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Nuclear Steam Supply Systems
Redacted

March 22, 2012

Nuclear Island Systems

- Systems Design Approach
- Reactor Coolant System (RCS)
- Reactor Coolant Inventory and Purification System (RCI)
- Emergency Core Cooling System (ECC)
- Auxiliary Condenser System (CNX)
- Fuel Handling System (FHS)
- Summary

Systems Design Approach

- Utilize unique features of the integral RCS to increase system response time
  - Large coolant inventory
  - Small coolant penetrations
- Eliminate use of soluble boron in normal operation
- Utilize non-safety systems to respond to day-to-day plant transients
  - Simplifies operator workload
  - Provides defense in depth
  - Minimizes reliance on emergency systems
- Maximize the flexibility of non-safety systems
  - All major RCS support functions incorporated into RCI
  - Reduce system and component count

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Systems Design Approach-cont.

- Use passive safety systems

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- PRA informed design [CCI per Affidavit 4(a)-(d)]
  - System diversity
  - Component diversity
  - Defense in depth

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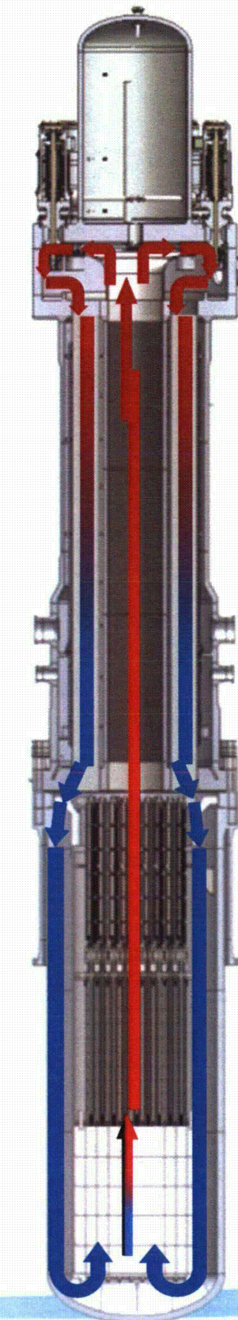
RCS Design Changes

- Power increase
  - Core thermal power increased from 425 to 530 MWt
  - Fuel assemblies[ ][CCI per Affidavit 4(a)-(d)]
  - Additional steam generator tubes added
  - RCS flow increased
- Reactor coolant pumps
  - Internal mixed flow pumps replaced with canned pumps using external motors
  - Upper steam generator and pressurizer modified



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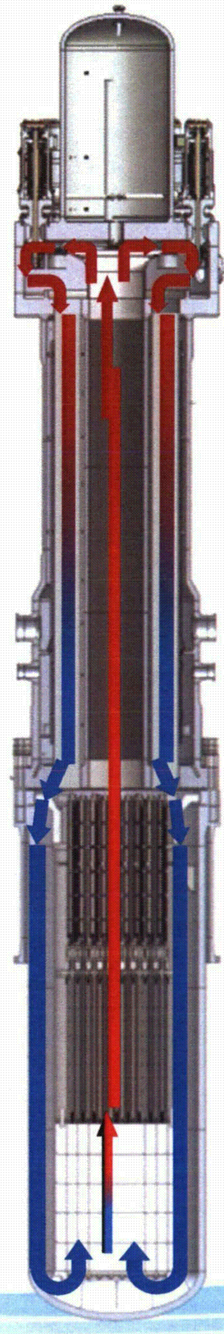
RCS Safety Functions

- Maintain pressure boundary integrity
- Remove core decay heat via natural circulation
- Provide overpressure protection for all RCS pressure boundary components for design basis events
- Provide a method of venting of non-condensable gases following severe accidents
- Provide means of unlatching the control rods



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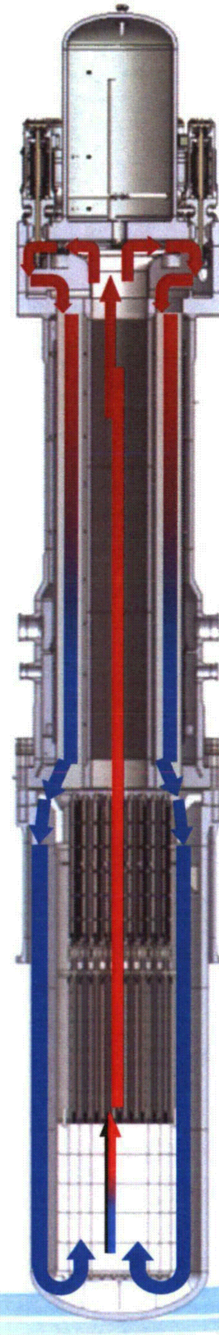
RCS Non-Safety Functions

- Provide forced circulation of reactor coolant to transfer heat produced in the core to the secondary side

- Maintain steam-water interface in the pressurizer



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RCS Process Flow Diagram

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 [CCI per Affidavit 4(a)-(d)]

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Key Features of the Integral RCS

Feature	B&W 177	Typical Gen 3 PWR	[B&W mPower
Rated Core power (MW_{th})	2568	3415	530
Core average linear heat rate (kW_t/m)	18.7	18.7	[
Average flow velocity through the core (m/s)	4.8	4.8	
RCS volume (m^3)	325	272	
RCS volume to power ratio (m^3/MW_t)	0.14	0.08	
Maximum LOCA area (m^2) *	1.3	1.0	
RCS volume/LOCA area ratio (m^3/m^2)	250	270	] [CCI per Affidavit 4(a)-(d)]

RCS volume and small break sizes allow simplification of RCS safety systems

* Assumes double ended break

Unique RCS Characteristics

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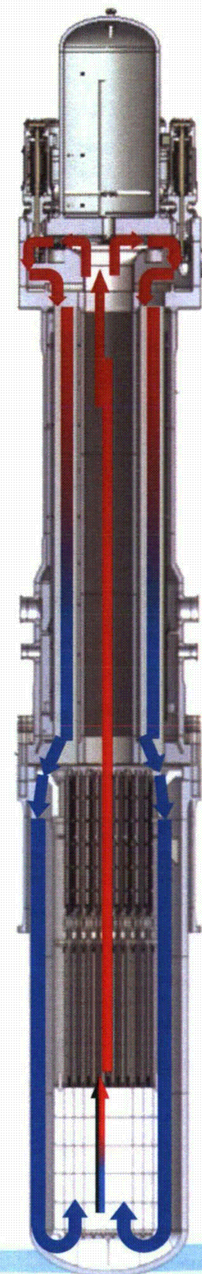
[CCI per Affidavit 4(a)-(d)]



RCI Design Changes

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[CCI per Affidavit 4(a)-(d)]

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Reactor Coolant Inventory & Purification System Safety Functions

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[CCI per Affidavit 4(a)-(d)]

Reactor Coolant Inventory & Purification System Non-Safety Functions

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[CCI per Affidavit 4(a)-(d)]

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RCI [ ] [CCI per Affidavit 4(a)-(d)]

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[CCI per Affidavit 4(a)-(d)]

RCI [ ] [CCI per Affidavit 4(a)-(d)]

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RCI [ ] [CCI per Affidavit 4(a)-(d)]

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RCI [ ] [CCI per Affidavit 4(a)-(d)]

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ECCS Design Changes

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[CCI per Affidavit 4(a)-(d)]

ECCS Safety Functions

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[CCI per Affidavit 4(a)-(d)]

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ECCS Process Flow Diagram

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ECCS [ ]

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ECCS [ ]

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ECCS Challenges

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[CCI per Affidavit 4(a)-(d)]

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Auxiliary Condenser System (CNX) Functions

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[CCI per Affidavit 4(a)-(d)]

CNX Process Flow Diagram

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[CCI per Affidavit 4(a)-(d)]

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Fuel Handling System (FHS)

- System Functions:
  - Transfer new and spent fuel assemblies and control equipment into and out of containment and the reactor service building while maintaining subcriticality and preventing fuel damage.
  - Store new and spent fuel assemblies and control equipment in seismically qualified storage racks while maintaining subcriticality and preventing fuel damage.

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Fuel Handling System (FHS)

- Key Design Features:
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[CCI per Affidavit 4(a)-(d)]

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Reliability Assurance Program

The purpose of the Reliability Assurance Program (RAP) is to ensure:

- The plant is designed, constructed and operated consistent with assumptions and risk insights for risk-significant Systems, Structures and Components (SSCs).
- Risk-significant SSCs are selected and maintained so that they do not degrade to an unacceptable level during the life of the plant.
- The frequency of transients to risk-significant SSCs is minimized.
- These SSC will function reliably when challenged.

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Reliability Assurance Program (cont.)

- Consistent with ISG-018, implementation of D-RAP in the mPower Project will be accomplished in the following phases:
- Phase I: Develop: (1) Design Reliability Assurance Program (D-RAP), a standard plant design list of risk-significant SSCs, and Tier 1 ITAAC
- Phase II: Develop a plant-specific list of risk-significant SSCs; define the integration of RAP SSCs into existing programs; and ensure that RAP SSCs have been placed under the appropriate programs
- Phase III: Apply reliability assurance to procurement, fabrication, construction and preoperational testing activities

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Summary

- Plant safety is enhanced by:
  - Unique features of the integral RCS that increase system response time
  - Elimination of soluble boron for normal operation
  - Flexible, non-safety systems that can respond to day-to-day plant transients
  - Use of passive safety systems

  [ ] **[CCI per Affidavit 4(a)-(d)]**
- PRA risk insights guiding design to maximize reliability

Risk Informed – Simplification - Defense in Depth