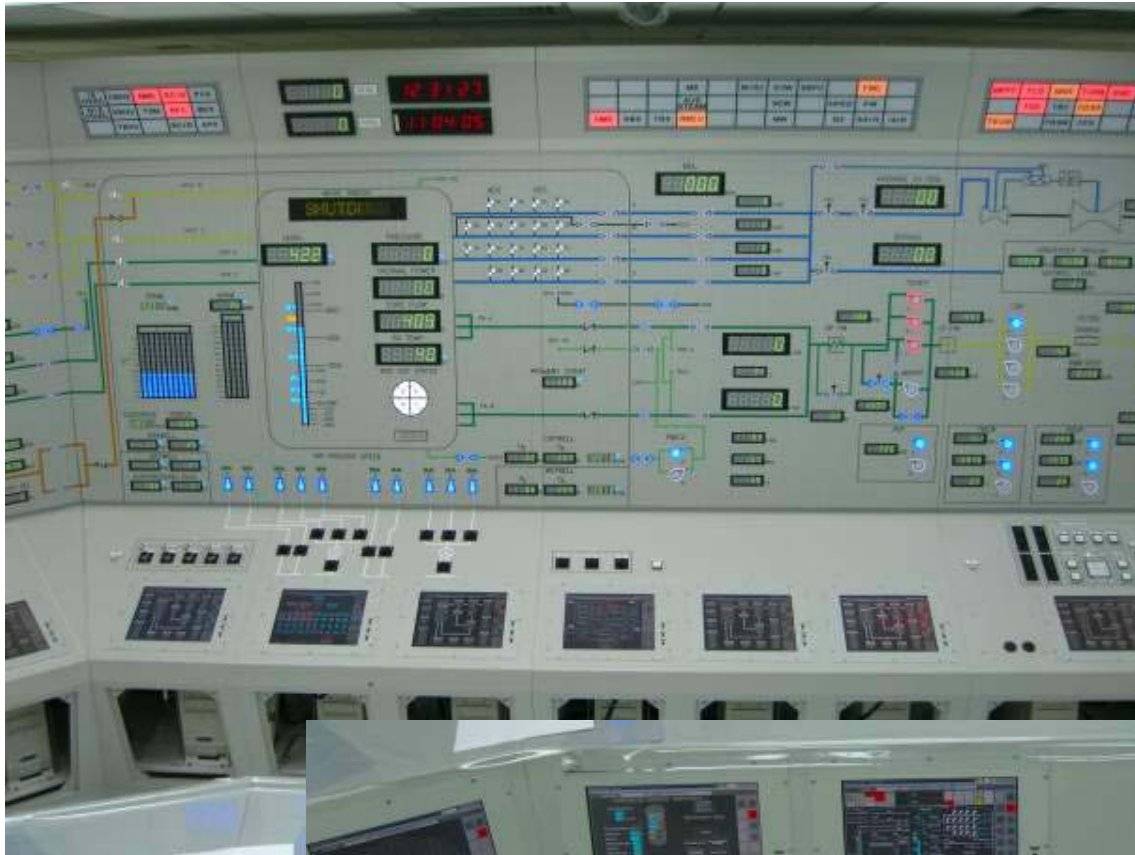
Challenges

Challenges

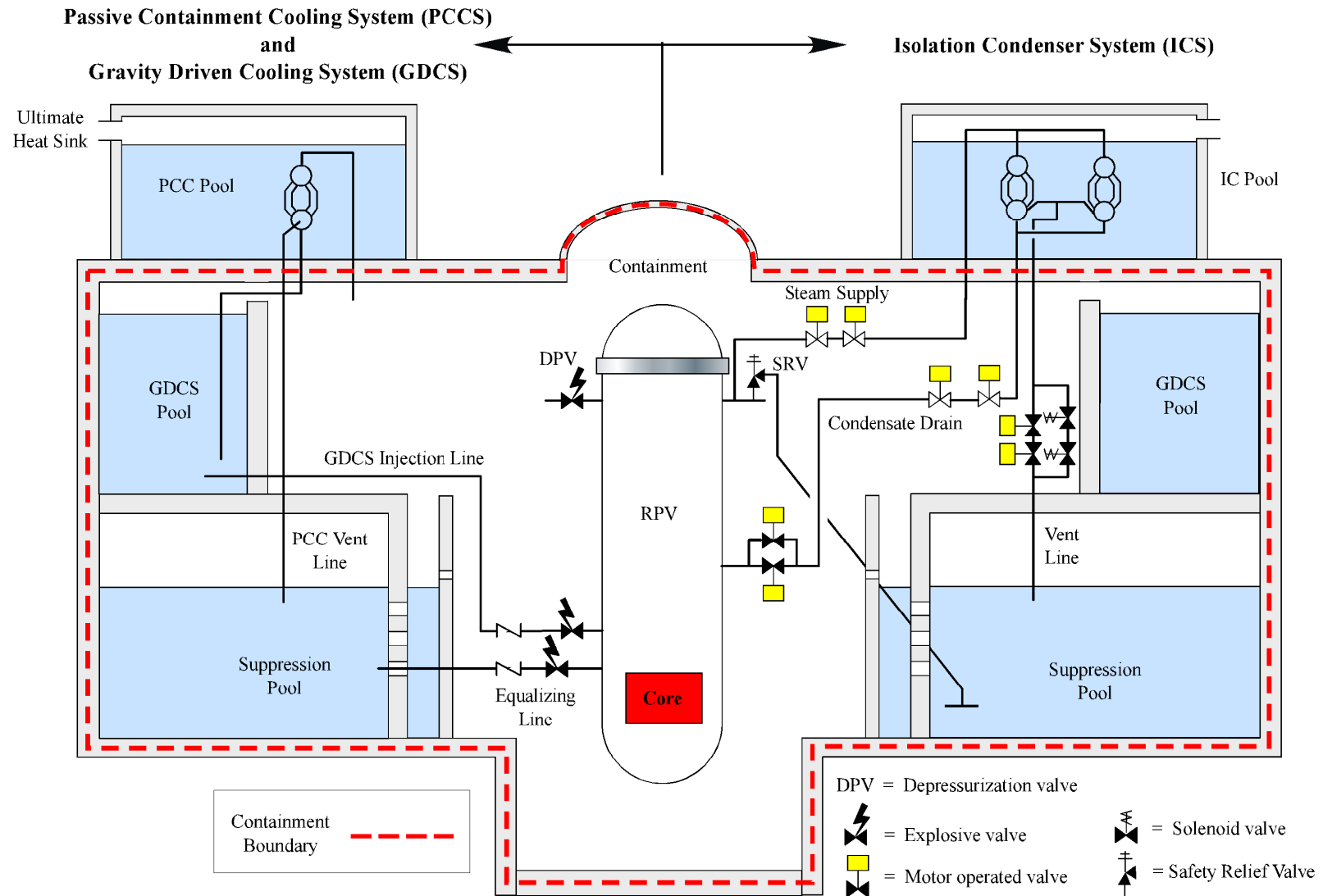
Design Completeness Examples

Control Room HFE and V&V

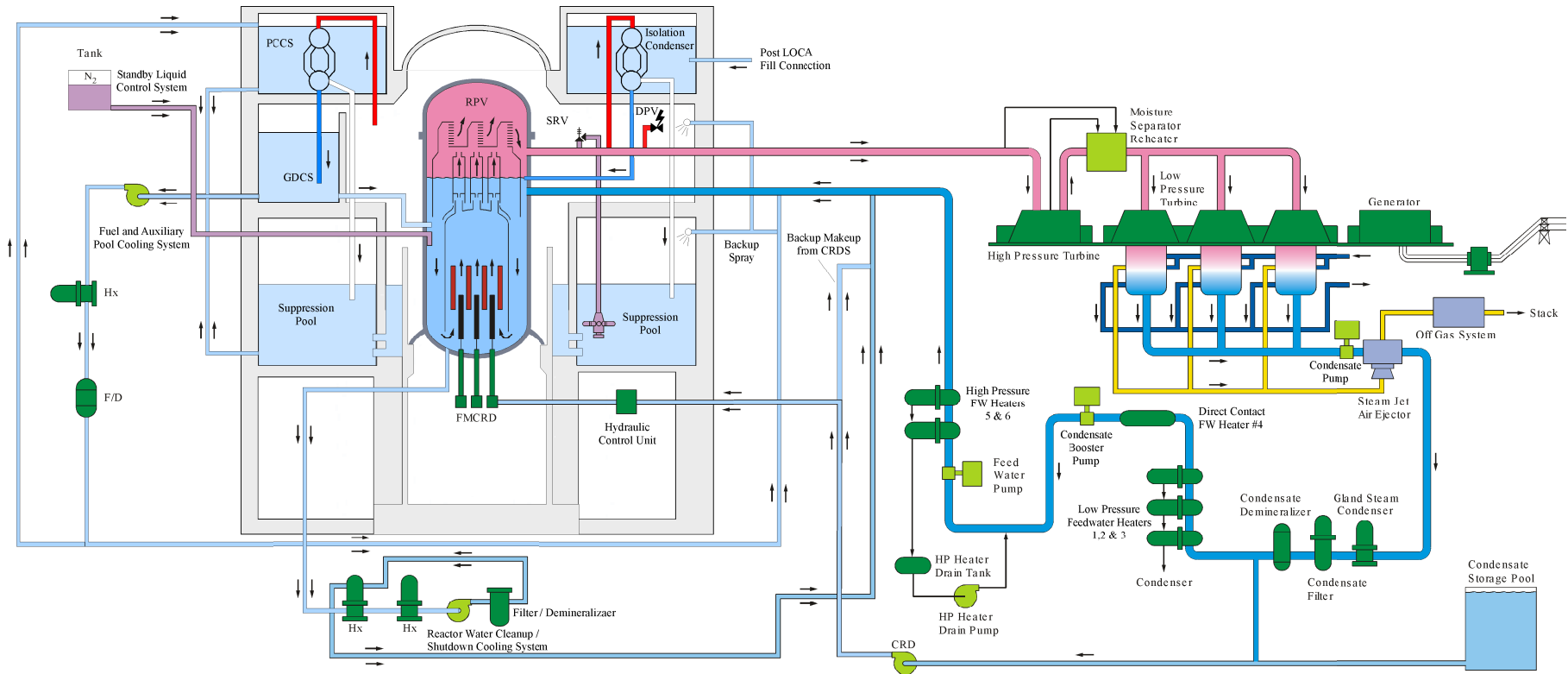




ESBWR Passive Safety ...



Simplification...



Plant design reduces operator challenges – direct cycle with major simplifications

ESBWR COL Schedule



COL Preparation Complete - Sept 07

NRC approved parallel path enables COD by 2015