U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR NuScale SMR DESIGN

3.13 THREADED FASTENERS - ASME CODE CLASS 1, 2, AND 3

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of materials engineering issues related to flaw evaluation and welding

Secondary - None

I. AREAS OF REVIEW

This Design-Specific Review Standard (DSRS) section provides guidance for reviewing and evaluating the adequacy of an applicant's criteria in regard to selection of materials, design, inspection and testing of its threaded fasteners (i.e., threaded bolts, studs, etc.) prior to initial service and during service. The scope of this chapter is limited to the review of threaded fasteners in American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Class 1, 2 or 3 systems. The staff's review in this DSRS chapter focuses on the information provided in Section 3.13 of the technical submittal or application.

The specific areas of review are as follows:

1. Design Aspects

A. Materials Selection

The staff reviews information pertaining to the selection of materials and material testing of threaded fasteners that are categorized as ASME Code Class 1, 2, or 3. The scope of the review includes material selection considerations and conformance with applicable codes or standards.

B. Mechanical Testing, Special Process and Controls

The staff reviews information in the safety analysis report (SAR) pertaining to the fabrication of threaded fasteners that have been selected for ASME Code Class 1, 2, and 3 systems. The scope of the review includes fabrication practices or special processes used to mitigate the occurrence of stress corrosion cracking (SCC) or other forms of material degradation in the fasteners during service.

The staff reviews information pertaining to the environmental considerations that should be accounted for when selecting materials of fabrication for threaded fasteners. The scope of the review includes any information in the SAR or submitted by the applicant that pertains to the use of lubricants and/or surface treatments in mechanical connections secured by threaded fasteners and the compatibility of these materials with the threaded fasteners.

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C. Fracture Toughness Requirements for Ferritic Materials

The staff reviews information pertaining to fracture toughness tests that are necessary for and performed on threaded fasteners that are made from ferritic steel materials (i.e., from carbon steel grades or low-alloy steel grades).

D. Fabrication Inspection

The staff reviews information to confirm that the appropriate ASME Code, Section III, Division 1 (henceforth ASME Code, Section III) inspections for bolting, studs and nuts used in ASME Code Class 1, 2, or 3 applications are conducted.

E. Quality Records

The staff reviews information to confirm that the SAR indicates that the applicant is complying with the criteria of ASME Code, Section III regarding preparation of certified material test reports (CMTRs).

2. Preservice and Inservice Inspection Requirements

The staff reviews information to determine whether the applicant is complying with the preservice (PSI) and inservice (ISI) inspection requirements of Title 10 of the *Code of Federal Regulations* (CFR), 50.55a and conforming to the criteria of ASME Code, Section XI (henceforth ASME Code, Section XI) for threaded-fastener assemblies (i.e., mechanical joints) in ASME Code Class 1, 2, and 3 systems.

The staff reviews the description of the PSI and ISI programs provided by the combined license (COL) applicant in accordance with the guidance in Regulatory Guide (RG) 1.206 and SECY-05-0197. For DC applications, the staff should review the design described in the design certification (DC) application to ensure that the threaded fasteners for ASME Code Class 1, 2, and 3 systems are appropriately identified for inclusion in the COL PSI and ISI operational program.

3. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For DC and COL reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this 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.

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

1. Review of the quality assurance program for ASME Code Class 1, 2, and 3 threaded fasteners is performed under SRP Section 17.5.

2. Review of the programs for maintaining threaded fastener assemblies used in ASME Code Class 1, 2, and 3 systems and component supports and in core support structures is performed under SRP Section 13.5.2.2.

3. Review of the probabilistic risk assessment is performed under SRP Section 19.0.

II. ACCEPTANCE CRITERIA

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

1. 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1 and 30, as they relate to the requirement that SSCs important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed;

2. GDC 4, as it relates to the compatibility of components with environmental conditions;

3. GDC 14, as it relates to the requirement that the reactor coolant pressure boundary (RCPB) be designed, fabricated, erected, and tested in a manner that provides assurance of an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture;

4. GDC 31, as it relates to the requirement that the RCPB be designed with sufficient margin to ensure that when stressed under operating, maintenance, testing, and postulated accident conditions the boundary behaves in a nonbrittle manner and the probability of rapidly propagating fracture is minimized;

5. 10 CFR Part 50, Appendix B, as it relates to controlling the cleaning of material and equipment to prevent damage or deterioration;

6. 10 CFR Part 50, Appendix G, as it relates to materials testing and acceptance criteria for fracture toughness of reactor pressure boundary components;

7. 10 CFR 50.55a incorporates by reference the design criteria of ASME Code, Section III, Class 1, 2, and 3 components. The selection of materials, design, testing, fabrication, installation and inspection of threaded fasteners and mechanical joints are acceptable if they meet the criteria of the ASME Code, Section III, Class 1, 2, and 3 components. However, 10 CFR 50.55a(b)(4) permits use of code cases that have been adopted by the staff in Regulatory Guide (RG) 1.84 in lieu of applicable criteria of ASME Code, Section III, Class 1, 2, and 3 components;

8. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a facility that incorporates the DC has been constructed and will be operated in conformity with

the DC, the provisions of the Atomic Energy Act (AEA), and the U.S. Nuclear Regulatory Commission's (NRC's) regulations;

9. 10 CFR 52.79(a)(11), which references 10 CFR 50.55a for COL applicants; and

10. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the COL, the provisions of the AEA, and the NRC's regulations.

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are set forth below. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. 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.

1. Design Aspects

A. Materials Selection

The selection of materials used for the design of threaded fasteners is acceptable if the ASME Code, Section III criteria shown in Table 3.13-1 of this DSRS section are appropriately specified by the applicant for ASME Code Class 1, 2, and 3 systems.

B. Mechanical Testing, Special Process and Controls

The criteria for mechanical property testing of threaded fastener materials are provided in the particular ASME Code Section, II, Part A specification under which the material was procured. The material heat treatment and tensile test coupon preparation criteria for threaded fasteners that are fabricated from ferritic materials (i.e., carbon steel or low alloy steel) are acceptable if the ASME Code, Section III criteria shown in Table 3.13-1 are appropriately specified by the applicant for ASME Code, Class 1, 2, and 3 systems. The applicant should apply criteria of ASME Code Section III Subparagraphs NB-2200, NC-2200, and ND-2200 rather than the criteria of the material specification applicable to the mechanical testing if there is a conflict between the two sets of criteria.

Lubricants and sealants in mechanical connections secured by threaded fasteners should be specified to ensure they are compatible with the threaded fasteners. Any mechanical joint using threaded fasteners should be designed to preclude galvanic corrosion.

C. Fracture Toughness Requirements for Ferritic Materials

The fracture toughness of ferritic bolts, studs, and nuts (i.e., made from either low-alloy steel or carbon steel materials) is acceptable if the ASME Code, Section III criteria shown in Table 3.13-1 are appropriately specified by the

applicant for ASME Code Class 1, 2, and 3 systems. Ferritic bolts, studs, and nuts (i.e., bolts, studs, and nuts made from either low-alloy steel or carbon steel materials) used in RCPB applications must also meet the fracture toughness requirements of 10 CFR Part 50, Appendix G.

D. Fabrication Inspection

The examination criteria for threaded fasteners are acceptable if the ASME Code, Section III criteria shown in Table 3.13-1 are appropriately specified by the applicant for ASME Code Class 1, 2, and 3 systems.

E. Quality Records

The applicant should provide assurance that the CMTRs will be retained in accordance with the requirements of 10 CFR 50.71. The CMTR should identify the material specification for which the material was procured along with the associated material properties tests (including fracture toughness tests) and inspections that apply to the particular material specification.

Table 3.13-1

ASME Code, Section III Criteria for Selection and Testing of Bolting Materials [1]

Code Category		ASME Code Class 1 Criteria	ASME Code Class 2 Criteria	ASME Code Class 3 Criteria
Material Selection		NCA-1220 and NB-2128	NCA-1220 and NC-2128	NCA-1220 and ND-2128
Material Test Coupons and Specimens for Ferritic Steel Material (Tensile Test Criteria)	Heat Treatment Criteria	NB-2210	NC-2210	ND-2210
	Test Coupons Requirements Bolting/Stud Materials	NB-2221 NB-2224	NC-2221 NC-2224.3	ND-2221 ND-2224.3
Fracture Toughness Requirements	Material to be Impact Tested	NB-2311	NC-2311	ND-2311
	Types of Impact Test	NB-2321	NC-2321	ND-2321
	Test Coupons	NB-2322	NC-2322	ND-2322
	Acceptance Standards	NB-2333	NC-2332.3	ND-2333
	Number of Impact Tests Necessary	NB-2345	NC-2345	ND-2345

	Retesting	NB-2350	NC-2352	ND-2352
	Calibration of Test Equipment	NB-2360	NC-2360	ND-2360
Examination Criteria for Bolts, Studs, and Nuts		NB-2580	NC-2580	ND-2580
Certified Material Test Report Criteria		NCA-3860	NCA-3860	NCA-3860

Note 1: ASME Code, Section III paragraphs listed in this table represent those specified in the 2001 Edition of Section III. Corresponding paragraphs may vary in other Editions or Addenda of ASME Code, Section III.

Table 3.13-2

ASME Section XI Examination Categories for Inservice Inspections of Mechanical Joints in ASME Code Class 1, 2, and 3 Systems that Are Secured by Threaded Fasteners [1]

Examination Type	ASME Class 1 Criteria	ASME Class 2 Criteria	ASME Class 3 Criteria
Specific Bolting Inspections	Table IWB-2500-1, Exam. Cat. B-G-1 for bolting greater than 2 inches in diameter	Table IWC-2500-1, Exam. Cat. C-D for bolting greater than 2 inches in diameter	Not Applicable - Currently there are no examination categories that correspond to those that exist for ASME Class 1 and 2 bolting.
	Table IWB-2500-1, Exam. Cat. B-G-2 for bolting less than or equal to 2 inches in diameter		
System Pressure Tests	Table IWB-2500-1, Exam. Cat. B-P	Table IWC-2500-1, Exam. Cat. C-H	Table IWD-2500-1, Exam. Cat. D-B

Note 1: ASME Code, Section XI paragraphs listed in this table represent those specified in the 2001 Edition of Section XI. Corresponding paragraphs may vary depending on specific Editions or Addenda of ASME Code, Section XI.

2. Preservice and Inservice Inspection Requirements

The PSI and ISI provisions for mechanical joints are acceptable if the ASME Code, Section XI criteria shown in Table 3.13-2 are appropriately specified by the applicant for ASME Code Class 1, 2, and 3 systems.

For system pressure testing, the requirements of 10 CFR 50.55a(b)(2)(xxvii) for visual examination of certain insulated bolting or studs during system pressure testing should also be identified.

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. GDCs 1 and 30 require that SSCs important to safety be designed, fabricated, erected, tested and inspected to quality standards commensurate with the importance of the safety functions to be performed. GDC 14 requires that the RCPB be designed, fabricated, erected, and tested in a manner that provides assurance of an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture. The RCPB provides a barrier to fission products, a confined volume for the inventory of reactor coolant, and flow paths to facilitate core cooling. Threaded fasteners and mechanical joints form an integral part of maintaining pressure boundary integrity and are essential for withstanding normal loading and any transient load created during abnormal or accident conditions. The failure of fasteners in a system could result in loss of fluid in the system and jeopardize safe operation of the plant. Conformance with criteria of the ASME Code, Section III and the regulatory positions of RG 1.65 satisfies, in part, the requirements of GDCs 1, 14, and 30 by providing assurance that threaded fasteners will be designed, fabricated, and tested to established and proven standards and, thereby, minimizing the likelihood of failure of the pressure boundary.

2. GDC 4 requires that SSC important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. Therefore, mechanical connections using threaded fasteners should be protected against the detrimental effects of certain lubricants/sealants that promote corrosion and its vulnerability to boric acid corrosion.

3. GDC 31 requires that the RCPB be designed with sufficient margin to ensure that when stressed under operating, maintenance, testing, and postulated accident conditions the boundary behaves in a nonbrittle manner and the probability of rapidly propagating fracture is minimized. Appendix G to 10 CFR Part 50 establishes fracture toughness requirements for ferritic materials of pressure-retaining components of the reactor coolant pressure boundary to ensure that there are adequate margins of safety during any condition of normal operation, including anticipated operational occurrences and system hydrostatic tests, to which the pressure boundary may be subjected over its service lifetime. Threaded fasteners and mechanical joints are integral to the design of the RCPB. Application of the requirements of Appendix G ensures that threaded fasteners in the RCPB will behave in a nonbrittle manner, minimizing the probability of rapidly propagating fracture and thereby satisfying the requirements of GDC 31.

4. 10 CFR Part 50, Appendix B, Criterion XIII, requires that measures be established to control the cleaning of material and equipment to prevent damage or deterioration. RG 1.28 provides quality assurance criteria for cleaning fluid systems and associated components that ensure compliance with 10 CFR Part 50, Appendix B. Application of the cleaning criteria in RG 1.28 to threaded fasteners provides assurance that contaminants to which they could be exposed will not damage or deteriorate the materials, alter their properties, accelerate effects associated with aging, or increase the susceptibility to failure mechanisms such as stress corrosion cracking. Application of these criteria reduces the likelihood that degradation of threaded fasteners could lead to loss of pressure boundary integrity.

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.

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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. Design Aspects

A. Materials Selection

ASME Code, Section III provides acceptable standards for selecting threaded fastener materials identified in Section II of the ASME Code. ASME Code, Section II provides the material properties for threaded fasteners used in mechanical joints for ASME Code, Class 1, 2 and 3 applications. Table 3.13-1 lists the applicable criteria in ASME Code, Section III that pertain to the material selection for threaded fasteners in Class 1, 2, and 3 systems. In accordance with ASME Code, Section III, Paragraph NB-2128, the use of washers is optional. If washers are used, they should be fabricated from wrought materials with mechanical properties that are compatible with the associated nuts.

Class 1 Applications: ASME Code, Section III, Paragraphs NCA-1220 and NB-2128 provide the material selection criteria for threaded fasteners used in Class 1 applications. Paragraph NB-2128 provides that materials for Class 1 bolts and studs should conform to one of the specifications listed in Table 4 of ASME Code, Section II, Part D, Subpart 1. The materials for nuts should conform to either ASTM SA-194 or to one of the specifications listed in Table 4 of ASME Code, Section II, Part D, Subpart 1. The applicant should, prior to determining the acceptability of proposed alternatives to the materials permitted in Table 4 of Subpart 1, perform a study of the suitability of the alternative materials selected for the threaded fasteners and compare with any precedents set forth and accepted in prior staff reviews. The reviewer should provide a rationale for accepting or rejecting any material that has been proposed as an alternative to the mandated material selection criteria.

RG 1.65, Position C.1 provides the NRC position that measured yield strength for reactor vessel (RV) closure studs should not exceed 1,034 Mpa (150 ksi). The basis for this position is described in RG 1.65, Section B

Class 2 and 3 Applications: ASME Code, Section III, Paragraphs NCA-1220 and NC-2128 provide the material selection criteria for threaded fasteners used in Class 2 applications. The criteria for selecting bolt materials for ASME Code Class 3 applications are specified in Paragraphs NCA-1220 and ND-2128. Paragraphs NC-2128 and ND-2128 provide that the bolting materials should conform to one of the specifications listed in Table 3 of ASME Code, Section II,

Part D, Subpart 1. The materials used for nuts should conform to either ASTM SA-194 or to one of the specifications listed in Table 3 of Subpart 1.

B. Mechanical Testing, Special Process and Controls

The criteria for mechanical property testing of threaded fastener materials are identified in the specification of ASME Code, Section II, Part A. The reviewer should verify that the applicant has specified the appropriate mechanical tests in accordance with Part A for each type of threaded fastener. Table 3.13-1 identifies the appropriate section of the ASME Code relative to material heat treatment and tensile test coupon preparation criteria for ferritic materials (i.e., carbon steel or low-alloy steel). The applicant should apply criteria of ASME Code, Section III, Subparagraphs NB-2200, NC-2200, ND-2200 rather than the criteria of the material specification applicable to the mechanical testing if there is a conflict between the two sets of criteria.

The reviewer should ensure that the applicant conforms to the recommendations in RG 1.65 for RV studs. The reviewer should also assess whether the applicant has implemented any special controls to ensure that the surface treatments, plating applications, or use of lubricants on RV closure studs are compatible with the stud material at the anticipated operating temperature for the RCPB.

Lubricants and sealants in mechanical connections secured by threaded fasteners should be specified by the applicant to ensure maximum compatibility with the threaded fasteners. For example, molybdenum disulfide lubricant is known to promote corrosion in low alloy steel and should not be used. The applicant should provide the technical basis for the acceptability of lubricants or sealants, with reference to accepted industry practice, experience, and supporting data. The guidance for selection of lubricants is provided in NUREG-1339.

Any mechanical connection using threaded fasteners should be designed to preclude galvanic corrosion. The application should identify any differences in materials used in mechanical connections and include the technical basis for the compatibility of the materials used, with reference to accepted industry practice, experience, and supporting data.

The reviewer should ensure that the applicant conforms to the RG 1.28 quality assurance criteria for cleaning fluid systems and associated components. The reviewer should also confirm conformance to the practices noted in the RG 1.28 that are intended to minimize the probability that SCC will occur in components that are fabricated from either austenitic stainless steel or nickel-based alloys.

Additional information summarizing the initiatives of the NRC staff and the industry to address bolting degradation and failure issues in the United States can be found in References 4 through 9.

C. Fracture Toughness Requirements for Ferritic Materials

The reviewer should ensure that the fracture toughness properties of ferritic bolts, studs, and nuts (i.e., made from either low-alloy steel or carbon steel materials) will be attained in accordance with the ASME Code, Section III criteria for threaded fasteners used in ASME Code Class 1, 2, and 3 systems.

Class 1 Applications: The reviewer should verify that ferritic bolts, studs, and nuts (i.e., bolts, studs, and nuts made from either low-alloy steel or carbon steel materials) used in RCPB applications meet the fracture toughness requirements of 10 CFR Part 50, Appendix G. Section IV.A of Appendix G requires (in part) that the fracture toughness values for these materials comply with the fracture toughness criteria for ferritic materials that are specified in Subarticle NB of ASME Code, Section III (refer to column 2 of Table 3.13-1).

Class 2 and 3 applications: 10 CFR 50.55a invokes fracture toughness requirements in ASME Code, Section III, Subarticles NC and ND for ferritic bolting used in Class 2 and 3 applications. The reviewer should ensure that applicant specifies the appropriate Section III criteria (refer to Columns 3 and 4 of Table 3.13-1).

D. Fabrication Inspection

The reviewer should verify that the applicant has specified the appropriate ASME Code, Section III examination criteria for threaded fasteners used in ASME Code Class 1, 2, and 3 systems. Table 3.13-1 identifies the appropriate inspection criteria for bolts, studs and nuts. Under ASME Code, Section III, Paragraph NB-2580, the following fabrication inspections should be performed: (1) visual examinations of the threads, shanks, and heads in all bolts, nuts, and studs used in ASME Code Class 1 applications, (2) surface examinations (i.e., either liquid penetrant examinations or, if the materials of fabrication are ferritic, magnetic particle examinations) of all Class 1 bolts, studs, and nuts that are larger than 1 inch in diameter, and (3) ultrasonic (UT) examinations for Class 1 bolts, studs, and nuts are larger than 2 inches in diameter and more comprehensive UT criteria if the bolts, studs, and nuts are larger than 4 inches in diameter as specified under ASME Code, Section III, Paragraphs NB-2585 and NB-2586 respectively.

E. Quality Records

The reviewer should ensure that the applicant commits to retaining the CMTRs in accordance with the requirements of 10 CFR 50.71. The reviewer should also confirm that the applicant commits to recording the results of its material chemistry tests (i.e., alloying elements) and physical property tests in applicable CMTRs, as provided in ASME Code, Section III.

4. Preservice and Inservice Inspection Requirements

The reviewer should ensure the DC applicant and the COL applicant commit to complying with the PSI and ISI requirements of 10 CFR 50.55a and the criteria of ASME Code, Section XI for threaded fasteners and mechanical joints used in ASME Code, Class 1, 2, and 3 systems consistent with the scope of their applications. A description of the PSI and ISI operational programs and their implementation should be provided by the COL applicant. The DC applicant should identify the systems and components specific to its design that should be included in the PSI and ISI program.

The reviewer should verify that applicants for COLs commit to complying with the requirements of ASME Code, Section XI, IWA-5000 and the requirements of 10 CFR 50.55a(b)(2)(xxvi)and Paragraph (xxvii).

The above commitments should be identified in the DC application as COL action items.

5. 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 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.

   In general, for review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit or other NRC approvals (e.g., manufacturing license, site suitability report or topical report). However, the scope of this DSRS section only addresses the NuScale DC application and COL applications that reference the NuScale certified design.

   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.

1. The staff concludes that the selection of materials, design, inspection, testing and recording is in accordance with the ASME Code, Section II and III criteria for ASME Code Class 1, 2 and 3 threaded fasteners and ensures application of quality standards commensurate with the importance of the safety functions to be performed. Application of these ASME Code criteria also provides assurance of an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture. The applicant has conformed to these ASME Code criteria and the guidance in RG 1.65, and, therefore, meets the requirements of 10 CFR Part 50, Appendix A, as well as GDCs 1, 14, and 30.

2. The fracture toughness tests provided for in the ASME Code, as augmented by the requirements of Appendix G of 10 CFR Part 50, provide reasonable assurance that adequate safety margins against nonductile behavior or rapidly propagating fracture will be provided for threaded fastener materials used in ASME Code Class 1, 2 and 3 systems. The applicant has conformed to these criteria and, therefore, meets the requirements of 10 CFR 50.55a and GDC 31.

3. The applicant has identified special processes used for threaded fasteners. Since the applicant has certified that the materials and fabrication criteria of Section III of the ASME Code have been complied with, the staff considers the special processes used to be acceptable.

4. The threaded fastener materials are compatible with the materials of the components being joined. Lubricants and sealants are compatible with the materials of the components being joined and with the piping system fluids. Following the criteria of the ASME Code, Section III ensures that the level of general corrosion of threaded fasteners will be acceptable. The applicant has provided evidence of compatibility of threaded fasteners with the materials being joined and with the piping system fluids, as well as compliance with ASME Code criteria. Therefore, the applicant meets the requirements of GDC 4 relative to compatibility of components with environmental conditions.

5. The applicant's controls to avoid contamination that could lead to SCC conform to the recommendations of RG 1.28. These controls satisfy the requirements of 10 CFR Part 50, Appendix B, Criterion XIII with respect to controls for cleaning of materials and components.

6. The staff concludes that the DC applicant provides commitment that the PSI and ISI operation program for threaded fasteners developed by the COL applicant meets the criteria of ASME Code, Section XI and the requirements of 10 CFR 50.55a.

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 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. ASME Boiler and Pressure Vessel Code, Sections II, III, and XI, American Society of Mechanical Engineers.

2. RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition),” June 2007.

3. SECY-05-0197, “Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria,” October 28, 2005.

4. SRP 13.5.2.2 (NUREG-0800), “Maintenance and Other Operating Procedures,” June, 1996.

5. SRP 17.5 (NUREG-0800), “Quality Assurance Program Description - Design Certification, Early Site Permit and New License Applicants,” March, 2007.

6. SRP 19.0 (NUREG-0800), “Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors,” June, 2007.

7. RG 1.28, “Quality Assurance Program Criteria (Design and Construction),” June 2010.

8. RG 1.65, “Materials and Inspections for Reactor Vessel Closure Studs,” April 2010.

9. RG 1.84, “Design, Fabrication, and Materials Code Case Acceptability, ASME Section III.”

10. Generic Letter No. 91-17, “Generic Safety Issue 29, Bolting Degradation or Failure in Nuclear Power Plants,” October 17, 1991.

11. NUREG-1339, “Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants,” June 1990.

12. EPRI NP-5067, Volume I (Large Bolt Manual), “Good Bolting Practices - A Reference Manual for Nuclear Power Plant Maintenance Personnel,” 1987.

13. EPRI NP-5067, Volume II (Small Bolt Manual), “Good Bolting Practices - A Reference Manual for Nuclear Power Plant Maintenance Personnel,” 1990.

14. EPRI NP-5769, Volumes 1 and 2, “Degradation and Failure of Bolting in Nuclear Power Plants, Volumes 1 and 2,” April 1988.

15. 10 CFR Part 50, Section 50.55a, "Codes and Standards."

16. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Plants."

17. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

18. 10 CFR Part 50, Appendix G, "Fracture Toughness Requirements."