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U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER™ iPWR DESIGN

9.5.3 LIGHTING SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Organization Responsible for Electrical Engineering

Secondary - None

I. AREAS OF REVIEW

The branch with primary review responsibility will review the normal and emergency or supplementary plant lighting systems, including reference information associated with that review.

The specific areas of review are as follows:

1. The capability of the normal lighting system(s) to provide adequate lighting during all plant operating conditions.
2. The capability of the emergency lighting system to provide adequate lighting during all plant operating conditions, including fire, transient and accident conditions.
3. The effect of the loss of all alternating current (AC) power (i.e. during a station blackout) on the emergency lighting system.
4. The failure modes and effects analyses (FMEA) of normal and emergency lighting systems.
5. 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 Design-Specific Review Standard (DSRS) section in accordance with DSRS 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 Standard Review Plan (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).

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For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL information items in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements for interface and site-specific included in the referenced DC.

Review Interfaces

Other DSRS sections interface with this section as follows:

1. The review for lighting requirements for fire protection is coordinated and performed by the branch that has primary review responsibility for SRP Section 9.5.1.
2. The review of the adequacy of lighting systems and their power supplies with respect to security and physical protection requirements is coordinated and performed by the staff that has primary review responsibility for SRP Section 13.6.
3. The review of the adequacy of control room lighting systems and features related to their effectiveness to support reliable human performance, including evaluation with respect to the criteria specified in NUREG-0700 (Reference 1), is performed by the staff that has primary review responsibility for SRP Section 18.0.

Specific acceptance criteria and review procedures are contained in the referenced DSRS sections.

II. ACCEPTANCE CRITERIA

Requirements

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

1. There are no general design criteria or other requirements that directly apply to the normal and emergency or supplementary plant lighting systems.
2. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (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 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, and the NRC's regulations.

DSRS Acceptance Criteria

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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. Acceptance criteria of the design of the normal and emergency lighting systems, as described in the applicant's safety analysis report (SAR), is based in part on the degree of similarity of the systems design with those for previously reviewed plants with satisfactory operating experience.
2. The normal lighting system(s) is acceptable if the integrated design of the system(s) will provide adequate station lighting in all areas, from power sources described in Sections 8.3.1, "AC Power Systems (ONSITE)," and 8.3.2, "DC Power Systems (ONSITE)," of the DSRS (Reference 4) that are required for control and maintenance of equipment and plant access routes during normal plant operations.
3. The emergency lighting system(s) is acceptable if the integrated design of the system(s) will provide adequate emergency station lighting in all areas, required for fire fighting, control and maintenance of equipment from power sources described in Sections 8.3.1, "AC Power Systems (ONSITE)," and 8.3.2, "DC Power Systems (ONSITE)," of the DSRS (Reference 4) for implementing safe shutdown of the plant during all plant operating conditions, and the access routes to and from these areas.
4. The lighting systems designs will be acceptable if they conform to the lighting levels recommended in NUREG-0700, which is based on the Illuminating Engineering Society of North America (IESNA) Lighting Handbook (Reference 5) as related to systems design and illumination levels recommended for industrial facilities.

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. The information (i.e., FMEA) provided in the SAR pertaining to the designs of the normal and emergency lighting systems is evaluated to determine that the lighting in all plant areas and access routes to and from these areas is adequate. The reviewer should verify that the lighting systems include isolation devices to separate between lighting circuits and Class 1E circuits based on Regulatory Guidance 1.75 (Reference 6).

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2. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including interface and site-specific requirements set forth in the final safety analysis report (FSAR) meet 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, 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 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.

The normal and emergency lighting systems include all components necessary to provide adequate lighting during normal and emergency plant operating conditions. The scope of review of the lighting systems provided for the plant included assessment of the systems designs, adequacy of the normal and emergency power sources, and verification of adequate lighting during fire, transient, and accident conditions.

The basis for acceptance of the normal and emergency lighting systems was conformance of the design, design criteria, and design bases to staff positions and industry standards and the ability of the emergency lighting system to provide adequate station lighting in all vital areas from onsite power sources during the full spectrum of accident and/or transient conditions and to the access routes to and from these areas.

The staff concludes that the design of the lighting system conforms to the applicable staff positions and industry standards and is therefore acceptable.

For DC and COL reviews, the findings will also summarize the staff's evaluation of interface and site-specific requirements, 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 acceptance criteria, as applicable.

V. IMPLEMENTATION

The staff will use this DSRS section in performing safety evaluations of mPower™-specific design certification (DC), combined license (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 DSRS – MPower™ 9.5.3 9.5.3-4

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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 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. NUREG-0700, "Human-System Interface Design Review Guidelines," Rev. 2, May, 2002.
2. NUREG-1793, "Final Safety Evaluation Report Related to Certification of the AP1000 Standard Design."
3. Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."
4. Standard Review Plan Sections 8.3.1, "AC Power Systems (ONSITE)," and 8.3.2, "DC Power Systems (ONSITE)."
5. Illuminating Engineering Society of North America Lighting Handbook.
6. Regulatory Guidance 1.75, "Criteria for Independence of Electrical Safety System." .