

# Proposed - For Interim Use and Comment



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

### **14.3.8 RADIATION PROTECTION - INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA**

#### **REVIEW RESPONSIBILITIES**

**Primary** - Organization responsible for the review of radiation protection

**Secondary** - None

#### **I. AREAS OF REVIEW**

This Design-Specific Review Standard (DSRS) section addresses inspection, test, analysis, and acceptance criteria (ITAAC) related to the radiation protection aspects of the design. ITAAC information is contained in the final safety analysis report (FSAR) of a combined license (COL) application or in the Tier 1 information from the design control document (DCD) of a design certification (DC) application.

The specific areas of review are as follows:

1. Primary review responsibility for area radiation monitoring systems and airborne radioactivity monitoring systems.
2. Primary review responsibility for radiation shielding provided by structures and components for normal and emergency conditions.
3. Primary review responsibility for design processes for radiation protection and their related design acceptance criteria (DAC).
4. Secondary review responsibility for all other Tier 1 and ITAACs which address the plant radiation protection design. These ITAACs include buildings, ventilation and filtration systems, and the process sampling systems.
5. 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 plant that incorporates the DC is built and will operate in accordance with the DC, the Atomic Energy Act (AEA), and the U.S. Nuclear Regulatory Commission's (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.

6. For a COL 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, the facility has been constructed and will operate in conformity with the COL, the AEA, and the NRC's regulations.
  - B. If the application references a standard DC, the staff verifies that the ITAAC contained in the certified design apply to those portions of the facility design that are approved in the DC.
7. 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

Systems described in the Technical Submittal may differ from those outlined in the DSRS. The staff should use the following recommended section interfaces as the basis for reviewing other supplemental or complementary information provided in the Technical Submittal for the specific plant design to identify ITAAC for radiation protection design features:

1. Standard Review Plan (SRP) Section 14.3 provides general guidance on review interfaces.
2. Acceptability of ITAAC information regarding the ability of structures, systems, and components (SSCs) to withstand various natural phenomena is reviewed under DSRS Section 14.3.2.
3. Acceptability of ITAAC information for piping design is reviewed under SRP Section 14.3.3.
4. Acceptability of ITAAC information for reactor systems is reviewed under DSRS Section 14.3.4.
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. Acceptability of ITAAC information for plant systems, including the heating, ventilation, and air conditioning design, containment isolation, and selected aspects of the containment design is reviewed under DSRS Section 14.3.7.

8. Acceptability of ITAAC information for emergency preparedness is reviewed under SRP Section 14.3.10.
9. Acceptability of ITAAC information for containment systems is reviewed under SRP Section 14.3.11.

## 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 plant that incorporates the DC is built and will operate in accordance with the DC, the provisions of the AEA, and the NRC's 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 COL, the provisions of the AEA, and the NRC's regulations.

10 CFR 20.1406 Requires that the DC application design minimizes, to the extent practicable, contamination to the facility and to the environment and 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 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 primarily use the applicable rules and regulations, general design criteria (GDC), regulatory guides (RGs), unresolved safety issues, and generic safety issues in the review of Tier 1 to determine the safety significance of SSCs with respect to the radiation protection for occupational workers and the general public they provide. Other sources include the DSRS and applicable NRC generic correspondence. The reviewer should use the guidance in Appendix C to SRP Section 14.3 as an aid for ensuring the comprehensiveness and consistency of this review.
2. Radiation Protection: The reviewer should ensure that Tier 1 identifies and describes, commensurate with their safety significance, those SSCs that provide radiation

shielding, confinement or containment of radioactivity, ventilation of airborne contamination, or radiation (or radioactivity concentration) monitoring for normal operations and during accidents. Tier 1 identifies and describes the measures that need to be employed during first-of-a-kind engineering to ensure that final design details (i.e., materials and component selection, equipment placement, and pipe routing) are consistent with the radiation protection commitments (including the commitment that radiation exposures will be as low as is reasonably achievable (ALARA)) in the certified design. Tier 1 contains ITAAC that ensure that the identified SSCs will function in a manner consistent with the certified design.

3. Design Processes and Design Acceptance Criteria: A DC applicant may not provide sufficient detail in selected aspects of the design, including sufficient information to stipulate the source terms needed to verify the design of the shielding, ventilation, and airborne radioactivity monitoring systems. The applicant may choose to provide design processes and DAC for this material, as discussed in Appendix A to SRP Section 14.3. The applicant should document in DCD Tier 2, Section 14.3, its rationale for determining which areas of the design should use design processes and acceptance criteria. Essentially, the applicant should extract the most important design processes and acceptance criteria from DCD Chapter 12 of Tier 2 and identify them in Tier 1. This may be done either in a separate section of Tier 1 or in the applicable systems of Tier 1. A COL applicant or licensee must meet these criteria in the design of the plant, and the staff can audit the facility's design documentation to ensure that the criteria are met. The following discussion is specific to the review of design processes and acceptance criteria in this area.

DC applicants may not provide the complete design information in this design area before the design is certified because the radiation shielding design and the calculated concentrations of airborne radioactive material depend on as-built and as-procured information about plant systems and components. Therefore, applicants may be unable to describe the standard design's radiation source terms (i.e., the quantity and concentration of radioactive materials contained in, or leaking from, plant systems) in sufficient detail to allow the staff to verify the adequacy of the shielding design, ventilation system designs, or the design and placement of the airborne radioactivity monitors. Instead, applicants may provide the processes and acceptance criteria by which the details of the design in this area are to be developed, designed, and evaluated. The design description should state the scope of the material in Tier 1. The application could, for example, encompass the radiological shielding and ventilation design of the reactor building, turbine building, control building, service building, and radwaste building. The COL applicant or licensee is responsible for the implementation of the process and the design.

The DAC may be taken from the acceptance criteria in the applicable sections of Chapter 12 of the DSRS. The analysis methods and source term assumptions specified in the DAC should be consistent with the approved methods and assumptions listed in the DSRS. The DSRS is the basis for the staff's safety review of the standard design. Therefore, demonstrating that the final design meets these DAC with the methods and assumptions specified in Tier 1 ensures that the as-built design will meet the applicable acceptance criteria of the DSRS and the associated regulations and staff technical positions.

The DAC in Tier 1 should address the verification of the plant radiation shielding design and the plant airborne concentrations of radioactive materials (e.g., the ventilation

system and airborne monitoring system designs). The DAC should require the COL applicant to calculate radiation levels and airborne radioactivity levels within the plant rooms and areas to verify the adequacy of these design features during plant construction (concurrently with the verification of the ITAAC). The plant rooms and areas to which the DAC apply may be given in figures in Tier 1. The appropriate section of DCD Tier 2, Chapter 12, should include detailed supporting information for the DAC.

The criteria in Tier 1 should ensure that the radiation shielding design (as provided by the plant structures or by permanent or temporary shielding included in the design) is adequate so that the maximum radiation levels in plant areas are commensurate with the areas' access requirements. This will allow radiation exposures to plant personnel to be maintained ALARA during normal plant operations and maintenance. Tier 1 should ensure that adequate shielding is provided for those plant areas that may require occupancy to permit an operator to aid in the mitigation of or the recovery from an accident. Tier 1 should ensure that the contribution of gamma shine to the radiation dose (particularly from the turbine building) to a member of the public (off site) will be a small fraction of the U.S. Environmental Protection Agency's dose limits in found at 40 CFR Part 190.

The criteria in Tier 1 should ensure that the plant provides adequate containment and ventilation flow rates to control the concentrations of airborne radioactivity to levels commensurate with the access requirements of areas in the plant. Tier 1 should ensure that once the concentrations of airborne radioactivity are determined, the required airborne monitors are placed in the appropriate locations in the plant.

4. In accordance with 10 CFR 20.1406 applications must describe how contamination and generation of radioactive waste are minimized. RG 4.21 describes an acceptable method for demonstrating compliance with design related requirements of 10 CFR 20.1406.
5. 10 CFR 52.47(b)(1) specifies that the application of a DC should contain proposed ITAAC for SSCs necessary and sufficient to assure the plant is built and will operate in accordance with the DC. 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. SRP Section 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 radiation protection and components in the DC application and the COL, 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 DC), provides reasonable assurance that the SSCs in this area of review will operate in accordance with the design certification, the provisions of the AEA, and the NRC's regulations.
2. Application of 10 CFR 52.80(a), as it relates to ITAAC (for COLs), 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 AEA, and the NRC's regulations.

3. Compliance with 10 CFR 20.1406 requires the design of a nuclear power plant to address the minimization of contamination of the facility and the environment. This is accomplished by considering the design features and operation of SSCs that contain or handle radioactive material as described in the COL technical submittal. Regulatory positions C.1 through C.4 of RG 4.21 describe concepts to be implemented to provide reasonable assurance that inadvertent spills, leaks, and discharges of liquid, gaseous, and solid radioactive effluents are prevented, detected, and corrected.

### III. REVIEW PROCEDURES

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.

Specifically, the reviewer should perform the following:

1. The reviewer should 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. Review responsibilities may be consistent with those in Appendix B to SRP Section 14.3.
2. The reviewer should 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. The reviewer should ensure that Tier 1 clearly describes the SSCs that provide a significant radiation protection function, including the key performance characteristics and safety functions of SSCs based on their safety significance.
4. The reviewer should ensure that Tier 1 identifies and describes the measures that are to be employed during first-of-a-kind engineering to ensure that final design details (i.e., materials and component selection, equipment placement, and pipe routing) are consistent with the radiation protection commitments in the certified design.
5. The reviewer should ensure that appropriate guidance is provided to other branches so that radiation protection issues in Tier 1 are treated in a consistent manner among branches.
6. The reviewer should ensure that Tier 1 adequately addresses design features from the resolution of selected policy and technical issues on the basis of their safety significance. Ensure that the safety evaluation report (SER) clearly documents the appropriate Commission guidance, requirements, bases, and resolutions for these items.
7. 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 FSAR meets the acceptance criteria. DCs have

referred to the FSAR as the 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.

- A. 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).
8. Implementation of the ITAAC will be inspected in accordance with NRC Inspection Manual Chapter (IMC)-2503, "Construction Inspection Program: Inspections of Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) Related Work," October 3, 2007.
  9. The reviewer should ensure that the guidance contained in the issued final Interim Staff Guidance (ISG) documents associated with applications for new reactors is followed:
    - A. ISG on Post-Combined License Commitments (DC/COL-ISG-15).

#### IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the FSAR review and analysis support conclusions of the following type to be included in the staff's SER. The reviewer also states the bases for those conclusions.

1. The reviewer verifies that sufficient information has been provided to satisfy the requirements of SRP 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 SRP 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 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 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 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 20, Section 1406, “Minimization of Contamination
2. 10 CFR 52.47, “Contents of Applications; Technical Information.”
3. 10 CFR 52.80, “Contents of Applications; Additional Technical Information.”
4. 40 CFR Part 190, Environmental Radiation Protection Standards for Nuclear Power Operations
5. NRC IMC-2503, “Construction Inspection Program: Inspections of Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) Related Work,” October 3, 2007.
6. ISG DC/COL-ISG-015, “Post-Combined License Commitments.”
7. RG 1.68, “Initial Test Program for Water-Cooled Nuclear Power Plants.”
8. RG 1.160, “Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.”
9. RG 1.182, “Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants.”
10. RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition).”
11. RG 1.215, “Guidance for ITAAC Closure Under 10 CFR Part 52.”
12. RG 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning.”