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U.S. NUCLEAR REGULATORY COMMISSION

DESIGN SPECIFIC REVIEW STANDARD FOR mPower™ iPWR DESIGN

3.5.1.5 SITE PROXIMITY MISSILES (EXCEPT AIRCRAFT)

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of manmade site hazards

Secondary - Organization responsible for the review of plant design for protection of structures, systems, and components from internal and external hazards

I. AREAS OF REVIEW

All structures, systems, and components (SSCs) important to safety are to be protected from site proximity missiles to ensure compliance with 10 CFR 50, Appendix A, General Design Criterion (GDC) 4 requirements. All safety-related and risk-significant SSCs are subject to missile protection. An SSC may be classified as:

- Safety-related risk-significant
- Safety-related nonrisk-significant
- Nonsafety-related risk-significant
- Nonsafety-related nonrisk-significant

If the SSC belongs in one of the first three classifications above, the review described in this Design-Specific Review Standard (DSRS) Section 3.5.1.5 is applied. For the purpose of brevity in this section, the first three categories above will be designated as “safety-related or risk-significant”. For SSCs classified as nonsafety-related nonrisk-significant, this DSRS applies only as noted below.

The specific areas of review are as follows:

1. The staff reviews the nature and extent of offsite activities identified in DSRS Section 2.2.1-2.2.2 to determine whether any missiles resulting from such activities, other than aircraft (DSRS Section 3.5.1.6 reviews aircraft hazards), have the potential to adversely affect structures, systems, and components (SSCs) that are safety-related or risk-significant. In the event that an offsite activity has the potential for missile production (e.g., explosion) and is found to be a design-basis event according to DSRS Section 2.2.3, the staff responsible for evaluating missile effects on SSCs that are safety-related or risk-significant will review the plant design to determine whether the plant is adequately protected against the effects of postulated missiles.
2. 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

DRAFT for Comment

DSRS section in accordance with 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 SRP 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.

3. 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 sections interface with this section as follows:

1. Reviews of those SSCs that should be protected against missile impact are performed under DSRS Section 3.5.2.
2. The acceptability of the design analysis, procedures, and criteria used to establish the ability of seismic Category I structures and/or missile barriers to withstand the effects of tornado missiles is reviewed under DSRS Section 3.5.3.
3. The identification and characterization of site proximity missiles is reviewed under DSRS Sections 2.2.1-2.2.2 and Section 2.2.3.
4. Review of the description and results of the Probabilistic Risk Assessment is performed under SRP Section 19.0.

II. ACCEPTANCE CRITERIA

Requirements

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

1. 10 CFR Part 100, 10 CFR 100.10, 10 CFR 100.20, 10 CFR 100.21, and 10 CFR Part 52, as they relate to the factors to be considered in the evaluation of sites, which indicate that reactors should reflect through their design, construction, and operation an extremely low probability for accidents that could result in the release of significant quantities of radioactive fission products. In addition, 10 CFR 100.10 and 10 CFR 100.20 indicate that the site location, in conjunction with other considerations, should ensure a low risk of public exposure.

DRAFT for Comment

2. Appendix A to 10 CFR Part 50, General Design Criterion (GDC) 4, requires that SSCs important to safety be appropriately protected against the effects of missiles that may result from events and conditions outside the nuclear power unit.
3. 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, 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;
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 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 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."

1. To meet the requirements of 10 CFR Part 100, the probability that site proximity missiles will impact the plant and cause radiological consequences greater than the 10 CFR Part 100 exposure guidelines must be less than an order of magnitude of 10^{-7} per year (see guidance in DSRS Section 2.2.3). If the review indicates that the above criterion is not met, then the acceptance criterion described in item 2 below applies.
2. The plant will meet the relevant requirements of GDC 4 and will be considered appropriately protected against site proximity missiles' design if the SSCs important to safety are capable of withstanding the effects of the postulated missiles without loss of safe-shutdown capability and without causing a release of radioactivity in excess of the 10 CFR Part 100 dose 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 paragraphs:

DRAFT for Comment

1. 10 CFR Part 100, 10 CFR 100.10, and 10 CFR 100.20 establish site requirements in conjunction with other design features to ensure a low risk of public exposure. The NRC has established a probability of less than an order of magnitude of 10^{-7} per year as a staff objective for meeting the requirements of 10 CFR Part 100. In terms of missiles generated by explosions, RG 1.91 indicates that it is the judgment of the NRC staff that, if the exposure rate can be shown to be less than about 10^{-7} per year, the risk of damage from explosions is sufficiently low. Regardless of the source of site proximity missiles, missile hazards that have the potential to cause onsite accidents leading to the release of significant quantities of radioactive fission products, thus posing an undue risk of public exposure, should have a sufficiently low probability of occurrence. Meeting the probability objective for site proximity missiles and the 10 CFR Part 100 exposure guidelines provides a high level of assurance that individuals will not be exposed to excessive radiation doses.
2. Because of the low probabilities of the events under consideration, data are often not available to permit accurate calculation of probabilities. Accordingly, the expected rate of occurrence of potential exposures in excess of the 10 CFR Part 100 guidelines of an order of magnitude of 10^{-6} per year is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower (see guidance in DSRS Section 2.2.3).
3. GDC 4 requires that SSCs important to safety be appropriately protected against dynamic effects, including the effects of missiles that may result from events and conditions outside the nuclear plant. Offsite activities that are determined to be a design-basis event, such as an explosion, could have the potential for missile generation. The initiation of externally generated missiles is a dynamic event and the effects of those missiles on SSCs important to safety must be evaluated. Protecting those SSC that are important to safety from the effects of externally generated missiles prevents failure of those systems required for safe-shutdown capabilities and prevents the release of radioactivity which might cause doses in excess of the 10 CFR Part 100 guidelines.

III. REVIEW PROCEDURES

These review procedures are based on meeting 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 identification and description of events that could possibly generate missiles is evaluated based on a review of the information addressed in the application in accordance with DSRS Sections 2.2.1-2.2.2 and 2.2.3.
2. The SSCs identified in accordance with DSRS Section 3.5.2 are reviewed with respect to missile vulnerability. Using experience gained from past reviews of similar SSCs on missile interactions and the evaluation of the applicant's information, a determination is made of those portions of the plant that clearly have the potential for unacceptable missile damage. If all SSCs appear to be adequately protected against the effects of the

DRAFT for Comment

postulated missiles, then the review is terminated and the evaluation findings are written in terms of design-basis considerations (see Subsection II.2 of this DSRS section).

3. The total probability of the missiles striking a vulnerable critical area of the plant is estimated. The total probability per year (P_T) may be estimated using the following expression:

$$P_T = P_E \times P_{MR} \times P_{SC} \times P_p \times N$$

where:

P_E = probability per year of design-basis event obtained from the review performed under DSRS Section 2.2.3

P_{MR} = probability of missiles reaching the plant

P_{SC} = probability of missiles striking a vulnerable critical area of the plant

P_p = probability of missiles exceeding the energies required to penetrate to vital areas (e.g., based on wall thickness provided for tornado missiles) or producing secondary missiles that could damage vital equipment

N = number of missiles generated by the design-basis event

P_p may be assumed to be equal to 1 as a first step in the analysis. If P_T thus calculated is greater than an order of magnitude of 10^{-7} per year, then site proximity missile impact effects should be estimated, on request, by the organizational unit responsible for reviewing specific SSC. The request should be accompanied by a specified missile description, including missile size, shape, weight, energy, material properties, and trajectory.

4. 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 application meets the acceptance criteria. 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 application.

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).

DRAFT for Comment

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.

For DC and COL reviews, a conclusion of one of the following types may be prepared for the staff's safety evaluation report:

1. The staff concludes that the protection for SSCs important to safety is acceptable and meets the requirements of GDC 4. This conclusion is based on the information provided by the applicant and reviewed by the staff which identified potential missiles that could adversely affect safety-related or risk-significant SSCs requiring protection from externally generated missiles and which demonstrates that these SSCs have adequate barriers protecting them from the effects of missiles such that radiation exposures in excess of those given in 10 CFR Part 100 will not be exceeded. SSCs important to safety are defined in DSRS Section 3.2.2 and includes both safety-related and risk-significant nonsafety-related SSCs.
2. Information provided by the applicant and reviewed by the staff has led to the identification of potential missiles that could adversely affect safety-related or risk-significant SSCs important to safety which warrant detailed evaluation of their protection against such externally generated missiles. However, some of these SSCs have adequate barriers protecting them from the effects of such missiles in accordance with the requirements of GDC 4 such that radiation exposures in excess of the limits given in 10 CFR Part 100 will not be exceeded. The remaining safety-related or risk-significant SSCs, although vulnerable to the potential effects of identified missiles, have a sufficiently low probability (within the criteria given in DSRS Section 2.2.3) of unacceptable damage (on the basis of considerations such as low strike probability or adequate separation and redundancy) such that the risk of public exposure is low and the design meets the requirements of 10 CFR 100.20.

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 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

DRAFT for Comment

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 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. 10 CFR Part 100, "Reactor Site Criteria," Subpart A, "Evaluation Factors for Stationary Power Reactor Site Applications Before January 10, 1997 and for Testing Reactors,"
2. 10 CFR 100.10, "Factors To Be Considered When Evaluating Sites."
3. 10 CFR Part 100, "Reactor Site Criteria," Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997,"
4. 10 CFR 100.20, "Factors To Be Considered When Evaluating Sites."
5. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," Subpart A, "Early Site Permits,"
6. 10 CFR 52.17, "Contents of Applications."
7. 10 CFR Part 100, "Reactor Site Criteria," Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997,"
8. 10 CFR 100.21, "Non-Seismic Siting Criteria."

DRAFT for Comment

9. 10 CFR Part 50.34(a)(1)(ii) "Contents of Application, Technical Information."
10. 10 CFR Part 50, Appendix A, General Design Criteria 4, " Environmental and Dynamic Effects Design Basis."
11. Regulatory Guide 1.117, "Tornado Design Classification."
12. Regulatory Guide 1.91, "Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants."