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U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER™ iPWR DESIGN

9.2.4 POTABLE AND SANITARY WATER SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of cooling water systems

Secondary – None

I. AREAS OF REVIEW

The potable and sanitary water system (PSWS) provides water for human consumption, sanitary and domestic purposes. The PSWS is typically nonsafety-related and provides no safety function; however, there could be portions of the PSWS that penetrate a safety-related boundary, such as the main control room boundary or primary containment.

The specific areas of review are as follows:

1. The system descriptions, and risk significance for the PSWS are reviewed. The piping and instrumentation drawings (P&IDs) may be reviewed as needed.
2. System design criteria to prevent connection to systems having the potential for containing radioactive material are reviewed.
3. The applicant's evaluation of the protection of PSWS piping against natural phenomena like earthquakes is to be reviewed. Protection of safety-related areas or components from the flooding will also be reviewed.
4. The applicant's evaluation of potential radiological contamination from any sharing (for multi-unit facilities) is to be reviewed.
5. Inspections, Tests, Analyses, and Acceptance Criteria. For design certification (DC) and combined license (COL), reviews the staff reviews the applicant's proposed Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) associated with the structures, systems, and components (SSCs) related to this Design Specific Review Standard (DSRS) section in accordance with Standard Review Plan (SRP) Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this DSRS section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.
6. COL Action Items and Certification Requirements and Restrictions. For a DC

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application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

7. The provisions for minimization of contamination of the facility and environment, the generation of radioactive waste, and the provisions to facilitate eventual decommissioning are reviewed.

Review Interfaces

Other DSRS/SRP sections interface with this section as follows:

1. DSRS Section 3.4.1: review for flood protection.
2. DSRS Section 6.2.4, review of the isolation of fluid systems penetrating the containment boundary.
3. DSRS Section 6.4: review of the isolation of fluid systems penetration of the main control room envelope/boundary
4. DSRS Sections 12.3-12.4: review for radiation protection design features.
5. SRP Section 19.0: review for probabilistic risk assessment and for the applicable risk classification.

The specific acceptance criteria and review procedures are contained in the referenced DSRS/SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. General Design Criterion 2 (GDC) 2 as it relates to SSCs important to safety being designed to withstand the effects of natural phenomena like earthquake, tornado, hurricane, flood, tsunami, and seiche without loss of capability to perform intended safety functions.
2. GDC 4 as it relates to SSCs important to safety being designed to accommodate the effects of, and to be compatible with, environmental conditions of normal operations,

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maintenance, testing, and postulated accidents, including loss-of-coolant accidents (LOCAs) and dynamic effects of pipe whip, missiles, and discharging fluids.

3. GDC 60, as it relates to design provisions provided to control the release of liquid effluents containing radioactive material from contaminating the PSWS.
4. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.
5. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.
6. 10 CFR 20.1406 as it relates to facility design and procedures for operation that will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this DSRS section. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. Identifying the differences between this DSRS section and the design features, analytical techniques, and procedural measures proposed for the facility, and discussing how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria, is sufficient to meet the intent of 10 CFR 52.47(a)(9), "Contents of applications; technical information."

1. Control of Releases of Radioactive Materials to the PSWS.

Information that addresses the requirements of GDC 60 in regards to controlling radioactive effluent releases is considered acceptable if the following are met:

- A. There are no interconnections between the PSWS and systems having the potential for containing radioactive material.
- B. The PSWS is protected by an air gap, where necessary.
- C. An evaluation of potential radiological contamination for safety implications of sharing (for multi-unit facilities) indicates that the system will not result in contamination beyond acceptable limits.

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2. Protection Against Natural Phenomena.

Information that addresses the requirements of GDC 2 regarding the capability of the PSWS itself to withstand the effects of natural phenomena will be considered acceptable if the guidance of Regulatory Guide (RG) 1.29, Position C.1 for safety-related portions of the PSWS and Position C.2 for nonsafety-related portions of the PSWS are appropriately addressed.

3. Environmental and Dynamic Effects.

Information that addresses the requirements of GDC 4 regarding consideration of environmental and dynamic effects will be considered acceptable if the acceptance criteria in the following DSRS sections, as they apply to the PSWS, are met: DSRS Section 3.4.1.

4. 10 CFR 20.1406

The requirements of 10 CFR 20.1406 are met when the design and procedures identify provisions to detect contamination that may enter as in-leakage from other systems, identifies potential collection points such as water treatment systems or system low points, and addresses the long term control of radioactive material in the system.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this DSRS section is discussed in the following paragraphs:

1. GDC 2 requires that nuclear power plant SSCs important to safety be designed to withstand the effects of natural phenomena like earthquake, tornado, hurricane, flood, tsunami, and seiche without loss of capability to perform intended safety functions.

The function of the PSWS is to supply potable water for human consumption, cleaning and other domestic purposes, plus process water to other systems, during periods of normal operation, shutdown, maintenance and construction. If the PSWS penetrates the boundary of a safety-related SSC, such as by supplying water to the main control room, failure of the system could affect ability of the main control room to be pressurized to withstand air inleakage. GDC 2 applies to this portion of the PSWS to ensure that the PSWS can withstand the effects of all appropriate combinations of seismic and dynamic effects from these natural phenomena without loss of capability to perform design safety functions.

GDC 2 requirements provide assurance that the PSWS and its equipment can withstand the most severe historical natural phenomena combined with appropriate normal operations and accident conditions without loss of capability to perform intended safety functions, or its failure will not prevent any other SSCs important to safety from performing their intended safety function.

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2. GDC 4 requires that SSCs important to safety be designed to accommodate the effects of, and to be compatible with, environmental conditions of normal operations, maintenance, testing, and postulated accidents, including loss-of-coolant accidents (LOCAs) and dynamic effects of pipe whip, missiles, and discharging fluids.

If the PSWS is routed within the boundary of the main control room, potential leakage from the system could impact control room instrumentation. GDC 4 applies to any portion of the PSWS in that area and the reviewer evaluates the PSWS and its equipment to verify that their failure caused by exposure to environmental conditions of normal operations, maintenance, testing, or postulated accidents, including LOCAs and dynamic effects of pipe whip, missiles, and discharging fluids will not prevent any other SSCs important to safety from performing their intended safety function.

3. Compliance with GDC 60 requires that the nuclear power unit design include, among other things, a suitable means to control the release of radioactive materials in liquid effluents.

GDC 60 applies to this DSRS section because potable and sanitary water systems have liquid effluents that must be suitably controlled to prevent the release of radioactive materials.

Meeting the requirements of GDC 60 provides assurance that design provisions are in place to prevent liquid effluents containing radioactive materials from contaminating the PSWS and being released to the environment.

4. 10 CFR 20.1406 requires the design of a nuclear power unit to address minimization of contamination of the facility and the environment, and ease of eventual decommissioning.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below.

These review procedures are based on the identified DSRS acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

1. Programmatic Requirements - In accordance with the guidance in NUREG – 0800 *“Introduction,” Part 2* as applied to this DSRS Section, the staff will review the programs proposed by the applicant to satisfy the following programmatic requirements. If any of the proposed programs satisfies the acceptance criteria described in Subsection II, it can be used to augment or replace some of the review procedures. It should be noted that the wording of “to augment or replace” applies to nonsafety-related risk-significant SSCs, but “to replace” applies to nonsafety-related nonrisk-significant SSCs according to the “graded approach” discussion in NUREG-0800 *“Introduction,” Part 2*. Commission regulations and policy mandate programs applicable to SSCs that include:

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- A. Maintenance Rule SRP Section 17.6 (DSRS Section 13.4, Table 13.4, Item 17, Regulatory Guides 1.160, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.” and RG 1.182; “Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants”.
 - B. Quality Assurance Program SRP Sections 17.3 and 17.5 (DSRS Section 13.4, Table 13.4, Item 16).
 - C. Technical Specifications (DSRS Section 16.0 and SRP Section 16.1) – including brackets value for DC and COL. Brackets are used to identify information or characteristics that are plant specific or are based on preliminary design information.
 - D. Reliability Assurance Program (SRP Section 17.4).
 - E. Initial Plant Test Program (Regulatory Guide 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants,” DSRS Section 14.2, and DSRS Section 13.4, Table 13.4, Item 19).
 - F. ITAAC (DSRS Chapter 14).
- 2. In the review of the PSWS, the reviewer considers the design criteria to prevent cross-connections, as described in the SAR. The P&IDs are reviewed at the DCD/COL stage to verify the absence of the potential for contamination of the PSWS with radioactive materials.
 - 3. The applicant’s evaluation of potential radiological contamination for safety implications of sharing (for multi-unit facilities) is to be reviewed.
 - 4. In the review of the PSWS, the reviewer considers flooding consequences as a result of the PSWS tank rupture, piping system breaks, and open flow paths (for example overflow of a toilet in the main control room boundary).

For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

For review of both DC and COL applications, DSRS Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

IV. EVALUATION FINDINGS

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The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

1. The PSWS include all components and piping from the supply connection to the municipal or other water source to all points of discharge to sewage facilities or other plant systems.
2. The applicant meets GDC 2 requirements for system safety-related portions capable of withstanding the effects of natural phenomena. Acceptance is based on RG 1.29, Position C.1 for the safety-related portions and Position C.2 for the nonsafety-related portions.
3. The applicant meets GDC 4 requirements for flood protection of safety-related components and areas in the event of the failure of PSWS piping or components.
4. Based on our review of the applicant's design criteria and design bases for the potable and sanitary water systems, we conclude that acceptable design provisions have been made to prevent the inadvertent contamination of the systems with radioactive material, and therefore find the proposed design of the potable and sanitary water system meets the requirement of GDC 60 and therefore is acceptable.
5. An evaluation of potential radiological contamination for safety implications of sharing (for multi-unit facilities) was conducted by the applicant and the results are acceptable.
6. The applicant meets 10 CFR 20.1406 requirements for minimization of contamination of the facility and the environment, and for avoiding design features that would interfere with eventual decommissioning.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this DSRS section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

V. IMPLEMENTATION

The staff will use this DSRS section in performing safety evaluations of mPower™-specific DC, COL, or early site permit (ESP) applications submitted by applicants pursuant to 10 CFR Part 52. The staff will use the method described herein to evaluate conformance with Commission regulations.

Because of the numerous design differences between the mPower™ and large light-water nuclear reactor power plants, and in accordance with the direction given by the Commission in SRM- COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010 (ML102510405), to develop risk-informed licensing review plans for each of the small modular reactor (SMR) reviews

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including the associated pre-application activities, the staff has developed the content of this DSRS section as an alternative method for mPower™ -specific DC, COL, or ESP applications submitted pursuant to 10 CFR Part 52 to comply with 10 CFR 52.47(a)(9), “Contents of applications; technical information.”

This regulation states, in part, that the application must contain “an evaluation of the standard plant design against the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application.” The content of this DSRS section has been accepted as an alternative method for complying with 10 CFR 52.47(a)(9) as long as the mPower™ DCD FSAR does not deviate significantly from the design assumptions made by the NRC staff while preparing this DSRS section. The application must identify and describe all differences between the standard plant design and this DSRS section, and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria. If the design assumptions in the DC application deviate significantly from the DSRS, the staff will use the SRP as specified in 10 CFR 52.47 (a)(9). Alternatively, the staff may revise the DSRS section in order to address new design assumptions. The same approach may be used to meet the requirements of 10 CFR 52.17 (a)(1)(xii) and 10 CFR 52.79 (a)(41), for ESP and COL applications, respectively.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 60, “Control of Releases of Radioactive Materials to the Environment.”
2. 10 CFR Part 50, Appendix A, GDC 2, “Design Bases for Protection Against Natural Phenomena.”
3. 10 CFR Part 50, Appendix A, GDC 4, “Environmental and Dynamic Effects Design Bases.”
4. 10 CFR Part 20.1406, “Minimization of Contamination.”
5. RG 1.29, “Seismic Design Classification.”