



## U.S. NUCLEAR REGULATORY COMMISSION

# DESIGN-SPECIFIC REVIEW STANDARD for NuScale SMR DESIGN

### 10.3 MAIN STEAM SUPPLY SYSTEM

#### REVIEW RESPONSIBILITIES

**Primary** - Organization responsible for the review of power conversion systems

**Secondary** - Organization responsible for the review of turbine-generator controls and overspeed protection systems, and

Organization responsible for the review of the turbine-generator arrangement and missile generation due to overspeed.

#### I. AREAS OF REVIEW

The main steam supply system (MSSS) transports steam from the steam generator to the power conversion system and various auxiliary systems during normal plant operation. Portions of the MSSS may be used as part of the heat sink to remove heat from the reactor facility during certain operations. In the NuScale small modular reactor (SMR) design, portions of the MSSS interface with the decay heat removal system. The NuScale MSSS also includes provisions for secondary system pressure relief.

The MSSS extends from the outlet of the RPV steam plenum, on the secondary side of the steam generators, up to and including the turbine stop valves and includes the containment isolation valves, and main steam safety valves, connected piping that is 6.4 centimeters (2.5 inches) in nominal diameter or larger (up to and including the first valve that is either normally closed or capable of automatic closure during all modes of operation), and the steamline to the decay heat removal system (DHRS) up to the DHRS actuation valves.

For the NuScale design, steam piping from the steam generator to the main steam isolation valves is shared with the safety-related decay heat removal system that provides passive decay heat removal through the heat exchangers in the reactor pool under conditions when normal decay heat removal through the main steam system is not available. The safety-related portions of the MSSS include the piping and valves associated with the containment and main steam isolation functions, the main steam piping to the DHRS up to and including the DHRS actuation valves, and the main steam isolation valves. Unlike existing large pressurized-water reactors (PWRs), the NuScale MSSS does not supply steam to drive safety-related engineered safety feature (ESF) pumps such as auxiliary feedwater pumps.

The specific areas of review are as follows:

1. Portions of the MSSS that are essential for safe-shutdown of the reactor or for preventing or mitigating the consequences of accidents are evaluated to determine the following:
  - A. A single malfunction or failure of an active component would not prevent important to safety portions of the system from functioning as required during

normal operations, adverse environmental occurrences, and accident conditions, including loss of offsite power.

- B. Appropriate quality group (as addressed in Regulatory Guide (RG) 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants") and seismic design classifications are met for important to safety portions of the system.
  - C. The system is capable of performing multiple functions, such as transporting steam to the power conversion system, providing heat sink capacity for normal operations and shutdown, safety-related decay heat removal, system isolation, or pressure relief capability.
  - D. The MSSS is designed to minimize the potential for, and to provide protection against, the effect of adverse dynamic loads such as water (steam) hammer resulting from rapid valve closure and safety valve fluid discharge loads.
  - E. Failures of non-seismic Category I equipment or structures, or cracks and breaks in moderate and high energy piping will not affect important to safety structures, systems, and components (SSCs).
- 2. Measures that limit blowdown of the system if a steamline were to break.
  - 3. The design of the MSSS is evaluated with respect to the following:
    - A. functional capability of the system to transport steam from the nuclear steam supply system as required during all operating conditions
    - B. capability to detect and control system leakage and to isolate portions of the system in case of excessive leakage or component malfunctions
    - C. capability to prevent accidental releases to the environment
    - D. provisions for functional testing of safety-related portions of the system
  - 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 the 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 DSRS Section 14.2 and SRP Section 14.3.7.
  - 5. Inspection and Tests, as appropriate, in accordance with DSRS Section 14.2:
    - A. preoperational and startup test program for valve testing, system testing, and pipe testing
    - B. inservice test program

- C. chemistry control and flow-accelerated corrosion (FAC) program
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

Other DSRS and SRP sections interface with this section as follows:

1. Acceptability of the seismic and quality group classifications for system components is reviewed under SRP Sections 3.2.1 and 3.2.2.
2. Acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the SSE, probable maximum flood, and tornado/hurricane missiles is reviewed under DSRS Sections 3.7.1, 3.7.2, 3.7.3, 3.8.4, and 3.8.5, and SRP Sections 3.3.1, 3.3.2, 3.5.3, and 3.7.4.
3. Review for flood protection is performed under SRP Section 3.4.1.
4. Review of the protection against internally generated missiles outside containment is performed under SRP Section 3.5.1.1.
5. Review of the protection against internally generated missiles inside containment is performed under SRP Section 3.5.1.2.
6. Review of the SSCs to be protected against externally generated missiles is performed under SRP Section 3.5.2.
7. Review of high- and moderate-energy pipe breaks is performed under SRP Section 3.6.1.
8. Review to determine whether piping, mechanical components, and support structures are designed in accordance with applicable codes and standards is performed under SRP Sections 3.9.1, 3.9.2 and 3.9.3.
9. Review of the system design capability to withstand the adverse dynamic loads, such as water or steam hammer resulting from rapid valve closure and relief valve fluid discharge loads is performed under SRP Section 3.9.3.
10. Review of the adequacy of the inservice testing program of the system valves is performed under SRP Section 3.9.6.
11. Review of the seismic qualification of components is performed as part of the primary review responsibility for SRP Section 3.10.

12. Review of the environmental qualification of components is performed under DSRS Section 3.11.
13. Review of essential components (associated with the portion of the MSSS inside the primary containment) that are required for: normal operations and accident conditions, establishing shutdown cooling load requirements versus time, and verifying the design transient used in establishing the flow capacity and setpoints of steam generator relief and safety valves, is performed under SRP Section 5.2.2.
14. Review of the compatibility of the materials of construction with service conditions is performed under SRP Sections 5.2.3 and 10.3.6.
15. Review of the design margins for decay heat removal during various transient conditions, including a comparison of system flow rates, heat loads, maximum temperatures, and heat removal capabilities to those of similarly designed systems for previously reviewed plants, is performed under DSRS Section 5.4.7.
16. Review of the adequacy of the containment isolation system and the acceptability of the containment leakage testing program, is performed under DSRS Sections 6.2.4 and 6.2.6.
17. Review of portions of the MSSS with respect to the adequacy of design, installation, inspection, and testing of essential components necessary for instrumentation and control functions is performed under DSRS Chapter 7.
18. Review of the adequacy of the design, installation, inspection, and testing of all electrical systems required for proper operations is performed under DSRS Section 8.3.1.
19. Review of the plant's capability to cope with a station blackout (SBO), including evaluation of required systems and their capabilities to support the overall determination of compliance with SBO requirements, is performed under DSRS Section 8.4.
20. Review of fire protection is performed under SRP Section 9.5.1.1
21. Review of the proper operation of the turbine steam admission valves, including extraction steam non-return valves, is performed under SRP Section 10.2.
22. Acceptability of the preoperational and startup tests is performed under DSRS Section 14.2.
23. Review of technical specifications is performed under DSRS Section 16.0.
24. Review of quality assurance is performed under SRP Section 17.5.
25. Review of the probabilistic risk assessment is performed under SRP Chapter 19.

## II. ACCEPTANCE CRITERIA

### Requirements

Acceptance criteria are based on meeting the relevant requirements of the following U.S. Nuclear Regulatory Commission (NRC) regulations:

1. Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix A, General Design Criterion (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 Part 50, Appendix A, GDC 5, “Sharing of Structures, Systems, and Components”
4. 10 CFR 50.63, “Loss of All Alternating Current Power,” as it relates to the ability of a plant to withstand for a specified duration and then recover from an SBO
5. 10 CFR 52.47(b)(1), which requires a DC application to 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 NRC’s regulations
6. 10 CFR 52.80(a), which requires a COL application to 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 be operated 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. As an alternative, and as described in more detail below, an applicant may identify the differences between a DSRS section and the design features (for 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 NRC regulations that underlie the DSRS acceptance criteria.

1. Satisfying GDC 2 is based, in part, on meeting the guidance of RG 1.29, “Seismic Design Classification,” Position C.1, for safety-related portions and Position C.2, for nonsafety-related portions.
2. Satisfying GDC 4 is based, in part, on meeting the guidance of RG 1.115, “Protection Against Turbine Missiles,” Position C.1, as it relates to the protection of SSCs important to safety from the effects of turbine missiles.

In addition, the system design should adequately consider water (steam) hammer and safety valve discharge loads to assure that system safety functions can be performed, and operating and maintenance procedures should include adequate precautions to prevent water (steam) hammer and safety valve discharge loads. The system design should also include protection against water entrainment.

3. Compliance with GDC 5 requires that SSCs important to safety shall not be shared by nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their intended safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units. Meeting

the requirements of GDC 5 provides assurance that the main steam system and its associated components will continue performing their required safety functions even if they are shared by multiple nuclear power units.

4. Satisfying 10 CFR 50.63 is based on meeting RG 1.155, "Station Blackout," as it relates to the MSSS design.
5. RG 1.117, "Tornado Design Classification," Appendix Positions 2 and 4, as they relate to the protection of SSCs important to safety from the effects of extreme wind events.

### 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. GDC 2 requires that SSCs important to safety be designed to withstand the effects of postulated local natural phenomena, such as earthquakes and tornadoes without loss of the capability to perform their safety functions. The MSSS safety functions include steamline isolation, steam generator and MSSS overpressure protection, and termination of main steamline break (MSLB) events. The MSSS must perform its safety functions while withstanding natural phenomena that may reasonably be expected to occur at the plant site. RG 1.29 provides specific guidance for determining those SSCs that should be designated seismic Category I and therefore designed to meet the SSE. RG 1.117 includes specific guidance for determining the SSCs that should be designed to withstand the effects of extreme wind events. Meeting the requirements of GDC 2 and the positions of RG 1.29 and RG 1.117 will ensure that the MSSS can perform its required safety functions in the event of adverse natural phenomena.
2. GDC 4 requires, in part, that SSCs important to safety are designed to withstand potential dynamic effects, such as missile impact, pipe whip, and jet impingement caused by equipment failure or events outside the plant. The MSSS safety functions include steamline isolation, steam generator and MSSS overpressure protection, and termination of MSLB events. The MSSS must perform its safety functions while withstanding the harshest effects of postulated plant equipment failures, such as pipe rupture, or potential external events, such as an airplane crash. RG 1.115 provides specific guidance for protecting important to safety SSCs from low-trajectory missiles resulting from turbine failure. Meeting the requirements of GDC 4 and the positions of RG 1.115 will offer assurance that the MSSS is capable of executing its safety functions in the event of adverse conditions caused by equipment failure or events outside the plant.
3. GDC 5 prohibits sharing of SSCs important to safety among nuclear units unless such sharing will not impair the ability of the SSCs to perform design safety functions in their respective units. The MSSS safety functions include steamline isolation, steam generator and MSSS overpressure protection, and termination of MSLB events. For multiple-unit sites, units may cross-connect the MSSS for startup, maintenance, or other related purposes. For such shared systems, the licensee must show that each MSSS can perform all of its required safety functions for its respective unit. Meeting GDC 5 will ensure that shared MSSSs at multiple-unit sites will execute their respective safety functions regardless of malfunctions in the other units.
4. 10 CFR 50.63 imposes explicit requirements on the plant regarding the capability to ensure that the core is cooled in the event of an SBO for a determined duration. The

MSSS may supply steam to the DHRS, which may be used to provide the decay heat removal capability for core cooling and safe-shutdown (nondesign-basis accident (DBA)), during an SBO. Its design capability to operate regardless of alternating current power source availability enables performance of these important functions during an SBO. RG 1.155 identifies methods acceptable for complying with the requirements of 10 CFR 50.63. Meeting the requirements of 10 CFR 50.63 and the positions of RG 1.155 provides assurance that the MSSS is capable of supporting core cooling or safe-shutdown (non-DBA) in the event of an SBO.

### 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 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: Light-Water Small Modular 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 small modular reactor (SMR) framework. Using the graded approach described in NUREG-0800, Intro Part 2, the NRC staff may determine that, for certain 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 completing the applicable ITAAC. The use of the selected programs to augment or replace traditional review procedures is shown in Figure 1 of NUREG-0800, Intro Part 2. Examples of such programs that may be relevant to the graded approach for these SSCs include:

- 10 CFR Part 50, Appendix A, GDC, Overall Requirements, Criteria 1–5
- 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 Nonsafety 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 DC or COL applications submitted under 10 CFR 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, "Resolution of Generic Safety Issues," 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 reviewer determines that essential (safety-related) portions of the MSSS are correctly identified and are isolable, to the extent required, from nonessential portions of the system. Review of the system description and the piping and instrumentation diagrams (P&IDs) verifies that they clearly indicate the physical division between the safety-related and nonessential portions of the system. Review of the system arrangement drawings identifies the means provided for accomplishing system isolation. Programmatic requirements are identified that provide verification or confirmation of isolation functions.
4. A review of the seismic design bases and the quality and seismic classification is performed, as indicated in Subsection I of this DSRS section. The review verifies that essential portions of the MSSS are designed to Quality Group B or seismic Category I requirements and confirms that the design classifications specified satisfy the acceptance criteria specified in Subsection II of this DSRS section. In general, seismic Category I and Quality Group B classifications apply to the main steamlines from the steam generators to the containment isolation valves.
5. The review assures that design provisions permit appropriate functional testing of safety-related system components. It is acceptable if the safety analysis report (SAR) delineates a testing and inspection program and the system drawings show any test recirculation loops or special connections around isolation valves that this program would require.
6. Review of the system description, safety evaluation, component table, P&IDs, and the implementation of the programmatic requirements identified in the acceptance criteria of



this DSRS section, verifies that the system has been designed for the following functions:

- A. Assure safe plant operation by including appropriate design margins for pressure relief capacity and setpoints for the secondary system.
- B. Provide a means to detect steam leakage from the system if a steamline were to break. Temperature or pressure sensors are an acceptable means for initiating signals to close the main steamline isolation valves and/or turbine stop valves to limit the release of steam during a steamline break accident.
- C. Assure that, in the event of a postulated break in a main steamline, the design will prevent the blowdown of more than one steam generator, assuming a concurrent single active component failure. In this regard, all main steam shutoff valves downstream of the MSIVs, the turbine stop valves, and the control valves are considered to be functional. The reviewer should verify that the MSIVs, shutoff valves in connected piping, turbine stop valves, and bypass valves can close against maximum steam flow. The reviewer verifies that the SAR provides a tabulation and descriptive text of all flowpaths that branch off the main steamlines between the MSIVs and the turbine stop valves. The descriptive information should include the following for each flowpath:
  - i. system identification
  - ii. maximum steam flow in pounds per hour (kilograms per second)
  - iii. type of shutoff valves
  - iv. size of valves
  - v. quality of the valves
  - vi. design code of the valves
  - vii. closure time of the valves
  - viii. actuation mechanism of the valves (i.e., solenoid-operated, motor-operated, air-operated diaphragm, and the like)
  - ix. motive or power source for the valve actuating mechanism
- D. In the event of a main steamline break, terminate steam flow from all systems identified in Item C above, except those that can be used for mitigation of the accident, as required to bring the reactor to a safe cold shutdown. For these systems, the reviewer verifies that the SAR describes the design features that have been incorporated to assure closure of the steam shutoff valves as well as any required operator actions. If the systems that can be used to mitigate the accident are not available, or if the decision is made to use other means to shut down the reactor, the reviewer verifies that the SAR describes the securing of these systems to assure positive steam shutoff, as well as any required operator actions.

7. The reviewer verifies that the system is designed so that essential functions will be maintained, as required, in the event of adverse environmental phenomena, certain pipe breaks, or loss of offsite power. The reviewer uses engineering judgment and the results of failure modes and effect analyses to determine the following:
  - A. Operation of the essential portions of the MSSS is not prevented by failure of (1) nonseismic Category I portions of the MSSS, (2) other systems close to essential portions of the system, or (3) non-seismic Category I structures that house, support, or are close to essential portions of the MSSS. Reference to SAR sections describing site features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems. Statements in the SAR that confirm that the above conditions are met are acceptable.
  - B. Essential portions of the MSSS are protected from the effects of floods, hurricanes, tornadoes, and internally and externally generated missiles. Flood protection and missile protection criteria are evaluated under the SRP and DSRS Chapter 3 Sections. Review of the locations and design of the system and structures determines whether the degree of protection provided is adequate. A statement to the effect that the system is in a seismic Category I structure that is protected from tornado/hurricane missiles and floods or that components of the system will be located in individual cubicles or rooms that will withstand the effects of winds, flooding, and tornado/hurricane missiles is acceptable.
  - C. Essential components and subsystems necessary for safe-shutdown can function as required in the event of loss of offsite power. Review of the SAR verifies that, for each MSSS component or subsystem affected by a loss of offsite power, the system functional capability meets or exceeds minimum design requirements. Statements in the SAR and results of failure modes and effects analyses are considered in assuring that the system meets these requirements. This approach is an acceptable verification of system functional reliability.
8. Review of the descriptive information, P&IDs, MSSS drawings, and failure modes and effects analyses in the SAR to assure that essential portions of the system will function after design-basis accidents, assuming a concurrent single active component failure. The reviewer evaluates the analyses in the SAR to assure the functionality of required components, traces the availability of these components on system drawings, and checks that the SAR verifies that minimum requirements are met for each accident situation for the required time spans. For each case, the design is acceptable if minimum system requirements are met.
9. Review of the SAR to assure that the applicant has committed to address the potential for water (steam) hammer and relief valve discharge loads and will take adequate action to minimize such occurrences. Drain pots, line slope, and valve operators should be addressed.
10. The reviewer confirms that the MSSS capability is sufficient with respect to the plant's ability to cope with, and recover from, an SBO of a specified duration by determining conformance with RG 1.155, as they relate to the design of the MSSS. This review is coordinated with the review of the SBO event under DSRS Section 8.4

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 final safety analysis report (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 other 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 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 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.

The MSSS includes all components and piping from the steam generator connection up to and including the turbine stop valves. The essential portions of the MSSS are designed to Quality Group B, from the steam generator to the outermost containment isolation valve as well as connected piping up to and including the first valve that is either normally closed or capable of automatic closure during all modes of normal reactor operation. Those portions of the MSSS necessary to mitigate the consequences of an accident such as a steamline break are designed to the quality standards commensurate with the importance of their safety functions and are designed to the standards listed below.

The scope of review of the MSSS for this plant included layout drawings, P&IDs, and descriptive information for the system.

The basis for acceptance of the MSSS in this review was the degree to which the applicant's design criteria and bases conform to the Commission's regulations at 10 CFR 50.63 and in the GDCs in Appendix A to 10 CFR Part 50. The staff concludes that the plant design is acceptable and meets the requirements of GDCs 2, 4, and 5, and of 10 CFR 50.63. This conclusion is based on the following:

1. The applicant has met the requirements of (1) GDC 2 with respect to the capability of structures housing the important to safety portions of the system to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods and (2) GDC 4 with respect to the capability of structures housing the important to safety portions of the system to withstand the effects of external missiles, internally generated missiles, and pipe whip and jet impingement forces associated with pipe breaks. The essential portions of the MSSS (as identified in the above discussion) are designed to seismic Category I criteria and are housed in a seismic Category I structure that provides protection from the effects of extreme wind events, turbine missiles, and floods. This approach meets RG 1.29, Positions C.1.f, C.2, and C.3; RG 1.115, Position C.1; and RG 1.117, Appendix Positions 2 and 4.

In addition, the system design includes the capability to accommodate water (steam) hammer dynamic loads resulting from rapid closure of system valves (including turbine bypass and stop valves) and safety/relief valve operation, without compromising required safety functions. Water entrainment considerations include provisions for drain pots, line sloping, and valve operation. The applicant will review operating and maintenance procedures to alert plant personnel to the potential for, and means to

minimize, water (steam) hammer occurrences. This commitment is stated in the applicant's SAR.

2. The applicant has met the requirements of GDC 5 with respect to the capability of shared systems and components important to safety to perform required safety functions. Each reactor module of the plant has its own MSSS with no interconnections between the safety-related and nonsafety-related portions.

For DC and COL reviews, the findings will also summarize the staff's evaluation regarding DC 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, 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 SRP revision in effect 6 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 SMR designs, however, differ significantly from large light-water nuclear 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 Staff Requirements Memorandum (SRM)-COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights To Enhance Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010. 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 preapplication activities. Accordingly, the staff has developed the content of the DSRS as an alternative method for evaluating 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 to address new design or siting assumptions.

## VI. REFERENCES

1. *U.S. Code of Federal Regulations*, “Domestic Licensing of Production and Utilization Facilities,” Part 50, Title 10, “Energy,” Appendix A, General Design Criterion (GDC) 2, “Design Bases for Protection against Natural Phenomena.”
2. *U.S. Code of Federal Regulations*, “Domestic Licensing of Production and Utilization Facilities,” Part 50, Title 10, “Energy,” Appendix A, GDC 4, “Environmental and Dynamic Effects Design Bases.”
3. *U.S. Code of Federal Regulations*, “Domestic Licensing of Production and Utilization Facilities,” Part 50, Title 10, “Energy,” Appendix A, GDC 5, “Sharing of Structures, Systems, and Components.”
4. *U.S. Code of Federal Regulations*, “Loss of all alternating current power,” Section 50.63, Title 10, “Energy.”
5. U.S. Nuclear Regulatory Commission, “Seismic Design Classification,” Regulatory Guide (RG) 1.29, Revision 4, March 2007, Agencywide Documents Access and Management System (ADAMS) Accession No. ML070310052.
6. U.S. Nuclear Regulatory Commission, “Protection against Turbine Missiles,” RG 1.115, Revision 2, January 2012, ADAMS Accession No. ML101650675.
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