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Design-Basis Accident Radiological Source Terms

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(Redacted Version)

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This is a pre-application document and includes preliminary B&W mPower reactor design or design supporting information and is subject to further internal review, revision, or verification.

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2013 Accident Source Term Position Paper

- Introduction
  - Defense-in-depth philosophy for the B&W mPower reactor
  - Radiological consequences requirements
- Design overview
  - Accident mitigating structures, systems, and components
  - System level defense-in-depth for design basis events
  - Long-term coping period
- Design basis events with potential radiological consequences
  - Six system response events
  - Liquid-filled tank and fuel handling accidents
- Maximum hypothetical accident
  - Accident scenario and evaluation methodology
  - Time delay [ ]
  - Scoping study results
- Conclusions

[Proprietary per Affidavit 4(a)-(f)]

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Design Overview Summary
Critical Safety Functions

- Reactor Criticality - RPS control redundancy
- Reactor Inventory/Core Cooling – IPITs and RWST
  - Reactor Inventory – IPITs and RWST
  - RCS Pressure – Safety/Relief valves
  - Decay Heat Removal – IPITs and RWST
- Containment of Radiological Hazards
  - Containment isolation – Isolation valves, leak tightness ~0.1%/day
  - Containment heat removal – Passive Containment Cooling Tank
  - Radiation and radioactive effluent control – Underground, EOP, SAMG, monitoring
- Others – Shielding, Structural Integrity, etc.

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Applicability of NUREG-0800 Transients to B&W mPower Reactor

15.1.4	Inadvertent Opening of a Steam Generator Relief or Safety Valve	SRP section is applicable. The design employs a conventional main steam system.
15.1.5.A	Radiological Consequences of Main Steam Line Failures Outside Containment of a PWR	SRP section is applicable. The design employs a conventional main steam system.
15.6.2	Radiological Consequences of the Failure of Small Lines Carrying Primary Coolant Outside Containment	SRP section is applicable. The design employs small lines carrying reactor coolant outside containment, such as instrument lines.
15.6.3	Radiological Consequences of Steam Generator Tube Failure	SRP section is applicable. The design employs an OTSG which is similar to operating PWR steam generators of the same type.
15.6.5.A	Radiological Consequences of a DB LOCA Including Containment Leakage Contribution	SRP section is applicable. This design employs a containment that is similar in design to other PWRs.
15.7.3	Postulated Radioactive Releases Due to Liquid-Containing Tank Failures	SRP section is applicable. This design includes presence of liquid containing tanks.
15.7.4	Radiological Consequences of Fuel Handling Accidents	SRP section is applicable. This design will include refueling activities, during which a fuel handling accident could occur.
15.7.5	Spent Fuel Cask Drop Accidents	SRP section is applicable. The design includes the spent fuel cask handling system.

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Maximum Hypothetical Accident
Loss of Coolant Accident

- The release of radioactivity from a nuclear power plant to the environment depends on the following factors:
  - the inventory of fission products and other radionuclides in the core,
  - the progression of core damage (if any),
  - the timing and fraction of radionuclide release from the fuel,
  - the physical and chemical forms of released radioactive materials,
  - the retention of radionuclides in the primary cooling system, and
  - the containment performance relative to radioactivity mitigation (e.g., leak rate, liquid effluent release rate, radioactive decay due to time delay of release, deposition on surfaces and resuspension)

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Design Features that Preclude Core Uncovery

- Low core average linear heat rate [ ] (vs. 18.7 or higher for conventional PWRs),
- High RCS volume per unit power of [ ] for conventional PWRs),
- Maximum break size of [ ] inches (vs. 36 inches for conventional PWRs),
- No Class 1 piping below the top of the pressurizer,
- High and low pressure ADVs to assure rapid primary system depressurization, assuring gravity-driven coolant injection from the RWST,
- IPITs providing additional coolant inventory during blow-down, and
- RWST coolant volume sufficient for at least 7 days

[Proprietary per Affidavit 4(a)-(f)]

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Delay [ ]

- Conservative model based on:
  - [

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  - No operator actions are assumed prior to 7 days into a LOCA

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Crediting Containment Deposition

- Four principal deposition phenomena considered
  - Sedimentation,
  - Brownian diffusion to surfaces,
  - Thermophoresis,
  - Diffusiophoresis
- MELCOR aerosol deposition model
  - [ ]
- [ ]

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EM and Assumptions

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LOCA Dose Results*

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Conclusion

- Preliminary LOCA dose results qualitatively show the benefits of mPower safety features

- Next Steps
  - Consider feedback from NRC on Radiological Source Term Methodology Position Paper
  - Complete preliminary analyses for remainder of Ch. 15 events
  - Prepare Accident Analysis Radiological Source Term Topical Report for submittal in 2Q2013

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