

Attachment 3

Electrical Power Systems and Balance of Plant Systems Overview Slides (Redacted)

generation

mPower

***Electrical Power Systems Overview
(Redacted)***

January 31, 2012

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- Purpose
 - Discuss AC & DC electrical power systems design features for the mPower reactor and applicability to the Standard Review Plan (SRP)
- Topics to be discussed
 - Simplified electrical single line diagram
 - AC Power System design & Equipment Layout
 - Standby Diesel Generators layout
 - DC/UPS Power System design & Equipment Layout
 - Island mode operation
 - SRP Applicability
 - NRC Informal Questions (10/11/11)

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

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

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

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

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

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

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

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

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mPower DC/UPS Equip. CR Air Supply System

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

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

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

SRP Applicability

| Section | Title | Remarks |
|---------|-------------------------------|---------|
| 8.1 | ELECTRIC POWER - INTRODUCTION | |
| 8.2 | OFFSITE POWER SYSTEM | [|
| 8.3.1 | AC POWER SYSTEMS (ONSITE) | |
| 8.3.2 | DC POWER SYSTEMS (ONSITE) | |
| 8.4 | STATION BLACKOUT | |
| | |] |

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

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

Electrical Design Questions to Support Staff Development of DSRS

1. In the event of a Loss of Off-site Power (LOOP) or other anticipated operational occurrences, is onsite AC power planned to be used (in the short term before 72 hrs) to support operation of decay heat removal, RCIPS, or other risk-significant functions? If so, please describe.

Response

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

2. A B&W presentation dated April 21, 2011, entitled “Design considerations for Fukushima-type Events,” identifies[

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

b. Are they in addition to the standby DGs?

[Response

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

3. What is the total number of standby / backup electrical power generators (e.g., EDGs) that are included in the design, and are any of them considered to be risk significant?

Response

The standard design will be based upon a two unit facility. [

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

4. Are backup/standby power sources shared between modules/units? If so, please describe.

Response

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

5. Are AC and DC electrical support system components for RTNSS or non-safety-related but risk-significant SSCs (e.g., DHR pump), also designated as RTNSS or non-safety-related but risk significant? Please describe.

Response

The required support systems for RTNSS components are classified appropriately [

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

6. The April 21, 2011 B&W presentation also identifies a “Long duration ‘station keeping’
[] [CCI per Affidavit 4(a)-(d)] for plant monitoring/control.” Please
provide a more detailed functional description of this equipment

Response

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

generation

mPower

BOP Systems Overview (Redacted Version)

January 31, 2012

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| SRP | Title |
|----------------------|---|
| <u>3.4.1</u> | Internal Flood Protection for Onsite Equipment Failures |
| <u>3.5.1.1</u> | Internally Generated Missiles – Outside Containment |
| <u>3.5.1.2</u> | Internally Generated Missiles – Inside Containment |
| <u>3.5.1.4</u> | Missile Generated by Tornadoes and Extreme Winds |
| <u>3.5.2</u> | Structures, Systems, and Components to be Protected from Externally-Generated Missiles |
| <u>3.6.1</u> | Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment |
| <u>9.1.2</u> | New and Spent Fuel Storage |
| <u>9.1.3</u> | Spent Fuel Pool Cooling and Cleanup System |
| <u>9.1.4</u> | Light Load Handling System (Related to Refueling) |
| <u>9.1.5</u> | Overhead Heavy Load Handling Systems |
| <u>9.2.1</u> | Station Service Water System |
| <u>9.2.2</u> | Reactor Auxiliary Cooling Water Systems |
| <u>9.2.4</u> | Potable and Sanitary Water Systems |
| <u>9.2.5</u> | Ultimate Heat Sink |
| <u>9.2.6</u> | Condensate Storage Facilities |

| SRP | Title |
|---------------------|--|
| <u>9.3.1</u> | Compressed Air System |
| <u>9.3.3</u> | Equipment and Floor Drainage System |
| <u>9.5.4</u> | Emergency Diesel Engine Fuel Oil Storage and Transfer System |
| <u>9.5.5</u> | Emergency Diesel Engine Cooling Water System |
| <u>9.5.6</u> | Emergency Diesel Engine Starting System |
| <u>9.5.7</u> | Emergency Diesel Engine Lubrication System |
| <u>9.5.8</u> | Emergency Diesel Engine Combustion Air Intake and Exhaust System |
| <u>10.2</u> | Turbine Generator |
| <u>10.3</u> | Main Steam Supply System |
| <u>10.4.1</u> | Main Condensers |
| <u>10.4.2</u> | Main Condenser Evacuation System |
| <u>10.4.3</u> | Turbine Gland Sealing System |
| <u>10.4.4</u> | Turbine Bypass System |
| <u>10.4.5</u> | Circulating Water System |
| <u>10.4.7</u> | Condensate and Feedwater System |
| <u>10.4.9</u> | Auxiliary Feedwater System (PWR) |
| <u>14.3.7</u> | Plant Systems – Inspections, Tests, and Acceptance Criteria |
| <u>16.0</u> | Technical Specifications |

SRP 3.4.1 Internal Flood Protection for Onsite Equipment Failures

- SRP 3.4.1 applies – No exceptions have been identified

[

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

- SRP 3.5.1.1 and 3.5.1.2 apply - No exceptions have been identified
- Safety-related SSCs are designed to be protected from internally-generated missiles (inside and outside containment)
 - e.g. Missile barriers

SRP 3.5.1.4 Missiles Generated by Tornadoes and Extreme Winds

- SRP 3.5.1.4 applies - No exceptions have been identified
- Safety-related SSCs and RTNSS-B equipment to be protected against missiles generated by tornadoes and extreme winds, as identified in SRP 3.5.2
- Design-basis tornado characteristics per Region I of Table 1 of RG 1.76
- Design-basis tornado-generated missile spectrum per Region 1 of Table 2 of RG 1.76
- Design-basis hurricane characteristics and hurricane-generated missiles (RG 1.221 under review)
- Consideration given to missiles generated by nonsafety-related structures (i.e., Turbine Building)

SRP 3.5.2 Structures, Systems, and Components to be Protected from Externally-Generated Missiles

- SRP 3.5.2 applies – No exceptions have been identified
- Safety-related SSCs and RTNSS-B equipment to be protected from externally-generated missiles
- Spent fuel pool structure and related systems are located such that impact from externally generated missiles is precluded. (RG 1.13)
- Ultimate Heat Sink designed to withstand the effects of externally-generated missiles (RG 1.27)
- Consideration given to the protection of safety-related and risk significant SSCs from the effects of turbine missiles (RG 1.115)
- Consideration given to the protection of safety-related and risk significant SSCs from the effects of tornado missiles (RG 1.117)

- SRP 3.6.1 applies – No exceptions have been identified
 - Note - there is no auxiliary feedwater system for this design
- Postulated break locations and dynamic effects per SRP 3.6.2
- Review the general layout of high and moderate energy piping systems with respect to the plant arrangement criteria of Section B.1 of Branch Technical Position (BTP) 3-3
- Perform analysis and determine environmental effects of postulated piping failures with respect to the guidelines of Section B.3 of BTP 3-3

SRP 9.1.2 New and Spent Fuel Storage

- SRP Section 9.1.2 applies to new and spent fuel storage. No exceptions have been identified
- Safety function is to maintain the fuel assemblies in a safe and subcritical array during all credible storage conditions and to provide a safe means of loading the spent fuel assemblies into shipping or storage casks
- Consists of new, hot, spent, and damaged fuel storage racks; control rod storage racks; in core waste storage; spent fuel inspection station; temporary fuel stand; the spent fuel pool; the spent fuel pool liner plate and liner leak detection system; the new fuel storage pit; the fuel transfer pit; and the cask loading and washdown pit

New Fuel Storage

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

- SRP 9.1.3 applies – no exceptions have been identified
- The primary function of the Spent Fuel Pool Cooling and Cleanup System (SFPCCS) is to keep the spent fuel assemblies cooled and covered with water during all storage conditions
- The spent fuel pool cooling system is a nonsafety-related system
- The spent fuel pool makeup water system and its source are safety-related and are designed to Seismic Category I
- The spent fuel pool is designed as a Seismic Category I structure with a large water inventory
- The cooling portion of the SFPCCS consists of two 100% capacity trains. Each cooling train consists of a pump, a heat exchanger, and associated suction, discharge, and cross-connect piping; valves; instrumentation; and controls
- The cleanup loop consists of two pre-filters, two demineralizer beds, a post-filter, cross-connect piping, valves, instrumentation, and controls

- Without any external intervention (makeup) after loss of the cooling system:

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

SRP 9.1.4 Light Load Handling Systems (Related to Refueling)

- SRP Section 9.1.4 applies to light load handling system, with no exceptions currently identified
- Safety-related system – System meets the requirements of General Design Criteria (GDC) 2, 5, 61, and 62

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

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

- System includes transfer tubes that connect the containment building of each operating unit with the common RSB fuel transfer pit for the purpose of allowing a direct travel path for new and spent fuel assemblies and control components between buildings
- System includes upenders – one inside Containment of each operating unit at the transfer tube, two in the fuel transfer pit in the RSB (each dedicated to fuel assembly transfers for a particular operating unit), and a shared fuel crate upender[] [CCI per Affidavit 4(a)-(d)]

Design Attributes

- Fuel handling cranes are single-failure-proof cranes designed in accordance with ASME NOG-1 and RG 1.29 Position C.1
- Fuel handling equipment is designed to ensure that subcriticality is maintained while handling fuel of maximum reactivity and is not contingent upon borated water
- Fuel handling equipment controls preclude the positioning of fuel assemblies in close proximity.
- Safety devices incorporated into system design prevent damage to fuel assemblies and conditions that pose a radiation hazard or exposure risk to personnel

[

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- SRP Section 9.1.5 applies to overhead heavy load handling system (OHLHS), with no exceptions currently identified

[

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

- System also includes monorail hoists with estimated lift capacities greater than 2 tons (estimated weight of one fuel assembly plus its handling tool)

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- SRP 9.2.1 – SRP assumes Station Service Water System is safety-related.

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

Departures from SRP criteria

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

[

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SRP 9.2.2 Reactor Auxiliary Cooling Water Systems (Component Cooling Water System)

- SRP 9.2.2 applies – mPower design utilizes a Component Cooling Water System (CCW)
- SRP assumes CCW is a safety-related system

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

Departures from SRP criteria

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

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

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SRP 9.2.4 Potable and Sanitary Water Systems

- SRP 9.2.4 applies – No exception has been identified
- Nonsafety-related system
- No interconnections to potentially radioactive systems
- Backflow prevention measures, such as air gaps and reduced pressure principle backflow prevention assemblies to prevent potential backflow
- Bacteriological and chemical quality requirements as referenced in EPA "National Primary Drinking Water Standards," 40 CFR Part 141
- Emergency eyewash stations or combination emergency eyewash/shower stations are provided in accordance with 29 CFR 1910.151(c)

- SRP Section 9.2.5 applies to the Ultimate Heat Sink (UHS)
- System will be described in Chapter 6
- Safety-related system
- System design to meet single failure criterion

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- Tank water circulated and treated to minimize tank corrosion [CCI per Affidavit 4(a)-(d)]
- Means provided for draining tank for inspections or repairs

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SRP 9.2.6 Condensate Storage Facilities

- SRP 9.2.6 applies – No exceptions have been identified
- Nonsafety-related system
- Storage tank will be designed for safe handling of tank overflow, detection of high and low water levels, and with a means of manual isolation

SRP 9.3.1 Compressed Air System

- SRP 9.3.1 applies – No exceptions have been identified
- Nonsafety-related system with the exception of the containment penetration piping and isolation valves which are safety-related

[

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

- Instrument air quality is in accordance with the limits specified in ANSI/ISA 7.0.01 “Quality Standard for Instrument Air”

SRP 9.3.3 Equipment and Floor Drainage System

- SRP 9.3.3 applies – No exceptions have been identified
- Nonsafety-related system
- Floor and equipment drainage is classified and segregated by the type of waste generated. The radioactive and non-radioactive drainage systems are separated.
- The Floor and Equipment Drains systems consists of collection piping, valves, equipment drains, floor drains, collection sumps, a tank, and sump pumps.

[

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

- SRP 9.5.4 –[

]

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

- SRP 9.5.5 – [

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

- Cooling water system consists of the jacket water and intercooler cooling system components (e.g., pumps, radiator, etc.) to maintain proper engine operation at maximum rated power

[

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

- Independent jacket water heater provided to maintain system temperature during diesel generator standby mode for starting reliability

- SRP 9.5.6 –[

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

- Starting system capable of cranking the diesel engine multiple times without recharging

- SRP 9.5.7 –[

] [CCI per Affidavit 4(a)-(d)]
- Lubricating oil system components (e.g., pumps, filter, crankcase vent, etc.) maintains proper engine operation at maximum rated power
- All system components are integrated with the respective standby diesel generator which is housed within the reactor service building providing protection from natural phenomena
- Independent lube oil heating provided to maintain system temperature during diesel generator standby mode for starting reliability

- SRP 9.5.8 –[

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

- Combustion air intake and exhaust system components (e.g., filters, silencers, etc.) designed to ensure engine operation at maximum rated power
- Components are either housed within the reactor service building or provided with protection from natural phenomena as required
- Combustion air intake and exhaust are arranged to prevent contamination of the intake air by exhaust products

- SRP10.2 applies –[

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

- SRP 10.3 applies – No exceptions have been identified

[

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

- RCB and RSB design protects safety-related portion of MSS per GDC 2 and 4
- MSS components are unit-specific and not shared per GDC 5
- The MSS will be analyzed for steam hammer during normal plant operation as well as during upset or accident conditions

- SRP 10.4.1 applies – No exceptions have been identified
- Nonsafety-related system

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

- Material selection dependent upon water quality (site specific)
- Provides means for detection of tube leakage

- SRP 10.4.2 applies – No exceptions have been identified
- Nonsafety-related system
- Establishes and maintains vacuum in condenser
- Capable of detecting radioactivity from vacuum pump discharge

- SRP10.4.3 applies – No exceptions have been identified
- Nonsafety-related system
- Consists of gland steam condenser and exhausters
- Sealing steam supplied from auxiliary steam system
- Condensate from gland steam condenser returns to main condenser
- Capable of detecting radioactivity from gland steam exhausters

- SRP 10.4.4 applies – No exceptions have been identified
- Nonsafety-related system

[

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

SRP 10.4.5 Circulating Water System

- SRP 10.4.5 applies – No exceptions have been identified
- Circulating water system is nonsafety-related, is not required to operate during or after a design basis accident, and all components are non-seismic
- Conventional circulating water system with mechanical draft cooling tower provides cooling water to the main condenser and other turbine building heat exchangers
- Majority of system components (e.g., cooling tower, makeup system, chemical treatment, etc.) are dependent upon site-specific information; system design will be representative based on standard plant design conditions
- Flood evaluation to confirm a break in the circulating water system will not adversely affect safety-related equipment

- SRP 10.4.7 applies – No exceptions have been identified
- The safety-related portion of the feedwater system provides containment isolation, and receives condensate from the auxiliary condenser. The remainder of the feedwater system is nonsafety-related
- The condensate and feedwater systems primary function is to supply feedwater to the Steam Generator
- The condensate and feedwater system will be analyzed for water hammer during normal plant operation as well as during upset or accident conditions

- SRP 10.4.9 does not apply – there is no auxiliary feedwater system

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- 10 CFR 52.47(b)(1) – DC Application Contains Proposed ITAAC
- SRP 14.3.7 – ITAAC for Plant Systems
 - Relevant Systems - New and Spent Fuel Handling, Power Generation, Air, Cooling Water, Radioactive Waste, HVAC
 - Issues that Affect Multiple SSCs
 - Equipment Qualification
 - Protection from Fires, Floods, Tornado Missiles
- ITAAC Provided in DCD Tier 1
 - Consistent with DCD Tier 2 Information
 - Content and Format Consistent with NRC and NEI Guidance
 - Informed by Review of Passive ALWR DCDs

- 10 CFR 52.47(a)(11) – DC Applicant to Propose Technical Specifications IAW 10 CFR 50.36 and 50.36a
- mPower Technical Specifications (TS)
 - Based on NUREG-1430 and approved Technical Specification Task Force (TSTF) travelers
 - Informed by Other Standard Technical Specifications (STS)
 - Informed by ALWR TSs
 - Not Risk-Informed
- Use of NUREG-1430
 - STSs Encouraged by RG 1.206
 - Provides Improved STS (ISTS) for B&W Plants
 - Correlation Between ISTS and mPower – B&W NSSS Designer

Standard Review Plan Applicability

| SRP | Title | Applicability |
|--------------|--|---------------|
| 3.4.1..... | Internal Flood Protection for Onsite Equipment Failures..... | Yes |
| 3.5.1.1..... | Internally Generated Missiles – Outside Containment..... | Yes |
| 3.5.1.2..... | Internally Generated Missiles – Inside Containment..... | Yes |
| 3.5.1.4..... | Missile Generated by Tornadoes and Extreme Winds..... | Yes |
| 3.5.2..... | Structures, Systems, and Components to be Protected..... | Yes |
| | From Externally-Generated Missiles | |
| 3.6.1..... | Plant Design for Protection Against Postulated Piping | Yes |
| | Failures in Fluid Systems Outside Containment | |
| 9.1.2..... | New and Spent Fuel Storage..... | Yes |
| 9.1.3..... | Spent Fuel Pool Cooling and Cleanup System..... | Yes |
| 9.1.4..... | Light Load Handling System (Related to Refueling)..... | Yes |
| 9.1.5..... | Overhead Heavy Load Handling Systems..... | Yes |
| 9.2.1..... | Station Service Water System..... | Yes |
| 9.2.2..... | Reactor Auxiliary Cooling Water Systems..... | Yes |
| 9.2.4..... | Potable and Sanitary Water Systems..... | Yes |
| 9.2.5..... | Ultimate Heat Sink..... | Yes |
| 9.2.6..... | Condensate Storage Facilities..... | Yes |

Standard Review Plan Applicability

| SRP | Title | Applicability |
|-------------|--|----------------|
| 9.3.1..... | Compressed Air System..... | Yes |
| 9.3.3..... | Equipment and Floor Drainage System..... | Yes |
| 9.5.4..... | <i>Emergency Diesel Engine Fuel Oil Storage and Transfer System.....</i> | <i>Limited</i> |
| 9.5.5..... | <i>Emergency Diesel Engine Cooling Water System.....</i> | <i>Limited</i> |
| 9.5.6..... | <i>Emergency Diesel Engine Starting System.....</i> | <i>Limited</i> |
| 9.5.7..... | <i>Emergency Diesel Engine Lubrication System.....</i> | <i>Limited</i> |
| 9.5.8..... | <i>Emergency Diesel Engine Combustion Air Intake and.....</i> <i>Exhaust System</i> | <i>Limited</i> |
| 10.2..... | Turbine Generator..... | Yes |
| 10.3..... | Main Steam Supply System..... | Yes |
| 10.4.1..... | Main Condensers..... | Yes |
| 10.4.2..... | Main Condenser Evacuation System..... | Yes |
| 10.4.3..... | Turbine Gland Sealing System..... | Yes |
| 10.4.4..... | Turbine Bypass System..... | Yes |
| 10.4.5..... | Circulating Water System..... | Yes |
| 10.4.7..... | Condensate and Feedwater System..... | Yes |
| 10.4.9..... | <i>Auxiliary Feedwater System (PWR).....</i> | <i>No</i> |
| 14.3.7..... | Plant Systems – Inspections, Tests, and Acceptance Criteria..... | Yes |
| 16.0..... | Technical Specifications..... | Yes |