

# Proposed - For Interim Use and Comment



## U.S. NUCLEAR REGULATORY COMMISSION DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER™ iPWR DESIGN

### 14.3.7 PLANT SYSTEMS - INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA

#### REVIEW RESPONSIBILITIES

**Primary** - Organizations Responsible for the Review of Plant Systems

**Secondary** - None

#### I. AREAS OF REVIEW

This Design Specific Review Standard (DSRS) section addresses inspections, tests, analyses, and acceptance criteria (ITAAC) related to the plant systems. ITAAC information is contained in the final safety analysis report (FSAR) of a combined license (COL) application or Tier 1 information from the design control document of a design certification (DC) application.

The specific areas of review are as follows:

1. New and spent fuel handling systems, power generation systems, air systems, cooling water systems, radioactive waste systems and heating, ventilation and air conditioning systems and fire protection systems. This includes systems, structures and components (SSCs) which may have special considerations for regulatory treatment of non-safety systems (RTNSS) or defense-in-depth functions.
2. Issues which affect multiple SSCs such as equipment qualification and protection from fires, floods and tornado missiles.
3. For a DC application:
  - A. The staff reviews 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.
  - B. The staff reviews the justification that compliance with the interface requirements is verifiable through ITAAC. The staff also reviews the method that is to be used for verification of the interface requirements.
4. For a COL application:

- A. The staff reviews the proposed plant-specific ITAAC 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 Atomic Energy Act, and the NRC's regulations.
  - B. If the application references a standard design certification, the staff verifies that the ITAAC contained in the certified design apply to those portions of the facility design that are approved in the design certification.
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 DSRS/ Standard Review Plan (SRP) sections interface with this section as follows:

1. DSRS Sections 11.2 to 11.5 provides guidance of waste management systems and radiological monitoring systems
2. SRP Section 14.3 provides general guidance on ITAAC information.
3. Acceptability of ITAAC information regarding building structures and structural aspects of major components and the ability of SSCs to withstand various natural phenomena is reviewed under DSRS Section 14.3.2.
4. Acceptability of ITAAC information for piping design is reviewed under DSRS Section 14.3.3.
5. Acceptability of ITAAC information for instrumentation and controls is reviewed under DSRS Section 14.3.5.
6. Acceptability of ITAAC information for electrical systems and components is reviewed under DSRS Section 14.3.6.
7. Review of probabilistic risk assessment and applicable risk classification is performed under SRP Section 19.0.
8. Review of RTNSS is performed under SRP Section 19.3.

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. 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 rules and regulations.
2. 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.

## DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified are set forth below. 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." The same approach may be used to meet the requirements of 10 CFR 52.79(a)(41) for COL applications.

1. The reviewer should utilize the DSRS with SRP section 19.3 in its review of Tier 1 to determine the safety classification and/or risk significance of SSCs. Other sources include applicable rules and regulations, GDCs, RGs, USIs and GSIs, NRC generic correspondence, PRA, insights from the standard design's safety and severe accident analyses, and operating experience. Tier 1 should be reviewed for consistency with the initial test program described in DCD Tier 2 Chapter 14.2. The reviewer should also use the review checklists provided in Appendix C to DSRS Section 14.3 as an aid for establishing consistency and comprehensiveness in his review of the systems. If applicable, the reviewer should utilize regulatory guidance from the Commission for selected policy and technical issues related to a particular design. Examples of these are contained in SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs." The SRM related to this is dated July 21, 1993.
2. Tier 1 should be reviewed for treatment of design information proportional to the safety significance and risk significance of the SSC for that system. Many items may be judged to be risk-significant, and thus should be included in Tier 1. The following issues are

identified to ensure comprehensive and consistent treatment in Tier 1 based on the safety significance and/or risk significance of the system being reviewed:

- A. System purpose and functions (including defense-in-depth functions and RTNSS considerations)
  - B. Location of system
  - C. Key design features of the system
  - D. Seismic and ASME code classifications
  - E. System operation in various modes
  - F. Controls, alarms, and displays
  - G. Logic
  - H. Interlocks
  - I. Class 1E electrical power sources and divisions
  - J. Equipment to be qualified for harsh environments
  - K. Interface requirements
  - L. Numeric performance values
  - M. Accuracy and quality of figures
  - N. Functional arrangement
  - O. Valve qualification and operation
3. Standard ITAAC entries should be utilized to verify selected issues, where appropriate. The reviewer should ensure consistent application and treatment of the standard ITAAC entries for basic configuration ITAAC, pump net positive suction head, and physical separation for appropriate systems in Tier 1. In particular, the general provision for environmental qualification aspects of SSCs invoked by the basic configuration ITAAC should be reviewed to ensure appropriate treatment in Tier 1.
  4. Environmental qualification (EQ) of safe-shutdown equipment may be verified as part of the basic configuration ITAAC for safety-related systems. EQ treatment in the ITAAC would then be discussed in the General Provisions section of Tier 1. Verification may include type tests or a combination of type tests and analyses of Class 1E electrical equipment identified in the Design Description or accompanying figures to show that the equipment can withstand the conditions associated with a design basis accident without loss of safety function for the time that the function is needed.
  5. The design features in Tier 1 should be selected to ensure that the integrity of the analyses is preserved in an as-built facility. For example, 3-hour fire boundaries and divisional separation may be shown in the building figures. Also, flooding features such as structure elevations should be specified in the site parameters, flood doors may be shown on the building figures, and elevations are shown on the buildings to verify that the approximate physical location of components and relative elevations of buildings minimize the effects of flooding. As-built reconciliation reports for fires and floods to ensure consistency with Tier 2 analyses should be required by the appropriate system ITAAC (e.g., fire protection system) and selected building ITAAC, respectively.
  6. Other specific issues that should be addressed include heat removal capabilities for design-basis accidents and tornado and missile protection. Heat removal capabilities may be verified through heat removal requirements for core cooling system heat exchangers and interface requirements for site-specific systems. Tornado and missile protection may be provided by inlet and outlet dampers in ventilation systems, and

through the structural design of buildings. In addition, water hammer mitigating design features should be addressed.

7. The areas of review for radioactive waste systems include design objectives, design criteria, identification of all expected releases of radioactive effluents, methods of treatment, methods used in calculating effluent source terms and releases of radioactive materials in the environment, and operational programs in controlling and monitoring effluent releases and for assessing associated doses to members of the public. The radioactive waste systems include the liquid waste management system (LWMS), gaseous waste management system (GWMS), and the solid waste management system (SWMS). These systems deal with the management of radioactive wastes, as liquid, wet, and dry solids, produced during normal operation and anticipated operational occurrences. In addition, the review includes an evaluation of the process and effluent radiological monitoring instrumentation and sampling systems (PERMISS) which are used to monitor liquid and gaseous process streams and effluents and solid wastes generated by these systems. The PERMISS includes subsystems used to collect process and effluent samples during normal operation, anticipated operational occurrences, and under post-accident conditions. The lead branch responsible in implementing the review should coordinate the review of these systems and operational programs and receive input on the design and compliance with acceptance criteria listed in DSRs Sections 11.2 to 11.5 from other branches, including, balance of plant, structural, instrumentation and controls, HVAC, quality assurance, technical specifications, and emergency planning.
8. The reviewer should receive inputs on the treatment of issues identified above from other branches such as the structural, electrical and I&C branches. In addition, the secondary review branches specified in SRP Section 14.3 should provide inputs on selected issues. These issues include key insights and assumptions from PRA and severe accident analyses, as well as inputs for issues such as treatment of alarms, displays and controls, and functionality of motor operated valves (MOV) and air operated valves (AOV). Cross-references from Tier 2 to Tier 1 for key insights and assumptions from PRA and severe accidents should be provided by applicants in Tier 2 together with these analyses.
9. Tier 1 should address and verify at least the minimum inventory of alarms, controls, and indications as derived from the Emergency Procedure Guidelines, the requirements of RG 1.97, and probabilistic risk assessment insights. These may be specified in the MCR and the Remote Shutdown System (RSS) ITAAC, or addressed in the appropriate ITAAC, and verified to exist. Other controls, indications and alarms should be identified in the system ITAAC based on their safety and/or risk significance. Locations for these should be shown on system figures if important to system design and function. The ability of these controls, indications, and alarms to function should be checked during operation of the system for the functional tests required by the system ITAAC. Because the intent of the ITAAC is to verify the final as-built condition of the plant, the operation of the system during the completion of the functional tests required in the system ITAAC should be conducted from the MCR. Therefore, the verification that the system can be operated from the MCR need not be a separate ITAAC. Also, because the operation of the equipment from the control room demonstrates the control function, continuity checks between the RSS and the equipment demonstrates that the control signal will be received by the component and provides adequate assurance that the equipment can be

operated by the RSS. The results of the pre-operational test program may be utilized to demonstrate the ability to operate plant equipment by the RSS.

10. 10 CFR 52.47(b)(1) specifies that the application of a design certification should contain proposed ITAAC for SSCs necessary and sufficient to assure the plant is built and will operate in accordance with the design certification. 10 CFR 52.97(b) specifies that the COL identifies the ITAAC for SSCs necessary and sufficient to assure that the facility has been constructed and will be operated in conformity with the license. DSRS 14.3 provides guidance for reviewing the ITAAC. The requirements of 10 CFR 52.47(b)(1) and 10 CFR 52.97(b) will be met, in part, by identifying inspections, tests, analyses, and acceptance criteria of the top-level design features of the plant systems engineering in the design certification application and the combined license, respectively.

### 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. Application of 10 CFR 52.47(b)(1), as it relates to ITAAC (for design certification) provides reasonable assurance that the SSCs in this area of review will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.
2. Application of 10 CFR 52.80(a), as it relates to ITAAC (for combined licenses) provides reasonable assurance that the SSCs in this area of review have been constructed and will be operated in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

### 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.

1. Follow the general procedures for review of Tier 1 contained in the Review Procedures section of SRP Section 14.3. Ensure that the DCD is consistent with Appendix A to SRP Section 14.3.
2. Ensure that all Tier 1 information is consistent with Tier 2 information. Figures and diagrams should be reviewed to ensure that they accurately depict the functional arrangement and requirements of the systems. Reviewers should use the Review Checklists in Appendix C to SRP Section 14.3 as an aid in establishing consistent and comprehensive treatment of issues.
3. Ensure that the plant systems are clearly described in Tier 1, including the key performance characteristics and safety and/or defense-in-depth functions of SSCs based on their safety and risk significance.

4. The reviewer should ensure that appropriate guidance is provided to other branches such that plant systems issues in Tier 1 are treated in a consistent manner among branches.
5. Ensure that the standard ITAAC entries related to plant systems items are included in the appropriate systems of the standard design. In particular, the reviewer should review the basic configuration ITAAC for verification of environmental qualification. The reviewer should ensure consistent application and treatment of the standard ITAAC entries for basic configuration ITAAC, pump net positive suction head, and physical separation for appropriate systems in Tier 1.
6. Ensure that design features from the resolutions of selected policy and technical issues are adequately addressed in Tier 1, based on safety and risk significance. Ensure that the appropriate Commission guidance, requirements, bases and resolutions for these items are documented clearly in the SER.
7. Ensure that definitions, legends, interface requirements, and site parameters that pertain to plant systems issues are treated consistently and appropriately in Tier 1.
8. 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).

9. Implementation of ITAAC will be inspected in accordance with NRC Inspection Manual Chapter IMC-2503, "Construction Inspection Program - ITAAC Inspections."

#### IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the staff's technical review and analysis 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 reviewer verifies that sufficient information has been provided to satisfy DSRS Section 14.3 and this DSRS section, and concludes that the ITAAC is acceptable. A finding similar to that in the Evaluation Findings section of DSRS Section 14.3 should be provided in a separate section of the SER.
2. 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.

## V. IMPLEMENTATION

The staff will use this DSRS section in performing safety evaluations of mPower™-specific design certification (DC), or combined license (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, 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 supplement the DSRS section by adding the 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 52.47, "Contents of Applications."
2. 10 CFR 52.80(a), "Contents of Applications."
3. 10 CFR 50.48, "Fire Protection."
4. 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants."
5. RG 1.97, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident."
6. RG 1.206, "Combined License Applications for Nuclear Power Plants".
7. RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants."
8. RG 1.215, "Guidance for ITAAC Closure Under 10 CFR Part 52."
9. NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor," Volumes 1 and 2, July 1994.



10. NUREG-1462, "Final Safety Evaluation Report Related to the Certification of the System 80+ Design," Volumes 1 and 2, August 1994.
11. NRC Inspection Manual Chapter IMC-2503, "Construction Inspection Program - ITAAC Inspections," issued April 26, 2006.
13. SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs."