

Draft for Comment



U.S. NUCLEAR REGULATORY COMMISSION **DESIGN-SPECIFIC REVIEW STANDARD FOR NuScale SMR DESIGN**

3.5.2 STRUCTURES, SYSTEMS, AND COMPONENTS TO BE PROTECTED FROM EXTERNALLY-GENERATED MISSILES

REVIEW RESPONSIBILITIES

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

Secondary - None

I. AREAS OF REVIEW

Title 10 of the *Code of Federal Regulations* (CFR), Part 50, Appendix A, General Design Criterion (GDC) 2 requires that all structures, systems, and components (SSCs) important to safety shall be designed to withstand the effects of natural phenomena such as tornadoes and hurricanes without loss of capability to perform their safety functions. At the same time, GDC 4 requires that all SSCs important to safety be appropriately protected against the effects of missiles that may result from events and conditions outside the nuclear power unit.

All safety-related and Regulatory Treatment of Non-Safety Systems (RTNSS) Category B SSCs outside containment are subject to missile protection. For the purpose of brevity in this section, safety-related and RTNSS-B SSCs will be designated as “SSCs subject to missile protection.” SRP 19.3 describes how SSCs are determined to be RTNSS-B.

The specific areas of review are as follows:

1. The functional operations or performance requirements for SSCs are reviewed for compliance with 10 CFR 50, Appendix A, General Design Criteria (GDCs) 2 and 4 and SSCs necessary for the safe shutdown of the reactor facility and SSCs, the failure of which could result in a significant release of radioactivity, must be identified.
2. SSCs subject to missile protection are reviewed for their capability to perform functions required to attain and maintain safe shutdown conditions during normal or accident conditions, mitigating the consequences of an accident, or preventing the occurrence of an accident, assuming impact from externally-generated missiles.
3. If the turbine is not properly oriented, the protection of SSCs from the effects of turbine missiles is reviewed. Based on their relation to safety, structures or areas of structures, systems or portions of systems, and components require protection from externally-generated missiles if they could prevent an intended safety function or if, missile impact on a SSC that is not safety-related could affect the intended safety function of SSCs subject to missile protection.

4. 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 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.
5. COL Information Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL information 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 information 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 SRP or DSRS sections interface with this section as follows:

1. Review of specific missile sources and the protection needed is performed under DSRS section 3.5.1.4 and SRP sections 3.5.1.5 and 3.5.1.6.
2. Review of the acceptability of barriers and structures designed to withstand externally-generated missiles is performed under DSRS section 3.5.3.
3. Review of RTNSS is performed under SRP section 19.3 as related to augmented design standards of missile protection for risk significant SSCs that are not safety-related.

The specific acceptance criteria and review procedures are contained in the referenced DSRS and SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

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

1. 10 CFR Part 50, Appendix A, GDC 2, Design Bases for Protection Against Natural Phenomena.
2. 10 CFR Part 50, Appendix A, GDC 4, Environmental and Dynamic Effects Design Bases.
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) 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 COL, the provisions of the AEA, and the NRC's rules and 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. As an alternative, and as described in more detail below, an applicant may identify the differences between a DSRS section and the design features (DC and COL applications only), analytical techniques, and procedural measures proposed in an application and discuss how the proposed alternative provides an acceptable method of complying with the NRC regulations that underlie the DSRS acceptance criteria.

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. 10 CFR Part 50, Appendix A, GDC 2 establishes requirements for the capability of SSCs important to safety to withstand the effects of natural phenomena without the loss of their safety functions. Application of GDC 2 determines whether the chosen design basis reflects the importance of the safety functions to be performed. RG 1.13 describes a method acceptable to the NRC staff for protecting spent fuel pool systems and structures from externally-generated missiles and preventing mechanical damage to the spent fuel by designing the facility to prevent externally-generated missiles from contacting the spent fuel within the pool. To properly designate SSCs to be protected from externally-generated missiles, the applicant should identify the systems and structures that prevent mechanical damage to the spent fuel. The ultimate heat sink constitutes the source of water supply necessary to safely operate, shut down, and cool down a nuclear plant. Because the ultimate heat sink is important to safety, its SSCs subject to missile protection should be identified and their safety functions secured. Protecting the ultimate heat sink from externally-generated missiles ensures that the system can perform its safety functions. Protecting SSCs subject to missile protection from externally-generated missiles should secure the following safety functions: maintenance of the integrity of the spent fuel pool, mitigation of the potential release of fission products, and preservation of the capability of the ultimate heat sink to maintain the plant in a safe condition.
2. 10 CFR Part 50, Appendix A, GDC 4 establishes requirements for the protection of SSCs important to safety from dynamic effects, including the effects of missiles from events and conditions outside the nuclear unit. Dynamic events originating outside the nuclear unit have the potential to generate missiles; therefore, this criterion applies directly to the assessment of SSCs subject to missile protection that may be affected. RG 1.115 describes methods acceptable to the NRC staff for identification and protection of SSCs subject to missile protection from the effects of missiles generated by turbine failure.

Cumulative failure data from conventional plants indicate that the protection of SSCs subject to missile protection from the effects of missiles is an appropriate safety consideration. RG 1.117 describes a method acceptable to the NRC staff for determining which SSCs should be protected from external missiles generated by extreme winds. The selection of SSCs to be protected is made to keep offsite exposures from exceeding an appropriate fraction of 10 CFR Part 100 offsite dose guidelines. Limits based upon an appropriate fraction ensures protection for events not as severe as design-basis events but with a higher probability of occurrence. Protecting SSCs subject to missile protection from externally-generated missiles secures the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a shutdown condition, and the capability to prevent significant uncontrolled release of radioactivity.

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.

1. Selected Programs and Guidance - In accordance with the guidance in NUREG-0800, "Introduction - Part 2: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: Integral Pressurized Water Reactor Edition" (NUREG-0800 Intro Part 2) as applied to this DSRS Section, the staff will review the information proposed by the applicant to evaluate whether it meets the acceptance criteria described in Subsection II of this DSRS. As noted in NUREG-0800 Intro Part 2, the NRC requirements that must be met by an SSC do not change under the SMR framework. Using the graded approach described in NUREG-0800 Intro Part 2, the NRC staff may determine that, for certain structures, systems, and components (SSCs), the applicant's basis for compliance with other selected NRC requirements may help demonstrate satisfaction of the applicable acceptance criteria for that SSC in lieu of detailed independent analyses. The design-basis capabilities of specific SSCs would be verified where applicable as part of completion of the applicable ITAAC. The use of the selected programs to augment or replace traditional review procedures is described in Figure 1 of NUREG-0800, Introduction - Part 2. Examples of such programs that may be relevant to the graded approach for these SSCs include:

- 10 CFR Part 50, Appendix A, General Design Criteria (GDC), Overall Requirements, Criteria 1 through 5
- 10 CFR Part 50, Appendix B, Quality Assurance (QA) Program
- 10 CFR 50.49, Environmental Qualification of Electrical Equipment (EQ) Program
- 10 CFR 50.55a, Code Design, Inservice Inspection and Inservice Testing (ISI/IST) Programs
- 10 CFR 50.65, Maintenance Rule requirements
- Reliability Assurance Program (RAP)
- 10 CFR 50.36, Technical Specifications
- Availability Controls for SSCs Subject to Regulatory Treatment of Non-Safety Systems (RTNSS)
- Initial Test Program (ITP)

- Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)

This list of examples is not intended to be all-inclusive. It is the responsibility of the technical reviewers to determine whether the information in the application, including the degree to which the applicant seeks to rely on such selected programs and guidance, demonstrates that all acceptance criteria have been met to support the safety finding for a particular SSC.

2. In accordance with 10 CFR 52.47(a)(8),(21), and (22), and 10 CFR 52.79(a)(17), (20) and (37), for design certification or combined license applications submitted under Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues and medium- and high-priority generic safety issues which are identified in the version of NUREG-0933 current on the date up to 6 months before the docket date of the application and which 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) for a DC application, and except paragraphs (f)(1)(xii), (f)(2)(ix), (f)(2)(xxv), and (f)(3)(v) for a COL application. 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.
3. The first step in the review of SSCs requiring protection against externally generated missiles is to ensure the equipment needed to perform a safety-related function or a risk-significant function have been identified as “SSCs subject to missile (externally-generated) protection”. RG 1.115, RG 1.117, and SRP Section 19.3 provide guidance for identification of the “SSCs subject to missile (externally generated) protection.” RG 1.115 describes methods acceptable to the NRC staff for identification and protection of SSCs subject to missile protection from the effects of missiles generated by turbine failure. RG 1.117 describes a method acceptable to the NRC staff for determining which SSCs should be protected from external missiles generated by extreme winds. SRP Section 19.3 as related to augmented design standards provides guidance on the identification of the risk-significant SSCs subject to missile protection.
4. The second step in the review is to determine which SSCs or SSC portions require protection against externally-generated missiles. The reviewer uses engineering judgment and the results of failure modes and effects analyses in conjunction with the results of reviews under other DSRS sections for specific SSCs in this determination. Most safety-related systems are located within structures resistant to external missiles by design for other purposes or because of specific construction to withstand missiles. Systems and components within such structures are considered adequately protected. The reviewer concentrates attention on SSCs subject to missile protection outside such structures and on penetrations and access openings in them. Detailed review of the site-specific systems that must be protected from missiles is typically deferred until the COL or other site specific review. Depending on the nature and source of the externally-generated missiles, protection may be by missile barriers for individual components, by location of independent redundant subsystems in compartments in missile-protected structures, or by subgrade location at sufficient depth. Physical separation alone is not normally an acceptable method of missile protection for redundant SSCs subject to missile protection as described in RG 1.117.

5. The reviewer determines whether the failure of nonsafety-related SSCs as a result of a missile could prevent SSCs subject to missile protection from externally-generated missiles from completing their safety function. The reviewer also verifies for applicants referring to certified designs whether SSCs outside the design scope might generate external missiles that would prevent SSCs subject to missile protection from performing their intended safety function.
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 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 information items. The reviewer may identify additional COL information items; however, to ensure these COL information 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 SER. The reviewer also states the bases for those conclusions.

The review of SSCs to be protected from externally-generated missiles included all SSCs subject to missile protection supporting the reactor facility. After review of the applicant's proposed design criteria, design bases, and safety classifications for SSCs subject to missile protection, the staff concludes that the SSCs to be protected from externally-generated missiles are in compliance with GDCs 2 and 4. This conclusion is based on the following findings:

The applicant has met the requirements of GDCs 2 and 4 for protection of important to safety SSCs against the effects of externally-generated missiles by:

1. Conformance with RG 1.13, "Spent Fuel Storage Facility Design Basis," Position C.2, by preventing missiles generated by tornado winds from causing significant loss of watertight integrity of the fuel storage pool and from contacting fuel within the pool.
2. Conformance with RG 1.115, "Protection Against Turbine Missiles," Position C.2, so that essential systems are protected from low-trajectory turbine missiles by either proper turbine orientation or missile barriers;
3. Conformance with regulatory Positions C.1, C.2, and C.3 and the Appendix to RG 1.117, "Tornado Design Classification," so that SSCs subject to missile protection are protected from the effects of missiles generated by the design basis tornado by missile barriers for

individual components, by location of independent redundant systems or components in missile-protected structures, or by underground locations at depth sufficient to protect against missiles;

4. Demonstrating that the SSCs are adequately protected from missiles generated by extreme winds; and
5. Identifying all SSCs requiring protection against the effects of externally-generated missiles, including those non-safety SSCs, the failure of which, as a result of missiles, may prevent SSCs subject to missile protection from performing their safety functions.

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 information 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 regulations in 10 CFR 52.17(a)(1)(xii), 10 CFR 52.47(a)(9), and 10 CFR 52.79(a)(41) establish requirements for applications for ESPs, DCs, and COLs, respectively. These regulations require the application to include an evaluation of the site (ESP), standard plant design (DC), or facility (COL) against the Standard Review Plan (SRP) revision in effect six months before the docket date of the application. While the SRP provides generic guidance, the staff developed the SRP guidance based on the staff's experience in reviewing applications for construction permits and operating licenses for large light-water nuclear power reactors. The proposed small modular reactor (SMR) designs, however, differ significantly from large light-water nuclear reactor power plant designs.

In view of the differences between the designs of SMRs and the designs of large light-water power reactors, the Commission issued 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) (SRM). In the SRM, the Commission directed the staff to develop risk-informed licensing review plans for each of the SMR design reviews, including plans for the associated pre-application activities. Accordingly, the staff has developed the content of the DSRS as an alternative method for the evaluation of a NuScale-specific application submitted pursuant to 10 CFR Part 52, and the staff has determined that each application may address the DSRS in lieu of addressing the SRP, with specified exceptions. These exceptions include particular review areas in which the DSRS directs reviewers to consult the SRP and others in which the SRP is used for the review. If an applicant chooses to address the DSRS, the application should identify and describe all differences between the design features (DC and COL applications only), analytical techniques, and procedural measures proposed in an application and the guidance of the applicable DSRS section (or SRP section as specified in the DSRS), and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria.

The staff has accepted the content of the DSRS as an alternative method for evaluating whether an application complies with NRC regulations for NuScale SMR applications, provided that the application does not deviate significantly from the design and siting assumptions made by the

NRC staff while preparing the DSRS. If the design or siting assumptions in a NuScale application deviate significantly from the design and siting assumptions the staff used in preparing the DSRS, the staff will use the more general guidance in the SRP as specified in 10 CFR 52.17(a)(1)(xii), 10 CFR 52.47(a)(9), or 10 CFR 52.79(a)(41), depending on the type of application. Alternatively, the staff may supplement the DSRS section by adding appropriate criteria in order to address new design or siting assumptions.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena."
2. 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases."
3. 10 CFR 52.47, "Contents of Application."
4. 10 CFR 52.80, "Contents of Applications; Additional Technical Information."
5. 10 CFR Part 100, "Reactor Site Criteria."
6. Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Basis."
7. Regulatory Guide 1.115, "Protection Against Turbine Missiles."
8. Regulatory Guide 1.117, "Tornado Design Classification."