

Proposed - For Interim Use and Comment



U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER™ iPWR DESIGN

10.4.6 CONDENSATE CLEANUP SYSTEM

Primary - Organization responsible for the review of chemical engineering issues

Secondary - None

I. AREAS OF REVIEW

The mPower™ integral pressurized water reactors (iPWR) designed by B&W includes a condensate cleanup system (CCS) that removes dissolved and suspended impurities resulting from corrosion caused by condenser or steam generator leaks that could be introduced into the CCS by carryover from the main steam system. The CCS is non-safety related and non-risk significant. The CCS is not necessary for safe shutdown or mitigation of postulated accidents, but it is important in maintaining the primary coolant quality in direct cycle plants or the secondary coolant quality in indirect cycle plants.

The specific areas of review are as follows:

1. The staff will review the design of the condenser to ensure that chloride and other contaminant concentrations are limited to allowable values until the condensate and feedwater systems can be isolated in the event of condenser tube leaks.
2. The staff will review provisions to ensure that the water purity criteria are maintained.
3. The staff will review the compatibility of the materials of construction with the service conditions in the system.
4. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this 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.
5. COL Action Items and Certification Requirements and Restrictions. For a DC 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.

Review Interfaces

Other SRP and design-specific review standard (DSRS) sections interface with this section as follows:

1. Review of the adequacy of the design with respect to breaks and cracks in high- and moderate-energy system piping is performed under SRP Section 3.6.1.
2. Review of the functional design criteria and seismic design classification for the connection between the CCS and the condensate and feedwater system is performed under DSRS Section 10.4.7.
3. Review of the effect of CCS on fission and corrosion product concentrations and the effect of the quantity of spent resin and regenerant solution on radwaste system requirements is performed under DSRS Sections 11.2, 11.3, and 11.4.
4. Review of the shielding design of the condensate demineralized system is performed under DSRS Section 12.2.
5. Review of the technical specifications is performed under DSRS Section 16.0.
6. Review of the probabilistic risk assessment performed under SRP Chapter 19.0 for potential risk significant CCS elements.

II. ACCEPTANCE CRITERIA

Requirements

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

1. General Design Criterion (GDC) 14 found in Appendix A to 10 CFR Part 50, as it relates to the reactor coolant pressure boundary being designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture.
2. 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.
3. 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 (AEA), and the U.S. Nuclear Regulatory Commission's (NRC's) regulations.

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for 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."

Specific criteria acceptable to meet the requirements of GDC 14 are as follows:

1. For indirect cycle (pressurized-water reactor (PWR)) plants, DSRS Section 5.4.2.1 provides the criteria for acceptable secondary water chemistry. DSRS Section 5.4.2.1 refers to the guidelines provided in the latest version in the EPRI report series, "PWR Secondary Water Chemistry Guidelines."

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 paragraph:

GDC 14 requires that the reactor coolant pressure boundary be designed, fabricated, erected, and tested to ensure an extremely low probability of abnormal leakage, rapidly propagating failure, and gross rupture. GDC 14 applies to DSRS Section 10.4.6 because the CCS maintains water quality to avoid corrosion-induced failure of the reactor pressure boundary.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

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.

The reviewer will evaluate the system design information and drawings. Using engineering judgment, operational experience, and performance characteristics of similar, previously approved systems, the reviewer will verify the following:

1. In accordance with 10 CFR 52.47(a)(8),(21), and (22), and 10 CFR 52.79(a)(17) and (20), for new reactor license applications submitted under Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues and medium- and high-priority generic safety issues which are identified in the version of NUREG-0933 current on the date up to 6 months before the docket date of the

application and which are technically relevant to the design; (2) demonstrate how the operating experience insights have been incorporated into the plant design; and, (3) provide information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v). These cross-cutting review areas should be addressed by the reviewer for each technical subsection and relevant conclusions documented in the corresponding safety evaluation report (SER) section.

2. The system meets the criteria for the condensate cleanup capacity, provides effluent of the necessary purity, and contains adequate instrumentation to monitor the effectiveness of the system.
3. The system is connected to radioactive waste disposal systems to allow disposal of spent resin or regenerant solutions when necessary.
4. The materials of construction are compatible with the service environment.

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 technical submittal meets the acceptance criteria. DCs have referred to the technical submittal 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 technical submittal.

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 or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

For review of both DC and COL applications, SRP 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

The reviewer verifies that the applicant has provided sufficient information and that the staff's technical review and analysis, , is in accordance with the staff's review approach in the DSRS Introduction, 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.

The condensate cleanup system includes all components and equipment necessary for the removal of dissolved and suspended impurities that may be present in the condensate. Based on the staff's review of the applicant's proposed design criteria and design bases for the condensate cleanup system and the criteria for operation of the system, the staff concludes that the design of the condensate cleanup system and supporting systems is acceptable and meets the applicable reactor coolant pressure boundary integrity requirements of GDC 14. This conclusion is based on the applicant having met the guidelines in the latest version in the EPRI report series, "PWR Secondary Water Chemistry Guidelines," with respect to maintaining acceptable chemistry control [for iPWR secondary coolant] during normal operation and anticipated operational

occurrences by reducing corrosion [PWR steam generator tubes and materials], thereby reducing the likelihood and magnitude of primary-to-secondary coolant leakage.

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, or COL, 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 including the associated pre-application activities, the staff has developed the content of this DSRS section as an alternative method for mPower™-specific DC, or COL 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 six 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 supplement the DSRS section by adding appropriate criteria in order to address new design assumptions. The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, GDC 14, "Reactor Coolant Pressure Boundary."
2. 10 CFR 52.47, "Contents of Applications."
3. 10 CFR 52.80, "Contents of Applications; additional technical information."
4. Electric Power Research Institute Report Series, "PWR Secondary Water Chemistry Guidelines."

5. RG 1.215, "Guidance for ITAAC Closure Under 10 CFR Part 52."
6. RG 1.68, "Initial Test Programs For Water-Cooled Nuclear Power Plants."