

# Proposed - For Interim Use and Comment



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

### 12.1 ASSURING THAT OCCUPATIONAL RADIATION EXPOSURES ARE AS LOW AS IS REASONABLY ACHIEVABLE

#### REVIEW RESPONSIBILITIES

**Primary** - Organization responsible for the review of health physics issues.

**Secondary** - None

#### I. AREAS OF REVIEW

The staff will review the applicant's final safety analysis report (FSAR) for a design certification (DC) or combined license (COL) as it relates to assuring that occupational radiation exposure (ORE) will be as low as is reasonably achievable (ALARA).

The specific areas of review are as follows:

#### 1. Policy Considerations

- A. The applicant's management policy with respect to designing and constructing the plant (DC FSAR or COL FSAR), and the planned organizational structure (COL FSAR).
- B. The applicable activities carried on by the applicant's management personnel having responsibility for radiation protection (COL FSAR).
- C. Information describing the applicant's implementation of policy, organization, training, and design review guidance provided in Regulatory Guides (RGs) 1.8, 8.8, and 8.10, and information describing any proposed alternatives (DC FSAR or COL FSAR).

#### 2. Design Considerations

- A. Information describing how the applicant has used operating experience from past designs and from operating plants to develop improved radiation protection design (DC FSAR or COL FSAR).
- B. Information describing the applicant's implementation of the design guidelines of RG 8.8, Section C.2 using activation product source terms adjusted for mPower™-specific design attributes, and other industry-developed design guidance that includes ALARA criteria, and information describing any proposed alternatives (DC FSAR or COL FSAR).
- C. Information describing the applicant's consideration of ALARA criteria during the implementation of a certified design or design modifications (COL FSAR).

3. Operational Considerations
  - A. The applicant's methods for planning and accomplishing work, including interfaces between radiation protection, operations, maintenance, planning, and scheduling.
  - B. The applicant's use of operating plant experience in planning the operational considerations for plant designs (COL FSAR).
  - C. Information describing the applicant's implementation of radiation protection programs, and operational guidance of RGs 8.8 and 8.10, as well as information describing any proposed alternatives (COL FSAR).
4. Radiation Protection Considerations. In accordance with the requirements of Title of the *Code of Federal Regulations* (CFR), Section 20.1101, ALARA procedures, including those covering work scheduling, work planning, and appropriate radiological controls, should be integral with the facility radiation protection program (COL FSAR).
5. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For DC and COL reviews, the staff reviews the applicant's proposed 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 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

None

## II. ACCEPTANCE CRITERIA

### Requirements

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

1. 10 CFR 19.12, as it relates to keeping workers who receive ORE informed as to the storage, transfer, or use of radioactive materials or radiation in such areas, and instructed as to the risk associated with ORE, precautions and procedures to reduce exposures, and the purpose and function of protective devices employed.
2. 10 CFR 20.1101 and the definition of ALARA in 10 CFR 20.1003, as they relate to those measures that ensure that radiation exposures resulting from licensed activities are

below specified limits and ALARA.

3. 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 DC has been constructed and will be operated in conformity with the DC, the provisions of the Atomic Energy Act (AEA), and the U.S. Nuclear Regulatory Commission's (NRC's) regulations.
4. 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.

### 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. Policy Considerations. Acceptability will be based on evidence that a policy for ensuring that ORE will be ALARA has been formulated in accordance with the training requirements in 10 CFR 19.12 and the ALARA provisions of 10 CFR 20.1101(b), and that the policy has been described, displayed, and will be implemented in accordance with the provisions of RGs 8.8 (Regulatory Position C.1) and 8.10 (Regulatory Position C.1) and NUREG-1736, as it relates to maintaining doses ALARA. A specific individual(s) will be designated and assigned responsibility and authority for implementing ALARA policy. Alternative proposed policies will be evaluated on the basis of a comparison with the above RGs and NUREG-1736.
2. Design Considerations. Acceptability will be based on evidence that the design methods, approach, and interactions are in accordance with the ALARA provisions of 10 CFR 20.1101(b) and RG 8.8 (Regulatory Position C.2) using activation product source terms adjusted for mPower™-specific design attributes, and will include incorporation of measures for reducing the need for time spent in radiation areas; reducing or simplifying maintenance; measures to improve the accessibility to components requiring periodic maintenance or inservice inspection; measures to reduce the production, distribution, and retention of activated corrosion products throughout the primary system; measures for assuring that ORE during decommissioning will be ALARA; reviews of the design by competent radiation protection personnel; instructions to designers and engineers regarding ALARA design; experience from operating plants and past designs; and continuing facility design reviews. Alternative proposed design policies will be evaluated on the basis of a comparison with the design guidance in RG 8.8 (Regulatory Position C.2) using activation product source terms adjusted for mPower™-specific design attributes.

3. Operational Considerations. Acceptability will be based on evidence that the applicant has a program to develop plans and procedures in accordance with RGs 1.33, 1.8, 8.8, and 8.10 that can incorporate the experiences obtained from facility operation into facility and equipment design and operations planning and that will implement specific exposure control techniques.
4. Radiation Protection Considerations. Acceptability will be based on evidence that overall facility operations, as well as the radiation protection program, integrate the procedures necessary to ensure that radiation doses are ALARA, including work scheduling, work planning, design modifications, and radiological considerations.

The following RGs and NUREGs provide information, recommendations, and guidance and in general describe a basis acceptable to the staff for implementing the requirements of 10 CFR 19.12 and 10 CFR 20.1101:

1. RG 1.8, as it relates to a basis acceptable to the staff for complying with the Commission's regulations with regard to the qualifications and training of radiation protection personnel.
2. RG 1.33, as it relates to compliance with the Commission's quality assurance regulatory requirements during nuclear power plant operations.
3. RG 8.8, as it relates to a basis acceptable to the staff for meeting the requirements of 10 CFR 20.1101(b) by providing radiation protection information pertaining to actions taken during design, construction, operation, and decommissioning to ensure that ORE is kept ALARA.
4. RG 8.10, as it relates to a basis acceptable to the staff for meeting the requirements of 10 CFR 20.1101(b) concerning the commitment by the applicant's management and vigilance by the radiation protection manager and the radiation protection staff to maintain ORE ALARA.
5. RG 8.27, as it relates to instructing personnel involved in licensed activities regarding their role and responsibilities for making every reasonable effort to maintain radiation exposures ALARA.
6. NUREG-1736, as it relates to the requirements for a radiation protection program to maintain doses ALARA.

### 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. Compliance with 10 CFR 19.12 requires that workers who receive occupational exposure be kept informed of the storage, transfer, or use of radiation and/or radioactive material; receive instructions with the objective of minimizing exposures to radioactive materials or radiation and health protection problems, and explaining precautions or procedures and protective devices associated with each; receive instructions to observe the applicable Commission regulations; receive instructions to report violations of applicable Commission regulations; receive instructions in response to warnings; and be advised of the availability of radiation exposure reports.

A specific requirement in 10 CFR 19.12 mandates that workers be instructed in

precautions or procedures to minimize radiation exposure; therefore, 10 CFR 19.12 relates to the principle of keeping occupational doses ALARA and applies to SRP Section 12.1. With full knowledge of the hazards associated with the exposure and handling of radioactive material and the precautions that should be observed, the individual will have sufficient knowledge such that radiation doses associated with his or her work duties will be kept ALARA.

Meeting these requirements will provide reasonable assurance that individuals exposed to, and handling, radioactive materials will perform their work duties in a manner that will keep occupational doses ALARA.

2. Compliance with 10 CFR 20.1101(b) requires that the licensee use, to the extent practicable, procedures and engineering controls based on sound radiation protection principles that result in occupational doses and doses to members of the public that are ALARA.

The regulation in 10 CFR 20.1101(b) is the principal basis for requiring licensees to adopt a policy and establish procedures designed to keep radiation exposures ALARA; therefore, it directly applies to DSRS Section 12.1. DSRS Section 12.1 describes staff positions related to the design and operation of nuclear plants, including positions to maintain radiation doses in conformance with the ALARA principle. The DSRS references RGs 8.8 and 8.10, which also cover ALARA principles.

3. Collectively, this DSRS subsection and the noted RGs provide the management policy and design and operational considerations that, if followed, will meet the NRC requirements relative to ALARA.

Meeting these requirements will provide reasonable assurance that plant operations will result in occupational doses and doses to members of the public ALARA.

### III. REVIEW PROCEDURES

The reviewer should select material from the procedures described below, as appropriate. 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. In accordance with 10 CFR 52.47(a)(8),(21), and (22), for new reactor license applications submitted under Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues (USIs) and medium- and high-priority generic safety issues (GSIs) that are identified in the version of NUREG-0933 current on the date 6 months before application and that 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 reviewer will evaluate the information furnished in the FSAR for completeness in accordance with RG 1.206 for DCs and COLs. The staff will review the management policy and planned organizational structure to determine how the guidance given in RGs 1.8, 8.8, and 8.10 will be implemented, and will consider any alternatives proposed. The

review of organizational structure includes a determination of whether the individuals responsible for the radiation protection program are at a sufficiently high level of management to ensure reasonable independence from operating pressures, as well as an evaluation of the implementation of management's commitment for ensuring that ORE will be ALARA and that radiation protection management has direct access to station management in radiation protection matters. Any concerns regarding organizational structure as related to the radiation protection manager will be communicated to the staff reviewers who have the primary review responsibility for this item under SRP Chapter 13.

3. The reviewer will evaluate information in this section in accordance with RG 8.8, Section C.1.b(3), to determine whether the organizational structure provides a mechanism for the radiation protection manager and the radiation protection organization to interact with design review groups in such a manner that the design of the plant will incorporate methods and techniques for reducing ORE. If the future plant radiation protection manager has not yet been selected, design review should be accomplished in accordance with the guidance of RG 8.8, unless acceptable alternatives are proposed. The reviewer will determine that appropriate personnel with operating plant experience have evaluated the proposed plant design. The reviewer will determine from information furnished whether the applicant has incorporated previously accepted design features and has used operating experience to improve the design of the plant with regard to ensuring that ORE will be ALARA. The reviewer will also evaluate the material in this section against the requirements of 10 CFR 19.12 and 10 CFR 20.1101(b) and the guidelines of RG 8.10.
4. Based on this review, the staff may request additional information or ask the applicant to modify its submission in order to meet the acceptance criteria given in Subsection II of this DSRS section.
5. The applicant's FSAR should describe the radiation protection program and its implementation. In SECY-04-0032, "Programmatic Information Needed for Approval of a Combined License Application Without Inspections, Tests, Analyses, and Acceptance Criteria," the Commission concluded that ITAAC on programs should not be necessary if the program and its implementation are fully described in the application, and that "fully described" should be understood to mean that the program is clearly and sufficiently described in terms of scope and level of detail to allow a reasonable assurance finding of program acceptability in the COL.

The NRC staff's SERs associated with Nuclear Energy Institute (NEI) technical reports NEI 07-03A "Generic DCD Template Guidance for Radiation Protection Program Description" (Agencywide Document Access and Management System (ADAMS) Accession Number ML091490684), NEI 07-08A "Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures are as Low as is Reasonably Achievable (ALARA)" (ADAMS Accession Number ML093220178) and NEI 08-08A "Guidance for Life Cycle Minimization of Contamination" (ADAMS Accession Number ML093220530) provide the bases for the use of the referenced templates to describe acceptable operational ALARA, Radiation Protection and Ground Water Protection programs. In lieu of fully describing the radiation program in the COL FSAR, COL applicants may elect to use these documents to describe the relevant portions of the radiation protection program.

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

7. 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.
8. The review of a COL application ensures that information contained in the FSAR is sufficient to fully describe the program, or that ITAAC have been provided for the program.

#### 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 SER. The reviewer also states the bases for those conclusions.

1. The staff concludes that the ALARA policy, design, and operational [or, for COLs, design and implementation] considerations are acceptable. This conclusion is based on the applicant having met the training requirements of 10 CFR 19.12, the ALARA provisions of 10 CFR 20.1101(b), and the guidance in RGs 8.8 (Regulatory Position C.2), using activation product source terms adjusted for mPower™-specific design attributes, and 8.10 (Regulatory Position C.1).
2. The applicant has provided a management commitment to ensure that [plant name] will be designed, constructed, and operated in a manner consistent with the above criteria. The [title of person or group (e.g., plant health physicist and staff)] periodically reviews, updates, and modifies as appropriate plant design features and changes, as well as all operating and maintenance features, using exposure data and experience gained from operating nuclear power plants to ensure that occupational exposures will be kept ALARA in accordance with RG 8.8 guidance.
3. The objective of the plant radiation protection design is to maintain individual doses and total person-Sievert (person-rem) doses to plant workers, including construction workers, and to members of the general public ALARA, and to maintain individual doses within the limits of 10 CFR Part 20. The staff's review considered all plant sources of direct radiation and airborne radioactive contamination within restricted areas.
4. [Utility/Applicant/Certified Design Vendor] will incorporate the following facility and equipment design considerations at [plant/design name] to satisfy the radiation protection design objectives listed above. [List several design considerations used.] These design considerations conform with the guidelines of RG 8.8 and are acceptable.
5. Operating and maintenance personnel follow specific plans and procedures to ensure that goals related to keeping exposures ALARA are achieved in the operation of the plant. Engineering controls for the protection of personnel have been optimized. Operations involving high person-Sievert (person-rem) exposures will be carefully preplanned and carried out by personnel who are well trained in radiation protection and using proper equipment. During such maintenance activities, personnel are monitored for exposure to radiation and contamination. Their radiation exposures are reviewed

and are used to make changes in future job procedures and techniques. The management staff will review radiation exposure trends periodically to determine major changes in problem areas and to note the worker groups that are accumulating the highest exposures. The staff will use these reports to recommend design modifications or changes in plant procedures. These practices conform with those described in RGs 8.8 and 8.10 and are acceptable.

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 (ADAMS Accession Number ML102510405), to develop risk-informed licensing review plans for each of the small modular reactor 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 19, "Notices, Instructions, and Reports to Workers; Inspections."
2. 10 CFR Part 20, "Standards for Protection Against Radiation."
3. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."



4. RG 1.206, "Combined License Applications for Nuclear Power Plants."
5. NUREG-1736, "Consolidated Guidance: 10 CFR Part 20—Standards for Protection Against Radiation."
6. RG 1.8, "Qualification and Training of Personnel for Nuclear Power Plants."
7. RG 1.33, "Quality Assurance Program Requirements (Operation)."
8. RG 8.8, "Information Relevant to Assuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable."
9. RG 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable."
10. RG 8.27, "Radiation Protection Training for Personnel at Nuclear Power Plants."
11. NEI 07-03A [Revision 0] "Generic FSAR Template Guidance for Radiation Protection Program Description" and the associated NRC SER (ADAMS Accession No. ML091490684).
12. NEI 07-08A [Revision 0] "Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures are as Low as is Reasonably Achievable (ALARA)" and the associated NRC SER (ADAMS Accession No. ML093220178).
13. NEI 08-08A [Revision 0] "Generic FSAR Template Guidance for Life Cycle Minimization of Contamination" and the associated NRC SER (ADAMS Accession Number ML093220530).
14. SECY-04-0032, "Programmatic Information Needed for Approval of a Combined License Without Inspections, Tests, Analyses, and Acceptance Criteria."