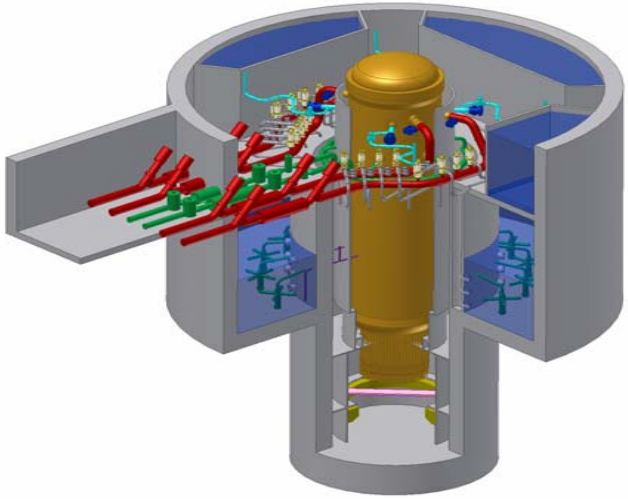
Presentation to
Nuclear Regulatory Commission



Summary
ESBWR Design Control Document, Tier 2
Chapter 7
Instrumentation And Control Systems

September 28, 2005

imagination at work

Summary of DCD Chapter 7 Content

- Description of chapter table of content organized according to NUREG-0800 SRP Chapter 7 guidelines

- Description includes all major ESBWR I&C systems of safety-related systems and major nonsafety systems important to plant safety and operation. Contents cover:

  1) Design Basis – system safety-related and nonsafety-related functional requirements & bases
  2) System Description – system and subsystem function descriptions including architect and arrangement, major protection and control logic functions, interfaces, etc.
  3) Safety Evaluation – compliance summary description to all pertinent regulations as called out in SRP Chapter 7 Table 7.1.
  4) Test & Inspection Requirements – system function test and inspection requirements
  5) Instrumentation Requirements – special instrumentation and control requirements including manual control requirements
  6) Simplified functional block diagrams to support text description

- The ESBWR I&C system design is based on and follows same design architect and system design concepts of ABWR digital I&C systems approved by NRC.

Summary Introduction of ESBWR I&C Systems

- **Safety-related protection systems**
  - **Safety System Logic Control (SSLC) (RPS, ESF, LD&IS)**
  - **Other safety-related systems (neutron & radiation monitorings, remote shutdown)**
- **Nonsafety-related (control) systems (RC&IS, FWCS, PAS, SBPC, etc.)**
- **Diverse Instrumentation & controls**
- **Data communication systems**

7.2 Reactor Trip System
- Reactor Protection System (RPS)
- Neutron Monitoring System (NMS)
- Suppression Pool Temperature Monitoring Subsystem (SPTMS)

7.3 Engineered Safety Features (ESF) Systems
- Emergency Core Cooling Systems (ECCS)
- Isolation Condenser System (ICS)
- Passive Containment Cooling System (PCCS)
- Leak Detection and Isolation System (LD&IS)
- Safety System Logic and Control System (SSLC)

7.4 Safety and Non-Safety Shutdown Systems
- Standby Liquid Control System (SLCS)
- Remote Shutdown System (RSS)
- Reactor Water Cleanup/Shutdown Cooling System (RWCU/SDC)
- Fuel and Auxiliary Pools Cooling System (FAPCS)
- Control Rod Drive System (CRD)

7.5 Safety-Related Information Systems
- General I&C Conformance to Regulatory Guide 1.97
- Containment Monitoring System (CMS)
- Process Radiation Monitoring System (PRMS)
- Area Radiation Monitoring System (ARMS)

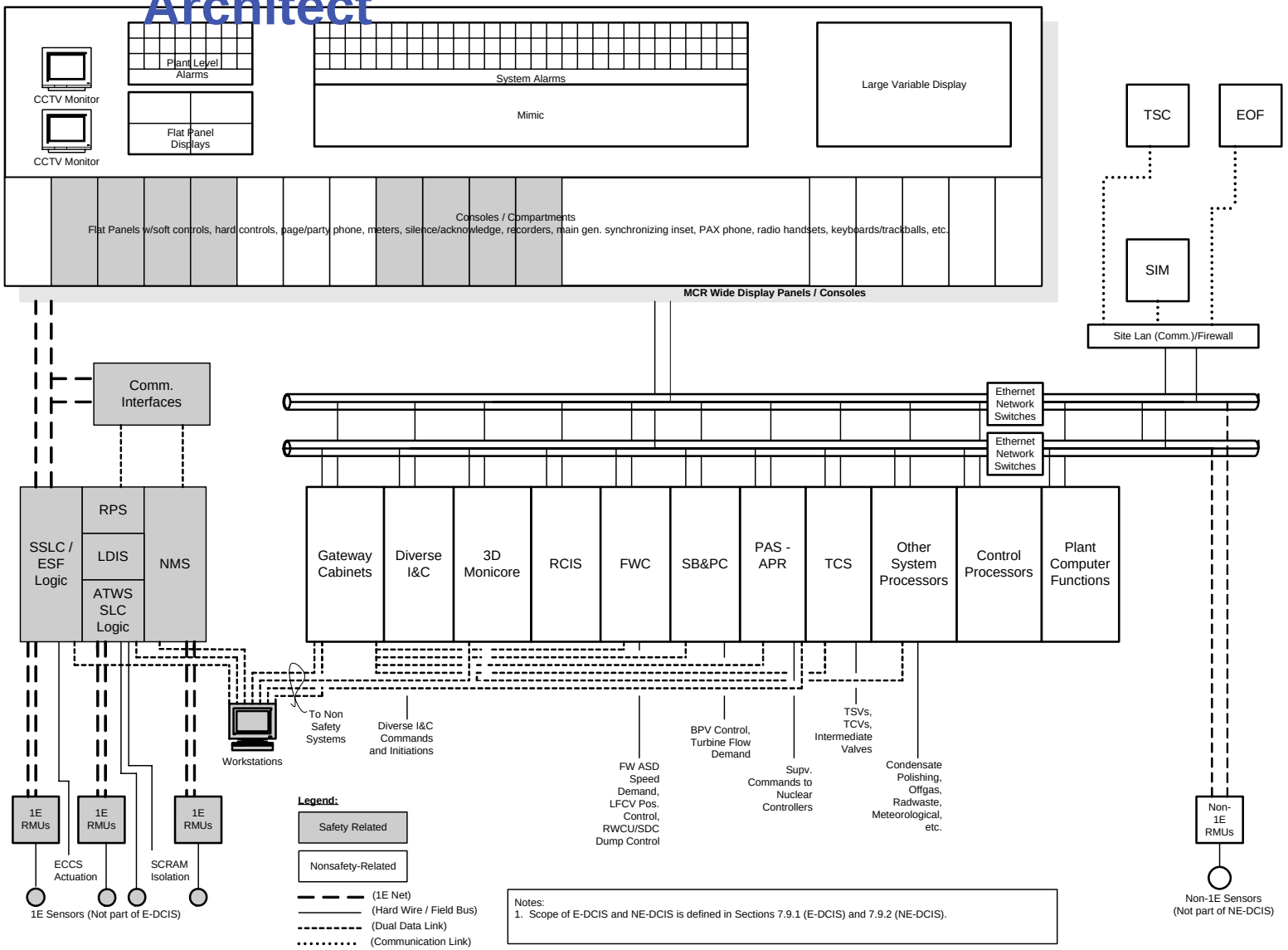
7.6 Interlock Systems
- Systems Interlock Function
- Interlock Systems

7.7 Control Systems
- Nuclear Boiler System Instrumentation
- Rod Control and Information System
- Feedwater Control System (FWCS)
- Plant Automation System (PAS)
- Steam Bypass and Pressure Control System (SBPC)
- Neutron Monitoring System - Nonsafety-related Subsystems
- Containment Inerting system

7.8 Diverse Instrumentation and Controls

7.9 Data Communication Systems

Overview of ESBWR I&C Systems Architect



Comparison of ESBWR I&C with ABWR I&C Systems

Reactor Trip System

- Reactor Protection System (RPS) ---------- ESBWR architecture same as ABWR
- Neutron Monitoring System (NMS) ---------- ESBWR architecture same as ABWR
- Suppression Pool Temperature Monitoring Subsystem (SPTMS) ------- ESBWR architecture same as ABWR

Engineered Safety Features (ESF) Systems

- Emergency Core Cooling Systems (ECCS) ---------- *ESBWR has passive systems, within SSLC*
- Isolation Condenser System (ICS) ---------- ICS logic within SSLC, ABWR has no ICS
- Passive Containment Cooling System (PCCS) ---------- No I&C
- Leak Detection and Isolation System (LD&IS) ---------- ESBWR architecture same as ABWR (within SSLC)
- Safety System Logic and Control System (SSLC) ---------- ESBWR architecture same as ABWR (platform)

Safety and Non-Safety Shutdown Systems

- Standby Liquid Control System (SLCS) ---------- ESBWR architecture same as ABWR
- Remote Shutdown System (RSS) ---------- *ESBWR is digital I&C, safety-related*

Safety-Related Information Systems

- General I&C Conformance to Regulatory Guide 1.97 ---------- ESBWR architecture same as ABWR
- Containment Monitoring System (CMS) ---------- ESBWR architecture same as ABWR
- Process Radiation Monitoring System (PRMS) ---------- ESBWR architecture same as ABWR
- Area Radiation Monitoring System (ARMS) ---------- ESBWR architecture same as ABWR

Control Systems

- Nuclear Boiler System Instrumentation ---------- ESBWR architecture same as ABWR
- Rod Control and Information System ---------- ESBWR architecture same as ABWR
- Feedwater Control System (FWCS) ---------- ESBWR architecture same as ABWR
- Plant Automation System (PAS) ---------- ESBWR architecture same as ABWR (APRS + PGCS)
- Steam Bypass and Pressure Control System (SBPC) ---------- ESBWR architecture same as ABWR
- Neutron Monitoring System - Nonsafety-related Subsystems ----- *ESBWR architecture same as ABWR, except AFIP*
- Containment Inerting system ---------- ESBWR architecture same as ABWR

Diverse Instrumentation and Controls ---------- *New system for ESBWR, except ATWS/SLCS/ARI logic*

Data Communication Systems ---------- ESBWR architecture same as ABWR

Most ESBWR I&C systems share same design/architect concept as ABWR I&C

Overview of Major ESBWR I&C Systems

Safety-Related Systems

- Safety System Logic and Control System (SSLC) Framework
    - Reactor Protection System (RPS)
    - Engineering Safety Features (ESF) Logics
    - Standby Liquid Control System (SLCS) Logic (Diverse Shutdown Function)
    - Leak Detection and Isolation System (LD&IS) Logic
- Neutron Monitoring System (NMS)
- Remote Shutdown System (RSS)
- Radiation Monitoring Systems (PRMS, ARMS)

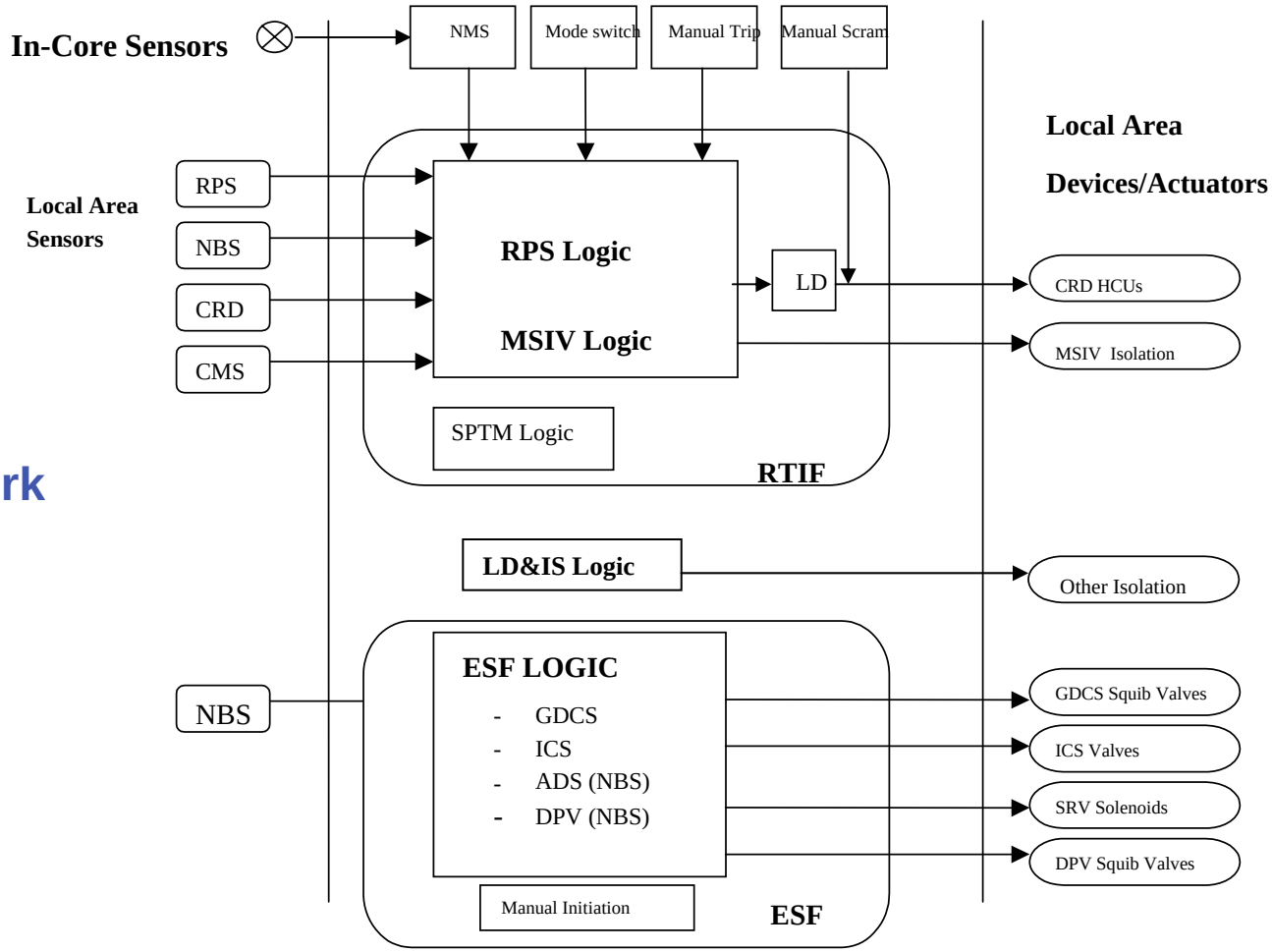
Control Systems

- Nuclear Boiler System Instrumentation
- Rod Control and Information System
- Feedwater Control System (FWCS)
- Plant Automation System (PAS)
- Steam Bypass and Pressure Control System (SBPC)
- Neutron Monitoring System - Nonsafety-related Subsystems

Diverse Instrumentation and Controls

Data Communication Systems

SSLC System Framework



Note:
1Local area sensors include:
RPS: turbine stop valve position, turbine CV oil pressure, turbine bypass valve position
NBS: MSIV position (for RTIF only), RPV pressure, water level
CRD: HCU accumulator charging water header pressure
CMS: drywell pressure
2Manual Scram interrupts power to the circuit.
3LD&IS resides in SSLC and shares sensors inputs with RTIP and ESF

(DCD Figure 7-3.5)

ESBWR Safety System Logic Control (SSLC) Framework

- Each Subsystem has 4 digital safety-related Divisions (Class 1E)
- RPS is independent and separate from ESF Logics

Reactor Protection System

- Based on ABWR design
  - 2/4 logic
  - Fail safe
  - Deterministic
  - Diverse from ECCS
- Any two unbypassed same parameters exceeding limits always cause a scram with:
  - Any single logic failure
  - Any division of sensors bypass status
  - Any division of logic bypass status (independent from sensor bypass)
  - Any single power failure
- Each division makes a per parameter trip decision
- Each division makes a 2/4 per parameter decision to scram
- Each division informs other divisions of divisional data (via communication module)
- Two divisions of load drivers – each driven by four divisional trip outputs – control HCU scram solenoids

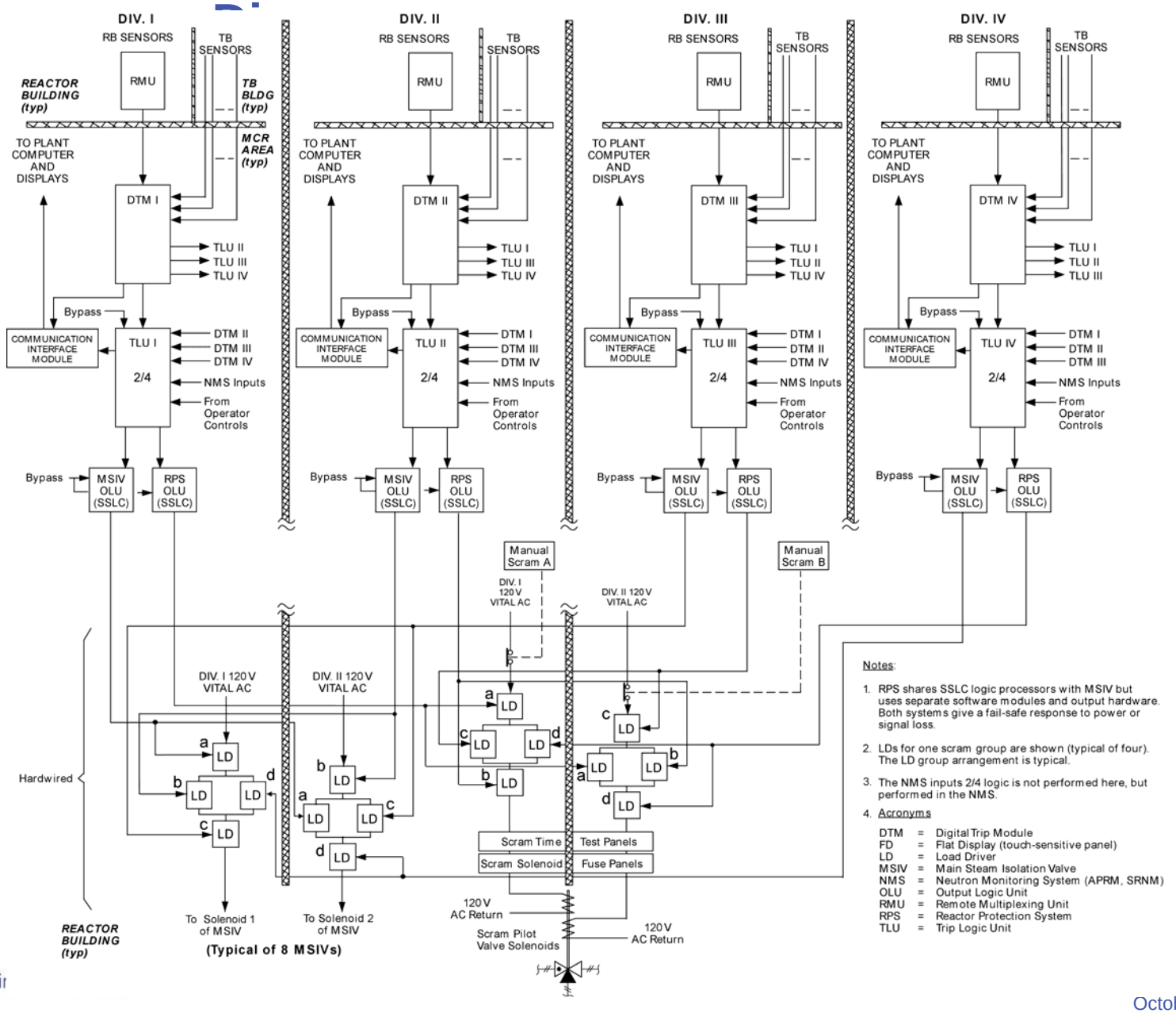
ESBWR Safety System Logic Control (SSLC) Framework

Engineering Safety Features Logics (SSLC/ESF)

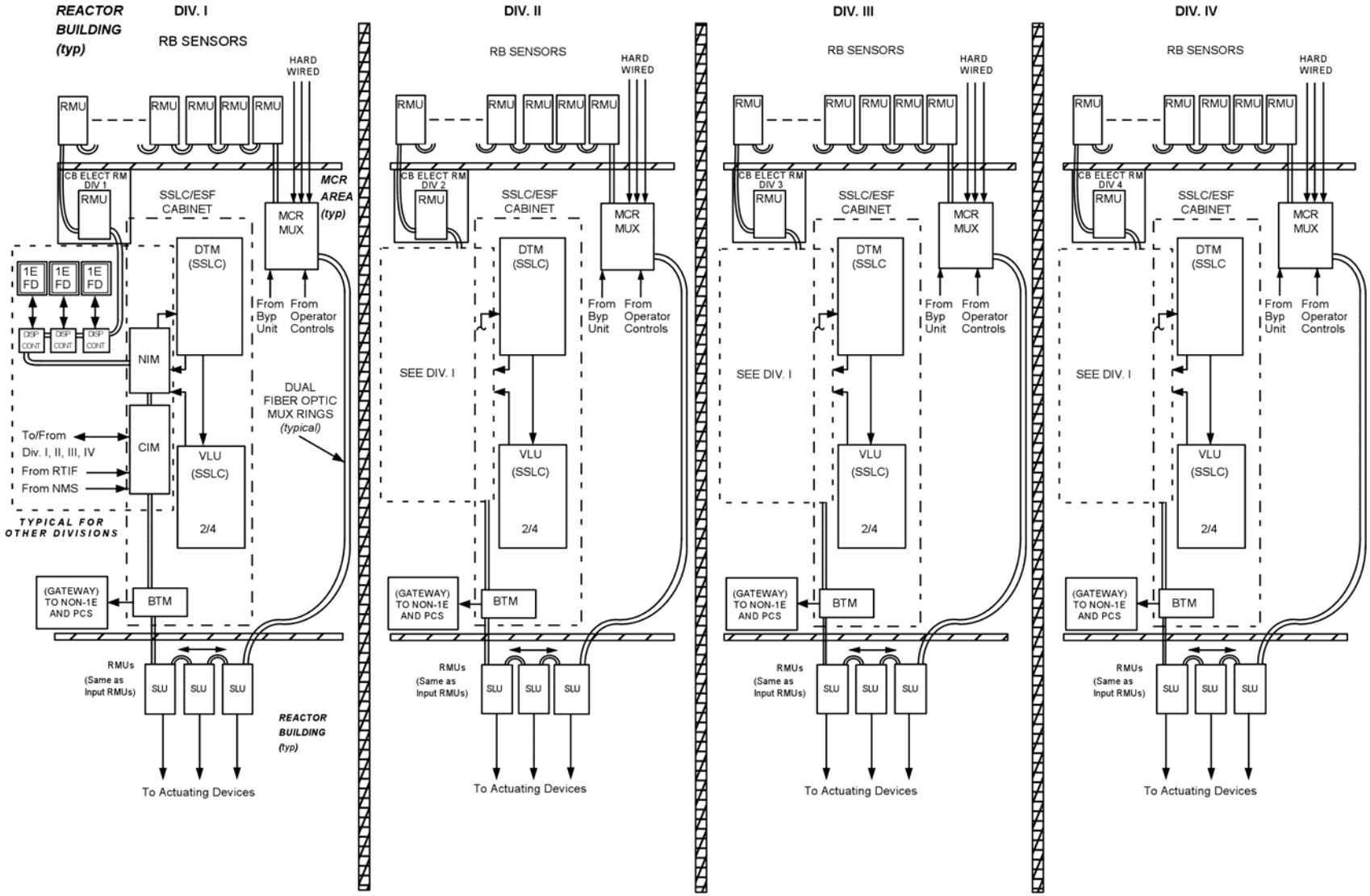
- Based on ABWR design
  - 2/4 logic
  - Fail As-Is
  - Deterministic
  - Diverse from RPS
- Any two unbypassed same parameters exceeding limits always initiate ECCS with:
  - Any single logic failure
  - Any division of sensors bypass status
  - Any single power failure
- Each division makes a per parameter trip decision
- Each division makes a dual 2/4 per parameter decision to initiate
- Each divisional redundant 2/4 logic drives an output load driver
- Each division informs other divisions of divisional data (via communication module)
- Redundant load drivers per division wired in series
- Design is single failure proof (logic and power) to actuate when required
- Design is single failure proof to prevent inadvertent actuation
- Any one of two power divisions can actuate one of the two actuators (squib valve or SRV solenoid) and open the valve

RPS Functional Block

(DCD Figure 7.2-1)

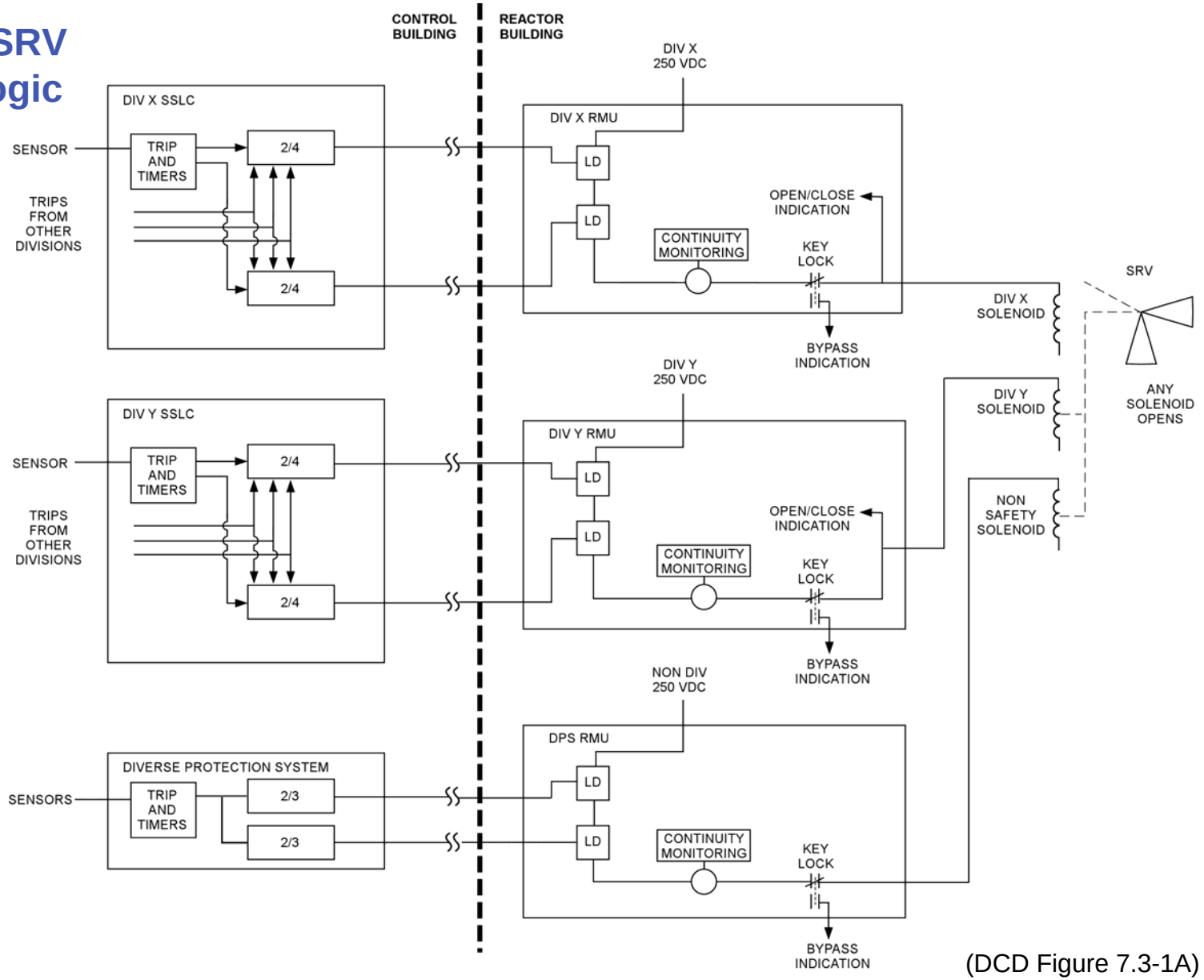


SSLC/ESF Functional Block Diagram (DCD Figure 7.3-4)



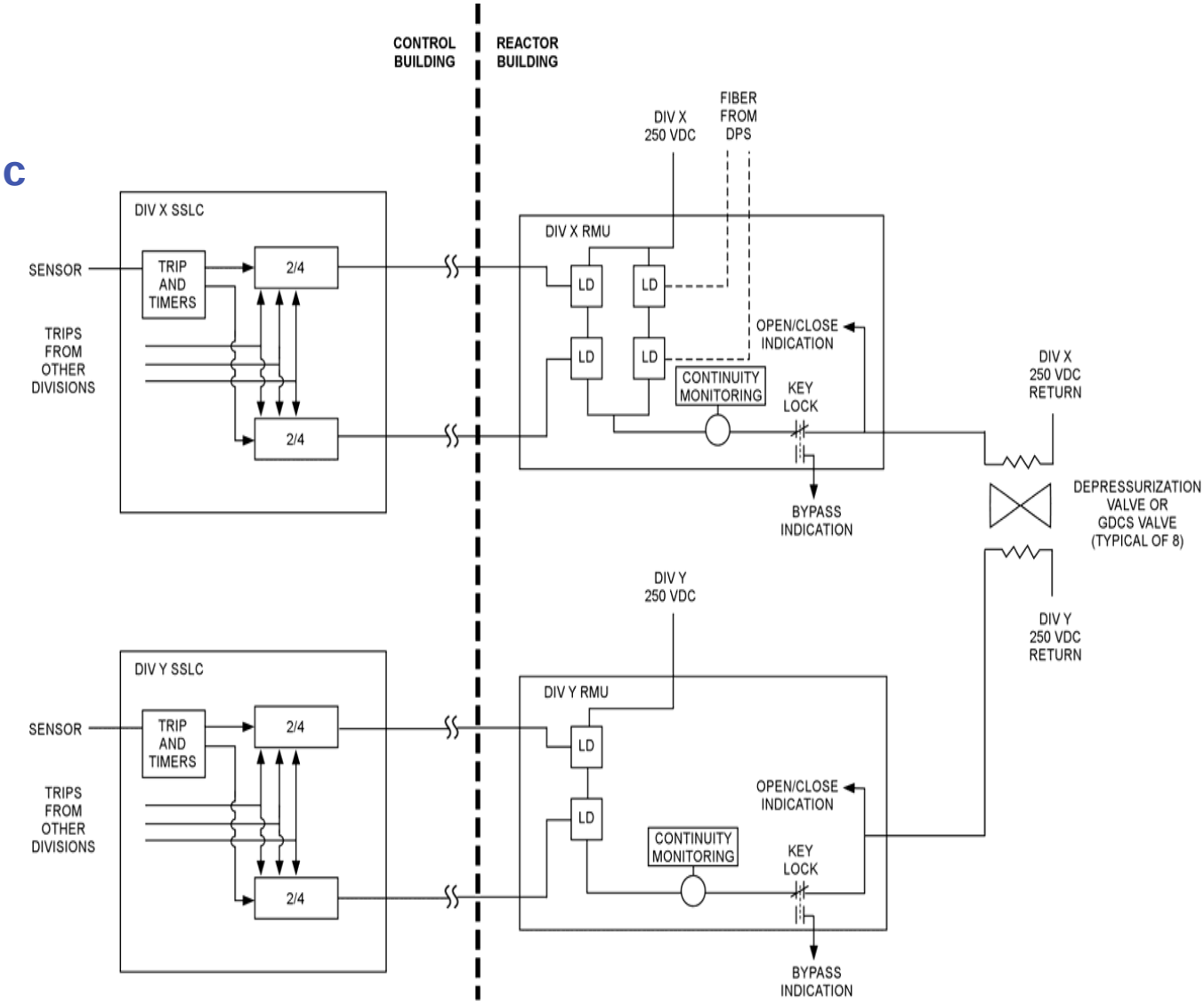
The VLU contains dual redundant 2/4 logics with two independent trip outputs

SSLC/ESF SRV Initiation Logic



(DCD Figure 7.3-1A)

SSLC/ESF DPV/GDCS Initiation Logic



(DCD Figure 7.3-1B)

Other Major ESBWR Safety-Related Systems

Neutron Monitoring System (NMS)

> Startup Range Neutron Monitor (SRNM)

– 12 SRNM detector assemblies assigned in 4 divisions

– Each divisional 2/4 logic final trip output sent to each of 4 RPS divisions

> Power Range Neutron Monitor (PRNM)

– LPRM: 64 LPRM assemblies with 4 detectors per assembly

– APRM: 256 LPRM detectors evenly assigned in 4 APRMs to represent average core power

– Each divisional 2/4 logic final trip output sent to each of 4 RPS divisions

Remote Shutdown System (RSS)

> Safety-related digital dual channels

> All safety and nonsafety systems MMI available to the operator from RSS

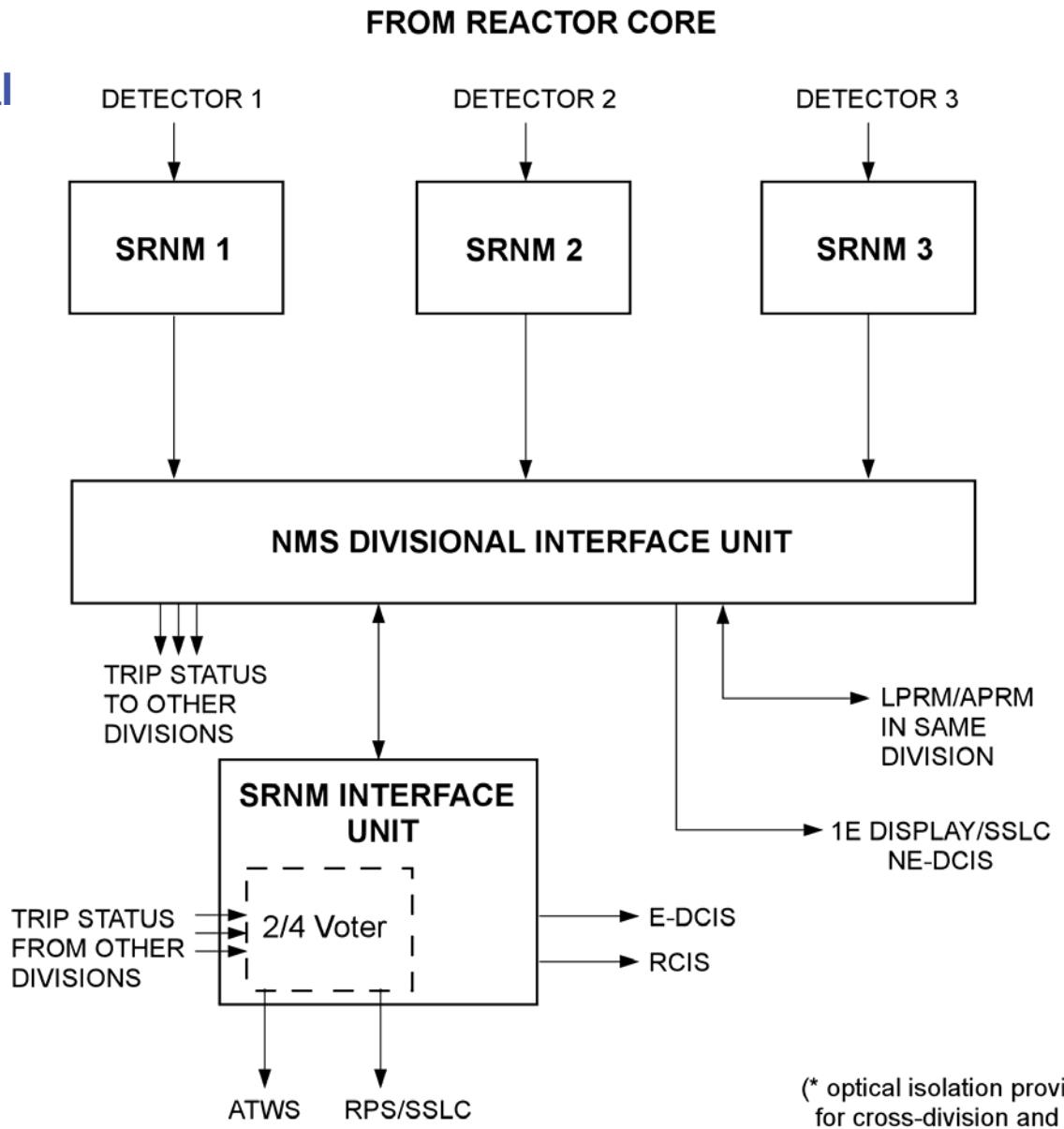
–If offsite power is available, normal heat sinks and injection systems can be operated

–If diesels are available the investment protection equipment can be operated

–If no AC power is available, safety systems (IC, ADS, GDCS etc) can be operated

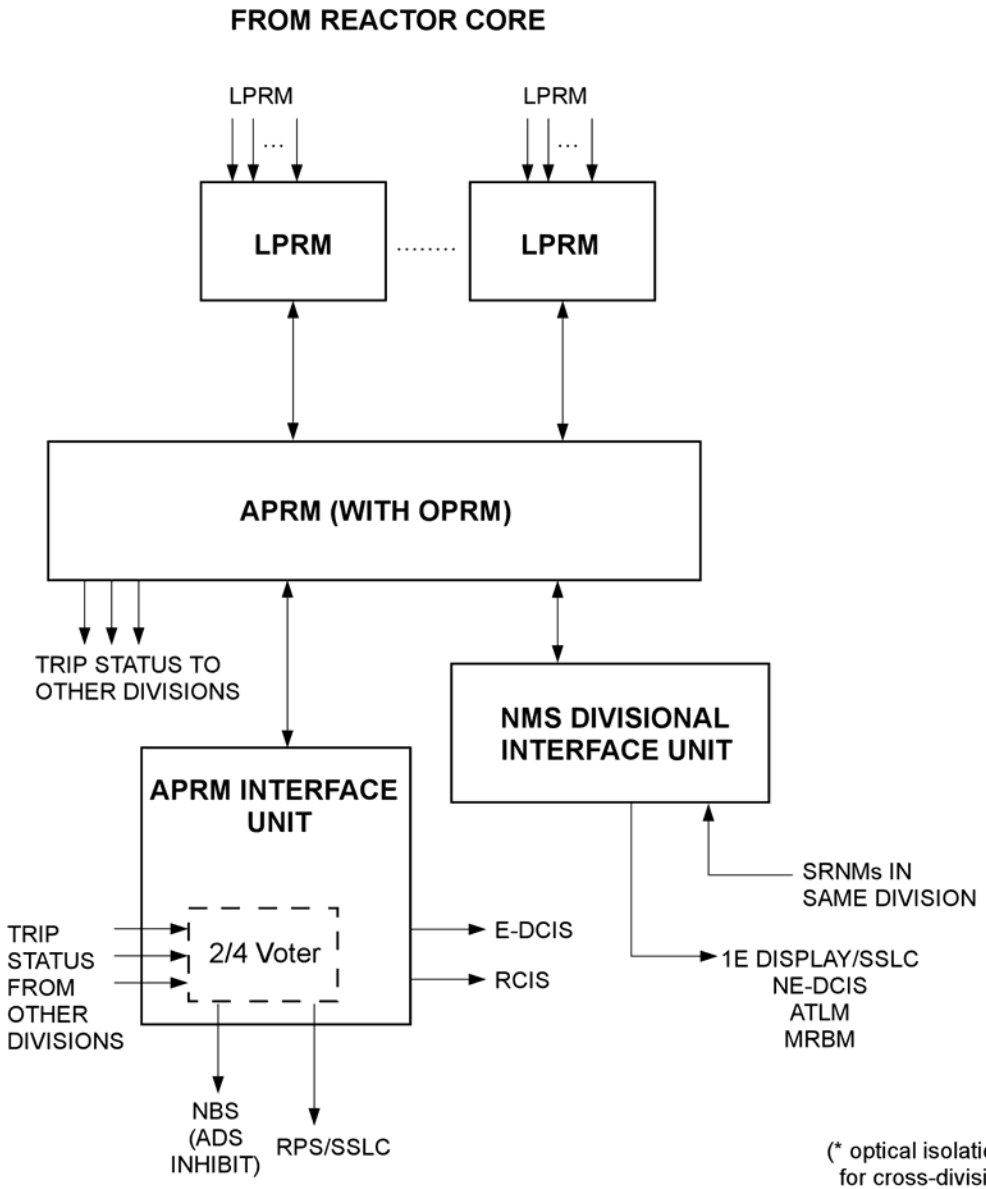
> Automatic and manual RSS operation does not depend on main control room operation after it has been evacuated

SRNM Functional Block Diagram



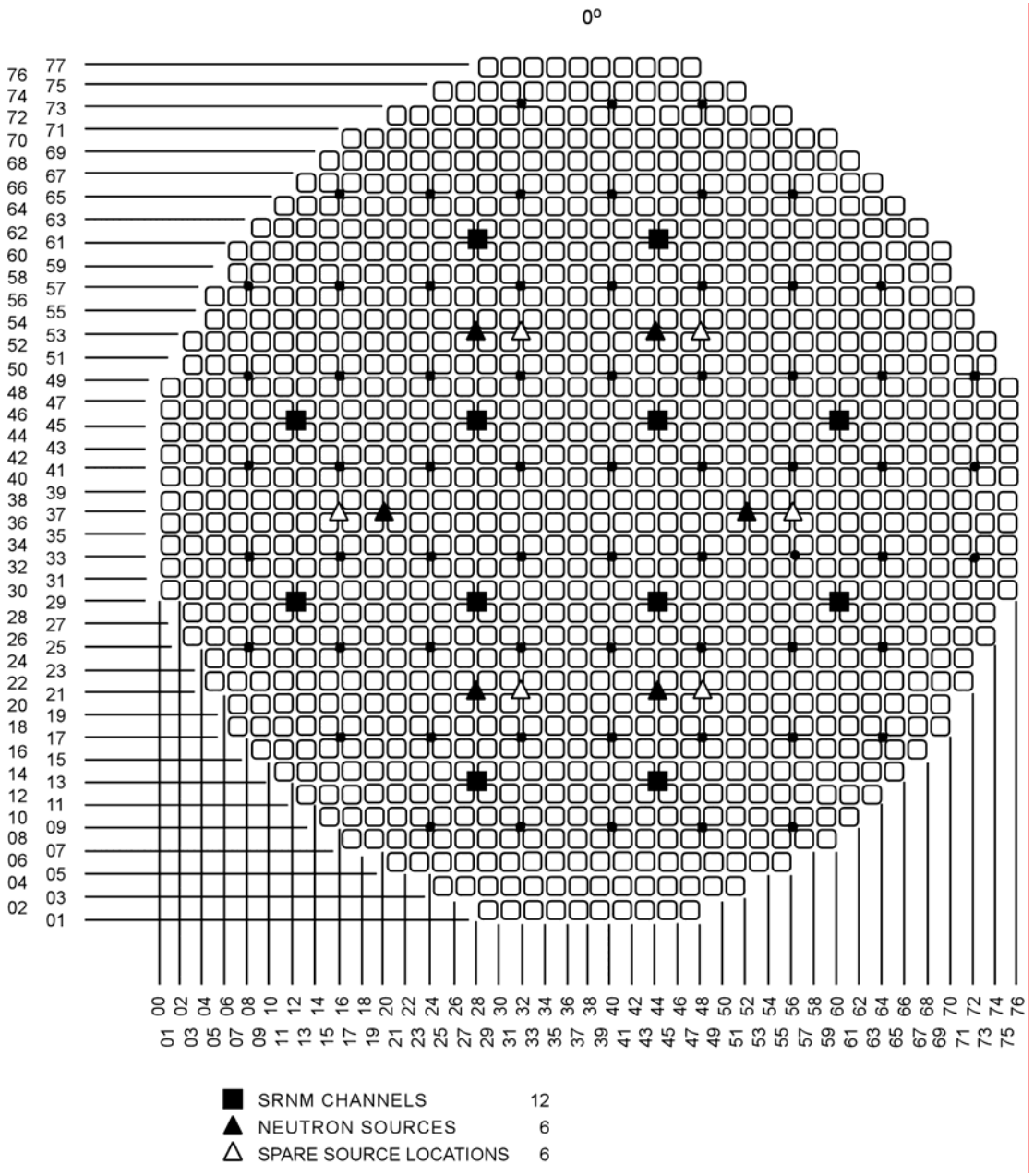
(DCD Figure 7.2-4)

PRNM Functional Block Diagram



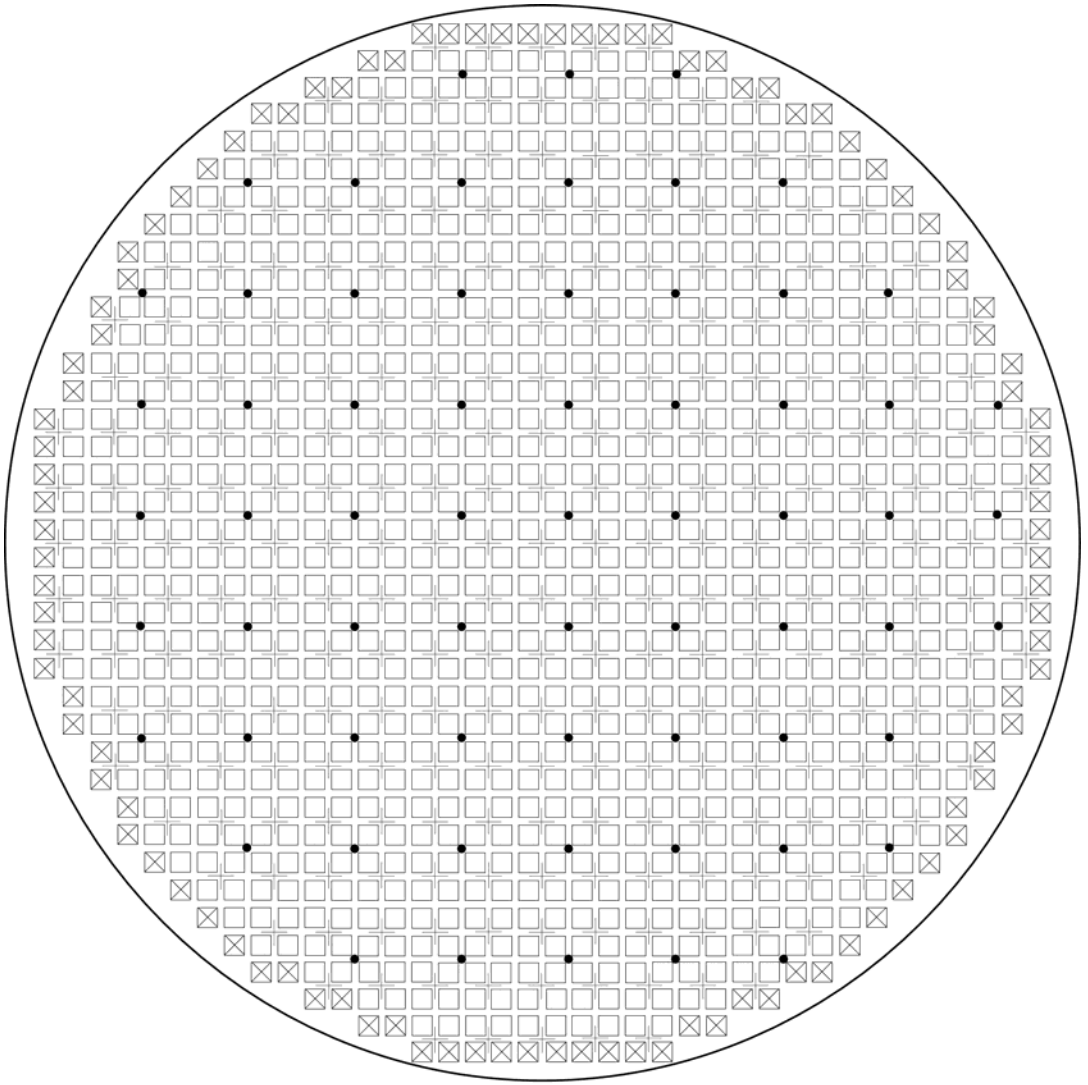
(DCD Figure 7.2-5)

SRNM Locations in Core



(DCD Figure 7.2-6)

LPRM Locations in Core

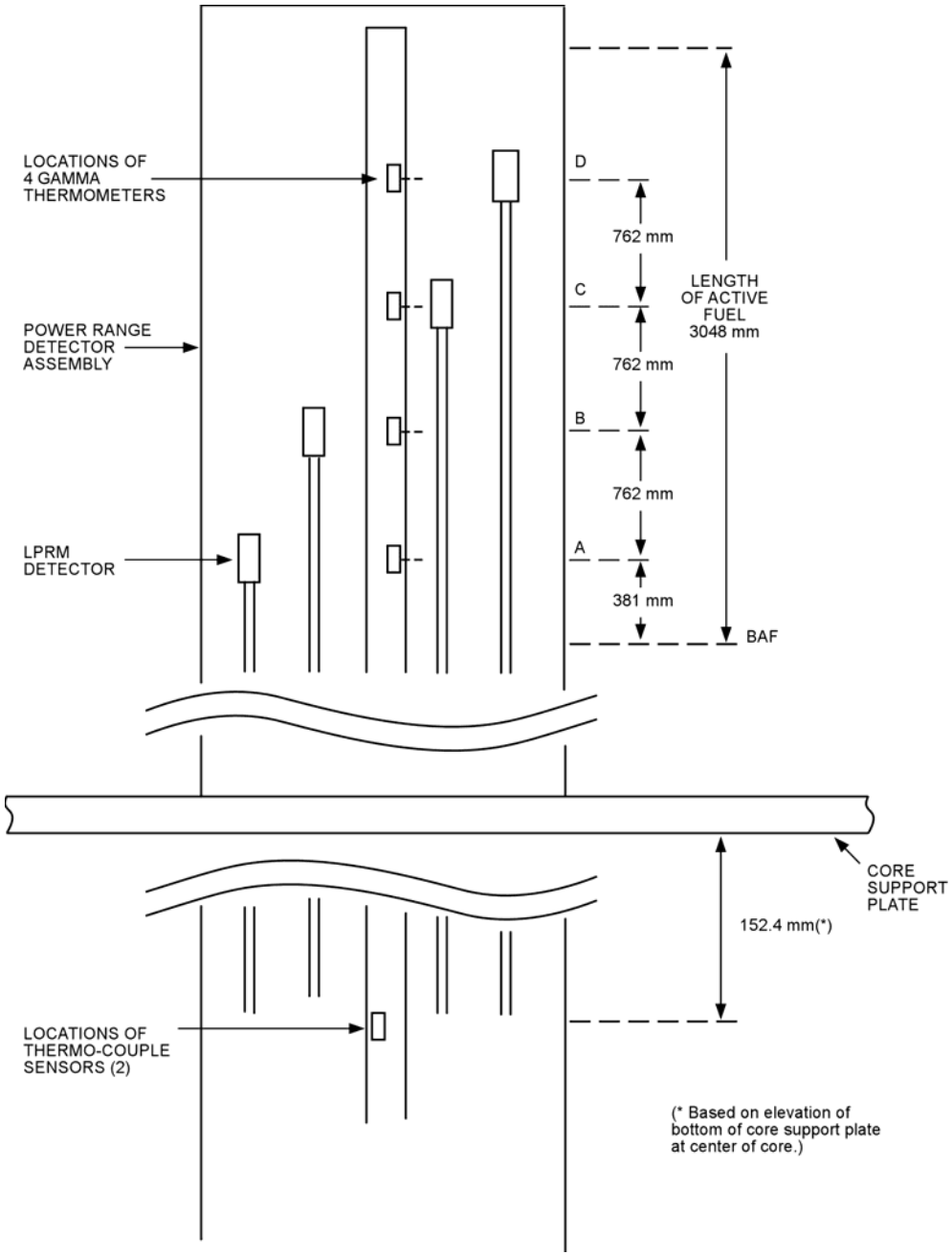


Central Region Bundle	1028	Control Rod	269
Peripheral Region Bundle	104	LPRM	64
Total	1132		

ESBWR Core Map

(DCD Figure 7.2-7)

Illustration of LPRM Assembly – Axial Locations



(DCD Figure 7.2-8)

Overview of ESBWR Major Control Systems

Nuclear Boiler System Instrumentation

> Safety-related and Nonsafety-related sensors (RPV pressure and water level) for diverse application

– Independent for RPS, ECCS, and control systems

> Safety Relief Valves (SRVs) and Depressurization Valves (DPVs) for ECCS Application

– Initiation logics within SSLC

Rod Control and Information System (RC&IS)

> Control of control rods movement for reactor power level control.

> Nonsafety-related dual independent and separate channels.

> The automated thermal limit monitor (ATLM) automatically enforces fuel operating thermal limits minimum critical power ratio (MCPR) and maximum linear heat generation rate (MLHGR).

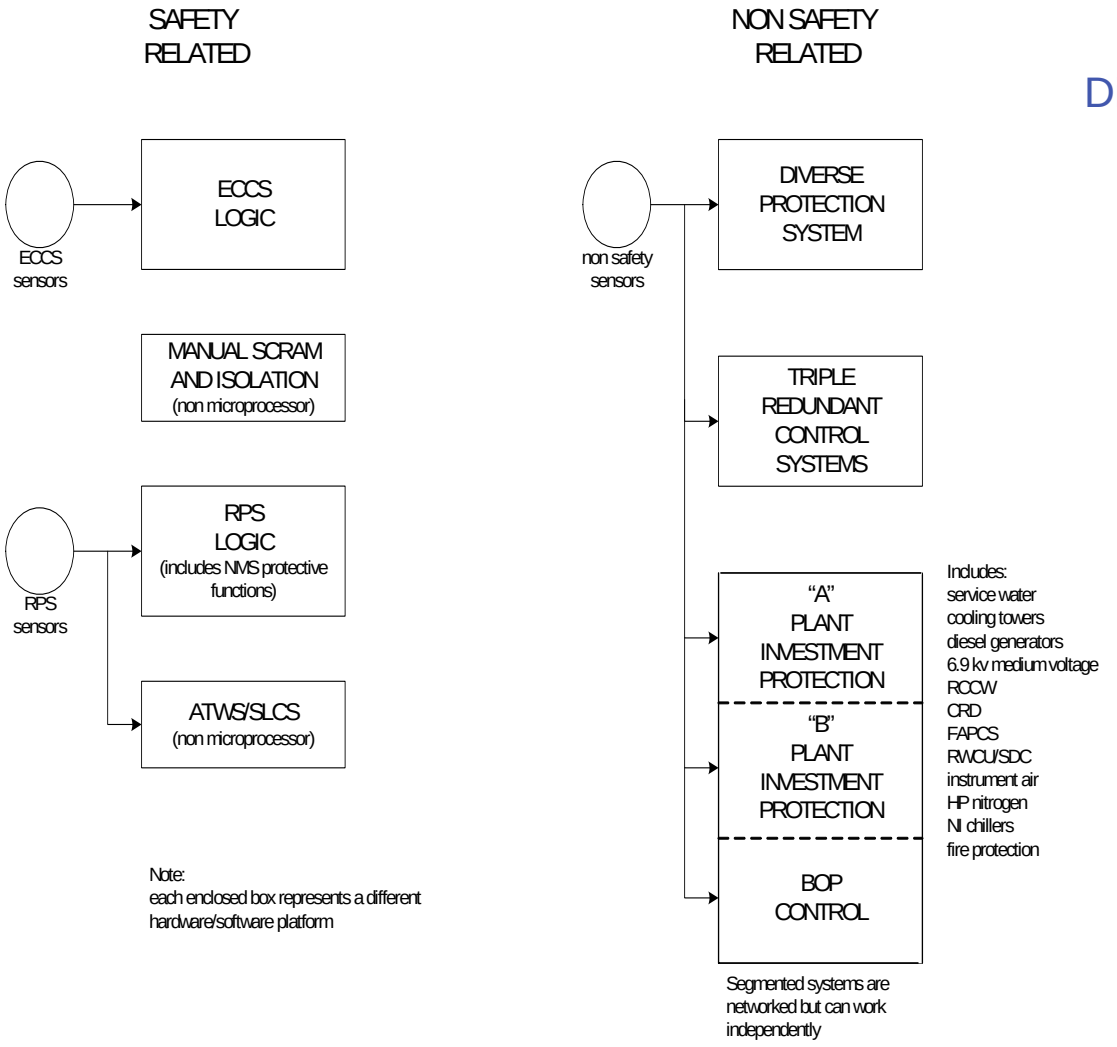
> Control rod position information display to plant operator in main control room

Feedwater Control System (FWCS)

> Triplicated redundant nonsafety-related I&C system.

> Automatically or manually regulates the feedwater flow into the reactor pressure vessel to maintain predetermined water level limits during transients and normal plant operating modes.

Diversity in Sensors & Equipment Application



Diversity (sensors & equipment)

- Manual scram, isolation
- Four divisions of RPS
- Four divisions on non microprocessor based ATWS/SLCS
- Four divisions of ECCS
- Triple redundant controller for diverse RPS and diverse ECCS
- Triple redundant controllers for major nuclear control functions
- Redundant controllers for investment protection and BOP control

Overview of ESBWR Major Control Systems (Continued)

Plant Automation System (PAS)

> Automatic power regulation subsystem (APRS): Nonsafety-related I&C provides automatic startup/shutdown algorithms and controls, regulates reactivity during criticality control, provides heatup & pressurization control,

> Power generation control subsystem (PGCS): Nonsafety-related I&C regulates reactor power, and provides automatic power generation control during power operation.

System Bypass and Pressure Control System (SBPC)

> Triplicated redundant nonsafety-related I&C system

> Controls reactor pressure during plant startup, power generation and shutdown modes of operation, by directly controlling the turbine bypass and indirectly controlling turbine control valve position by sending pressure regulation demand signals to the Turbine Control System - Electro-Hydraulic Control.

Neutron Monitoring System – Nonsafety-Related Subsystems

> Automated Fixed In-core Probe (AFTIP) (that replaces TIP system)

– Fixed in-core Gamma Thermometer for local and core-wide power determination

> Multi-Channel Rod Block Monitor (MRBM)

– Multiple regional RBMs based on regional LPRM measurements

– Safety Limit MCPR Protection

– RBM algorithm has same design concept as BWR 5 RBM

– MRBM has same design as in ABWR

ESBWR PAS Automation Features

Automation

- Plant operation is automated:
  - From cold startup to rated power
  - Full power operation
  - From rated power operation to plant shutdown
- No safety-related RPS/ECCS or nonsafety rod block protection is lost in automation
- Any control rod block (I&C self-check failure) or operator decision can convert the plant operation to manual operation
- Reduces operator burden by carefully selected “breakpoints” requiring operator attention (“acknowledgment”) between automation sequences
- Control algorithms proven in ABWR
- Plant can optionally be remotely dispatched within operator set power and rate limits

Independence, Separation, Redundancy in ESBWR I&C

- Power
  - Each safety related I&C system has two power sources per division – one is Class 1E uninterruptible
    - Backed up by On Site Diesel
  - Each investment protection/BOP I&C system has two power sources
  - For above systems, either power source will support complete system function/operation
  - Triple redundant control systems have three power sources (load groups)
  - Safety-related systems powered for 24/72 hours by corresponding divisional batteries
- I&C
  - Safety-related systems with four independent/separate divisions
  - Diverse protection system is triply redundant
  - Turbine control, reactor pressure control, plant automation, reactor level control are triply redundant
  - Investment protection/BOP control is dual redundant

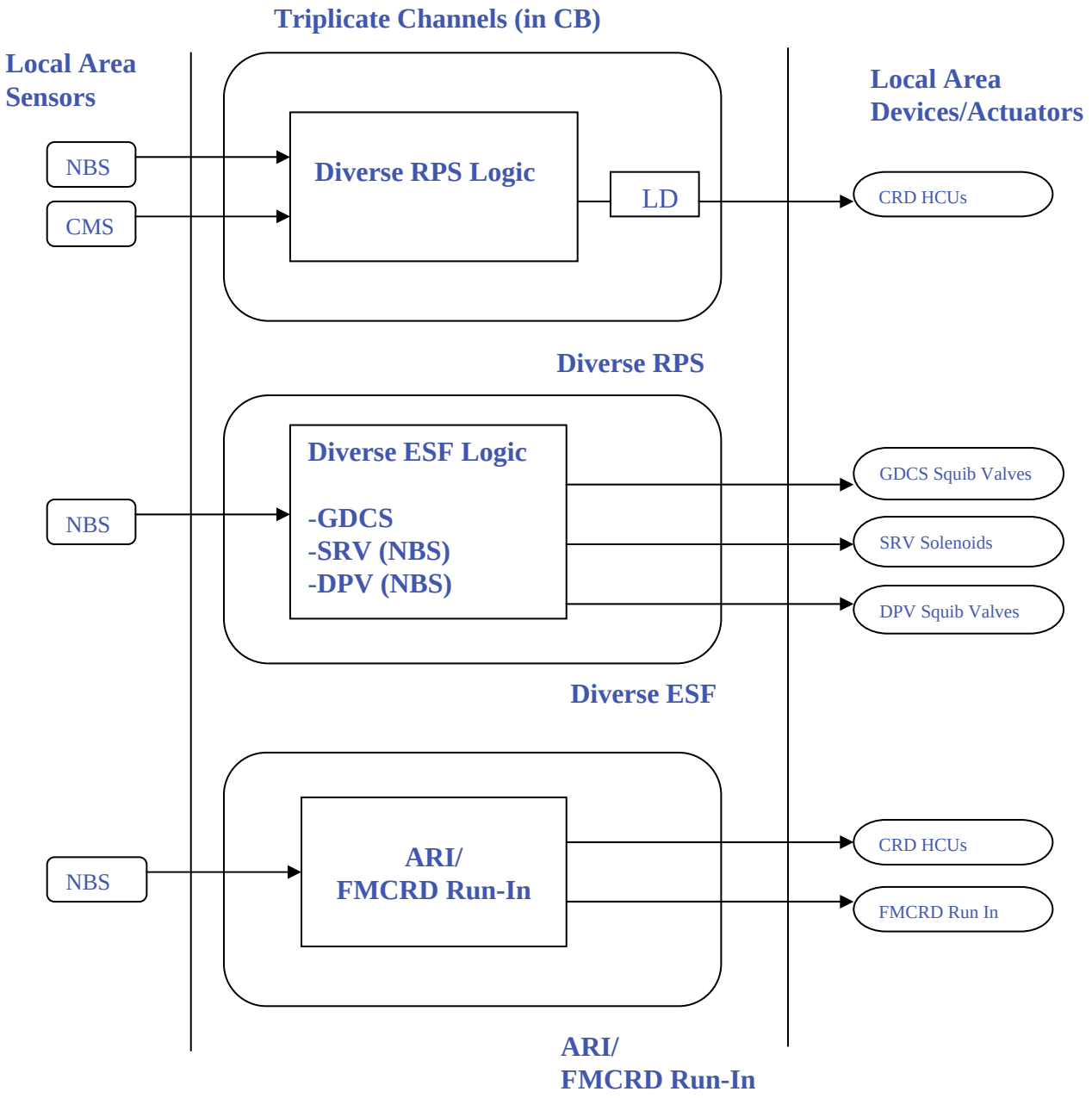
Independence, Separation, Redundancy in ESBWR I&C (cont'

- I&C Independence/Separation
  - Safety-related divisions are isolated from each other (optic fiber)
  - Safety-related divisions are isolated from non safety I&C (optic fiber)
  - Except for APRM/LPRM calibration (keylock controlled), all safety/non safety communication is one way (I.e., safety to nonsafety)
  - Divisional visual display units (VDUs) in Main Control Room can only show/control only corresponding divisional signals
  - Non divisional VDUs and mimic can show both safety and non safety parameters

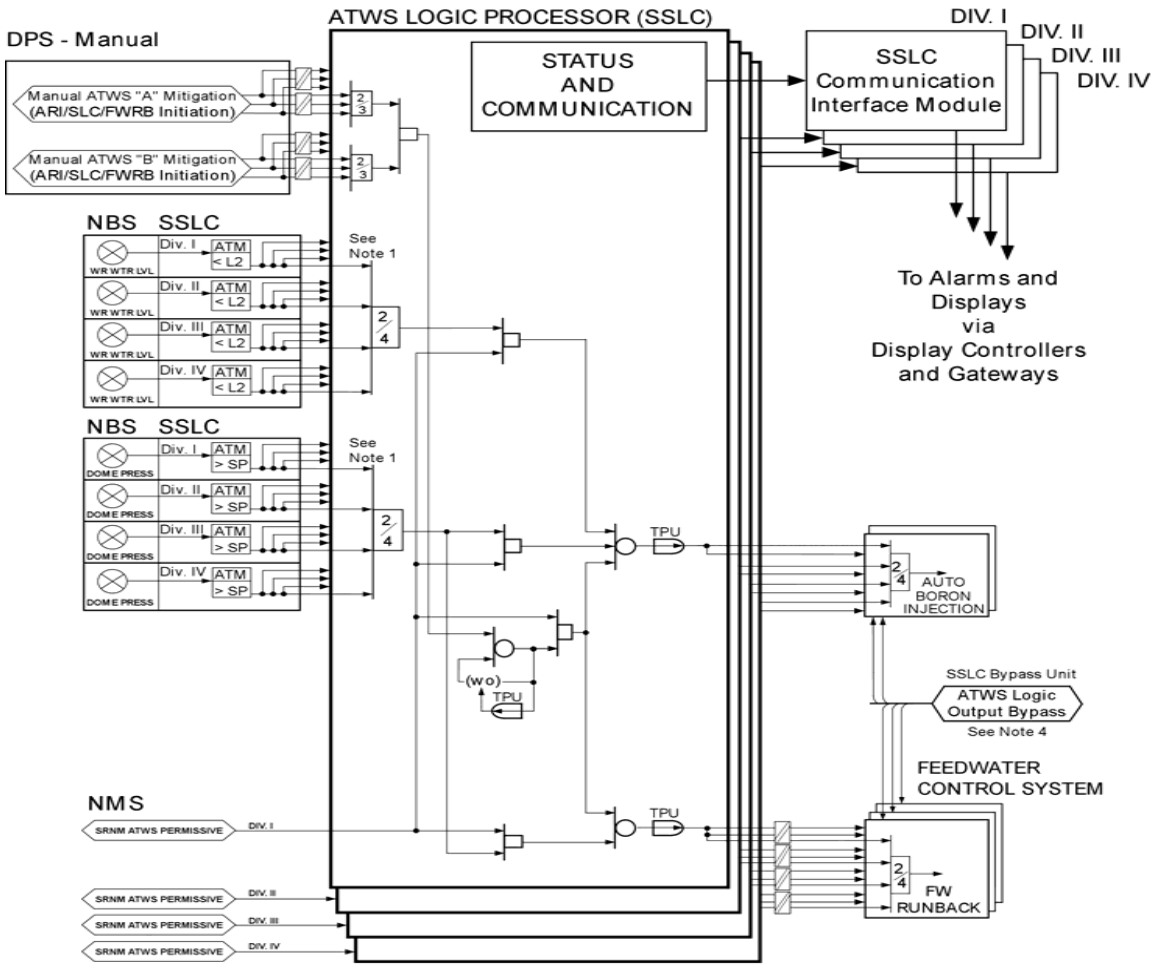
Diverse Instrumentation & Control Systems

- Safety-related “ATWS/SLCS” Logic (Liquid boron injection)
  - > Four Class 1E divisions within SSLC
  - > Non-microprocessor based logic (same as ABWR)
  - > Manual control available
- ESBWR “Diverse protection system”
  - > A subset of RPS protection logics that provide diverse means to scram the reactor using separate and independent sensors, hardware and software from the primary RPS.
    - – single failure proof
  - > A subset of ESF initiation logics that provide diverse means to initiate certain ESF functions using separate and independent sensors, hardware and software from the primary ESF systems.
    - – ADS and GDCS
    - – single failure proof
  - > A set of alternate rod insertion (ARI) and associated logics (e.g., control rod run in) through alternate means by opening the three sets of air header dump valves of the Control Rod Drive system. (also part of the ATWS mitigation function, same as ABWR)
  - > Does not degrade primary scram/ECCS reliability
  - > Manual control available

Diverse Protection System



ATWS/SLC SLogic



NOTES:

1. DIVISION-OF-SENSORS BYPASS INPUTS AND LOGIC NOT SHOWN.
2. THE ATWS LOGIC PROCESSOR SHALL INCLUDE DIVISION-OF-SENSORS BYPASS EXCLUSIONARY LOGIC THAT RESULTS IN A "NO BYPASS" CONDITION FOR ALL DIVISIONS IF TWO OR MORE BYPASS INPUTS ARE RECEIVED.
3. THE ATWS LOGIC PROCESSOR SHALL INCLUDE DIVISION-OF-SENSORS BYPASS LOGIC THAT BYPASSES TRIP INPUTS FROM ALL SENSORS IN ONE DIVISION WHEN DIVISION-OF-SENSORS FOR THAT DIVISION IS PRESENT.
4. SEE SSLC LOGIC DIAGRAM FOR ATWS OUTPUT BYPASS LOGIC.
5. SLC FUNCTIONS IN ATM NOT SHOWN. SEE SLC LOGIC DIAGRAM.

(DCD Figure 7.8-4)

Data Communication Systems

- The Distributed Control & Information System (DCIS) provides data communications networks to support the monitoring and control of interfacing plant safety and non-safety systems.
- DCIS provides the electrical devices and circuitry (such as multiplexing units, data transmission line and transmission controllers) between sensors, display devices, controllers and actuators.
- DCIS also provide acquisition and communication software required to support the function of transmitting plant-wide data for distribution control and monitoring.
  - >The Essential DCIS (E-DCIS)
    - – Data communication for safety-related systems (RPS, NMS, SSLC, etc.)
    - – Divisional dual redundant point to point (RPS) & ring network (SSLC/ESF)
  - >The Non-Essential DCIS (NE-DCIS)
    - – Data communication for nonsafety-related systems
    - – Includes plant computers and workstations support in calculation, display, alarm, monitoring and control functions
    - – Includes certain nonsafety control logic functions
    - – Includes plant computers functions that drive nonsafety-related display and control equipment in the main control room.

Summary of ESBWR I&C Characteristics

- ESBWR's digital I&C design is based on the same digital I&C framework, design, and hardware/software platforms of ABWR. The ABWR digital I&C design has been in operation and in construction (with hardware/software in fabrication/testing). – proven system and hardware/software designs.
- Automation implemented same as ABWR
- Minimized hardwired cables same as ABWR
- Digital Remote Shutdown System capable of full plant control and enhances EOP utilization
- Enhanced “diverse protection and actuation” capability in compliance to BTP HICB - 19
- Fixed in-core gamma thermometer AFIP to replace the TIP system
  – simplified operation and reduced personnel radiation dosage.
  - eliminated TIP containment penetrations
- The ESBWR I&C design will comply with updated or newly developed regulatory requirements such as BTP-14, BTP-19, as well as RG1.152.

ESBWR I&C Compliance to IEEE 603

- ESBWR I&C Design conforms to the requirements of IEEE Std. 603
  - > Design basis
  - > Safety system criteria
    - – Single Failure Criterion
    - – Completion of Protection Function
    - – Quality
    - – Equipment Qualification; System Integrity
    - – Independence
    - – Capability for Test and Calibration
    - – Information Displays; Control of Access
    - – Human Factors Consideration
    - – Reliability
    - – Common Cause Failure Criteria
  - > Requirements of sense and command features requirements
    - – Automatic & manual control
    - – Interaction between the sense and command features
    - – Operating and maintenance bypasses
    - – Setpoints
  - > Requirements of power sources
- IEEE Std. 603 Conformance description in DCD Chapter 7 will be improved.

ESBWR Software Life Cycle Design Process and BTP-14 Compliance

- BTP-14 divides the software-based product activities into 11 software development plans.
- GE has developed and accumulated the experiences and documentation of various aspects of the software development plans in GE's design work of software-based products in current products including that of ABWR (Lungmen).
- The ESBWR software development program will be developed using GE's current software development plans (e.g., Lungmen) as bases. Appendix 7B of Chapter 7 summarizes the development activities to be implemented for ESBWR in the following subject areas:
  - > Software Quality Assurance
  - > Software Management Plan
  - > Software Development Project plan
  - > Software Configuration Management Plan
  - > Verification and Validation Plan
  - > Software Safety Plan (SSP)
  - > Software Test Plan (SVTP)
  - > Operations and Maintenance Manual
- GE will provide ESBWR software plans to support the DCD review per agreed dates.

ESBWR DCD Chapter 7 (I&C) BTP HICB-14 Compliance Action

Software Life Cycle Process Planning

Plan identified in BTP-14	Base Plan Document	ESBWR draft plan document	ESBWR Plan document	Remarks
Software Management Plan (SMP)	Lungmen ABWR SMP	10/30/05	2/28/06	Proposed dates
Software Development Plan (SDP)	Lungmen ABWR SDP	10/30/05	2/28/06	See above
Software QA Plan (SQAP)	Lungmen ABWR SQA	11/30/05	3/30/06	See above
Integration Plan	-	12/15/05	4/30/06	See above
Installation Plan	-	12/15/05	4/30/06	See above
Maintenance Plan	-	12/15/05	4/30/06	See above
Training Plan	-	12/15/05	4/30/06	See above
Operations Plan (OP)	Lungmen ABWR O&M	12/15/05	4/30/06	See above
Software Safety Plan (SSP)	Lungmen ABWR SSP	11/30/05	3/30/06	See above
Software V&V Plan (SV&VP)	Lungmen ABWR SV&VP	11/30/05	3/30/06	See above
Software Configuration Management Plan (SCMP)	Lungmen ABWR SCMP	10/30/05	2/28/06	See above

Note: (1) This includes the dates of revision of design acceptance criteria (DAC) for the software life cycle process implementation tasks and process design outputs tasks
(2) The schedule is consistent with the next revision of DCD Tier 1.

ESBWR DCD Chapter 7 Conformance to BTP HICB-16

- The ESBWR DCD Chapter 7 content will be enhanced to address the NRC concerns raised in NRC letter dated Sept. 23, 2005.
  - > Interface requirements explanation as needed, Validation of innovative means
  - > Computer system development process
  - > Defense-in-depth and diversity (D-in-D&D) description

ESBWR Commercial-Off-the-Shelf (COTS) Qualification

- The ESBWR DCD Chapter 7 content will be enhanced to address the COTS qualification
  - > Safety-related; IEEE Std. 323
  - > EPRI-TR-106439 Guidelines on Evaluation and Acceptance of Commercial Grade Digital Equipment in Nuclear Safety Application
  - >CR-6421: A proposed Acceptance Process for Commercial off the shelf (COTS) Software in Reactor Application

ESBWR Setpoint Methodology

- The ESBWR setpoint methodology will follow the GE standard setpoint methodology as referenced in DCD Section 7.2.5 (“General Electric Instrument Setpoint Methodology,” Licensing Topical Report NEDC-31336P-A) in conformance to BTP-12
- The DCD Chapter 7 content description regarding compliance with BTP-12 and RG 1.105 will be improved to clarify the ESBWR conformance.

ESBWR DCD Chapter 7 (I&C) Revision Action Plan

NRC Question #	Item Subject	Action	Schedule	Remarks
1	IEEE 603 Compliance Description	GE will revise DCD Chapter 7 to include information on compliance to IEEE Std. 603 with road map.	10/30/05	DCD Rev. 1
2a	Hardware/Software Life Cycle Design Process Description	GE will provide Hardware/Software Life Cycle "Design Process" Description	12/15/05	Topical Report
2b	BTP HICB-14 Compliance Action Plan	GE will provide action plan for compliance of BTP -14		See chart on "BTP-14 Compliance Plan"
3	COTS Qualification Description	GE will revise DCD Chapter 7 to include information on COTS qualification	10/30/05	DCD Rev.1
4	Software V&V & Testing	GE will provide information on software V&V and testing		To be provided in #3 above
5	GE Setpoint Methodology Description	GE's current methodology is in compliance with BTP-12. GE will clarify the description in next revision of DCD Chapter 7.	10/30/05	DCD Rev.1

Back up slides

RPS Process Conditions for Reactor Scram

- High Drywell Pressure [Containment Monitoring System, (CMS)]
- Turbine Stop Valve Closure [RPS]
- Turbine Control Valve Fast Closure [RPS]
- NMS-monitored SRNM and APRM conditions exceed acceptable limits [NMS]
- High Reactor Pressure [NBS]
- Low Reactor Water Level (Level 3) [NBS]
- High Reactor Water Level (Level 8) [NBS]
- Main Steam Line Isolation Valve (MSIV) Closure (RUN mode only) [NBS]
- Low Control Rod Drive HCU Accumulator Charging Header Pressure [CRD syste
- High Suppression Pool Temperature [CMS]
- High Condenser Pressure [RPS]
- Loss of Power Generation Bus (Loss of Feedwater Flow)(RUN mode only) [RPS]
- Operator-initiated Manual Scram [RPS]
- Reactor Mode Switch in “Shutdown” position [RPS]

I&C Environment Considerations

> Normally various portions of DCIS are cooled by separate HVAC systems
> Divisional DCIS always physically/fire separated (except main control room)
> Non safety investment protection DCIS physically separated
> Safety DCIS hardware designed for 24/72 hour operation without HVAC

I&C Equipment Surveillance

- Channel checks are continuous
  - RPS and ECCS divisional parameters continuously compared and alarmed by plant computer systems
- Trip checks both manually initiated and continuous
  - Digital trip setpoints do not “drift”
  - Trip setpoints sent to plant computer systems and alarmed on change
- Communications, power, and microprocessors continuously self diagnosed

I&C Equipment Bypass Designs

Division of sensors bypass

- Joystick fiber switch allows only one division to be in bypass at a time
  - Each division is told to ignore bypassed division per parameter trip decisions
  - Each division can still make 2/4 scram decision

Division of logic bypass (RPS only)

- Joystick fiber switch allows only one division to be in bypass at a time
  - Each division is told to ignore bypassed divisional scram in load driver decision
  - Each division can still make 2/4 scram decision

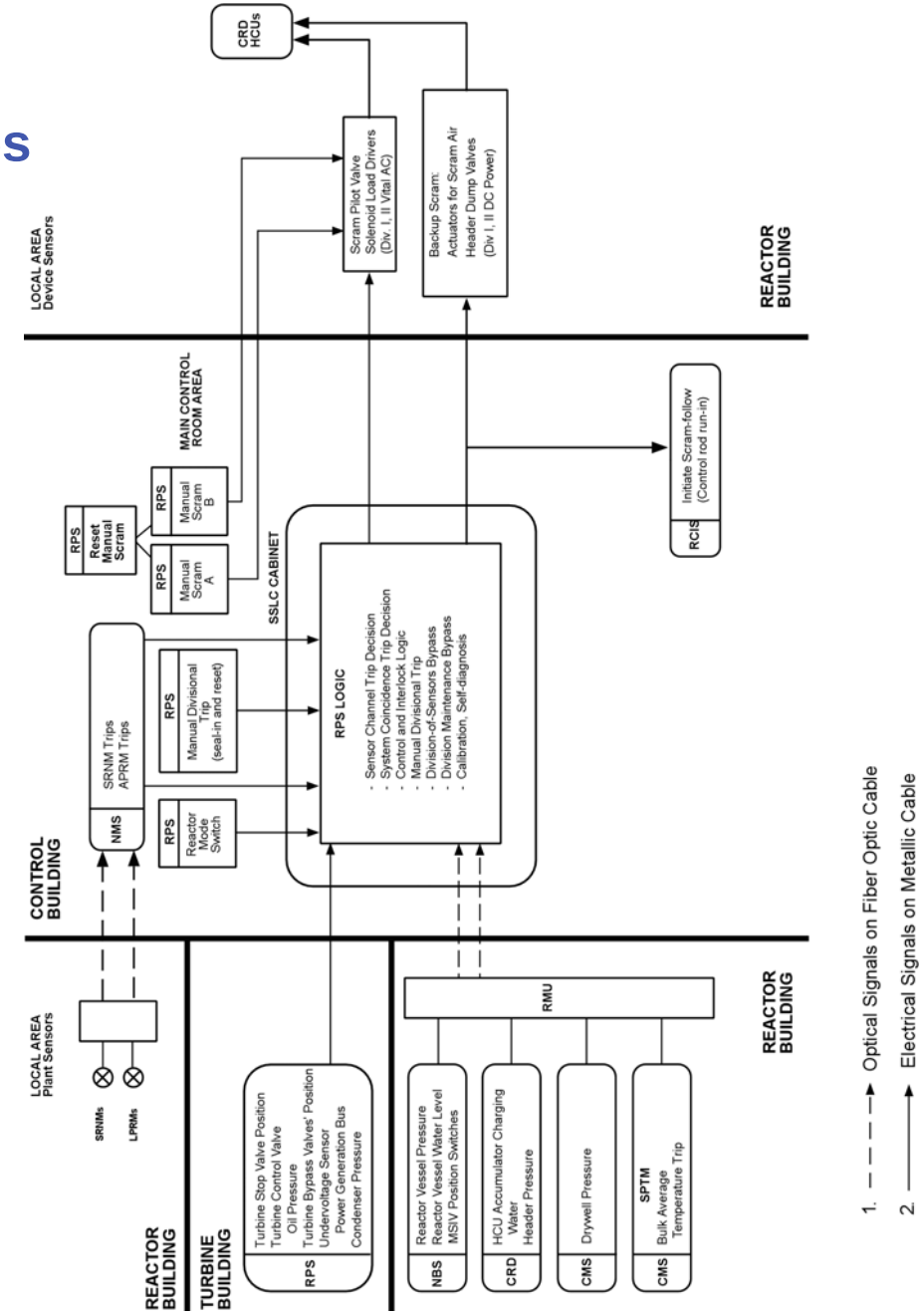
ECCS bypass

- Keylock switch to avoid inadvertent squib/SRV actuation
  - Alarmed in control room
  - At actuator level

Other I&C Design Consideration

- ESBWR I&C supports “hands off” operation for 72 hours
- Design incorporates HFE task analyses
- All plant alarms recorded
- Alarms annunciated and prioritized per plant condition
  - Reduces operator burden in accident
- Alarm displays keyed to specific alarm response procedure
- Main mimic incorporates all SPDS control parameters and many RG 1.97 parameters
  - Operator is aware of validation status of signals on mimic and displays
- Recording includes sequence of events, transient recording for planned and unplanned transients
- All plant signals in DCIS recorded for at least a fuel cycle

RPS Interfaces



(DCD Figure 7.2-2)