

APR1400 DCD TIER 2

3.13 Threaded Fasteners (ASME Section III Class 1, 2, and 3)

This section addresses relevant requirements of GDC 1, 4, 14, 30, and 31, and 10 CFR 50 Appendices B and G for ASME Section III (Reference 1) Class 1, 2, and 3 component threaded fasteners.

ASME Section III Class 1, 2, and 3 component fasteners materials are selected, fabricated, designed, tested, and inspected to meet the requirements of ASME Section III Subsections NB, NC, and ND corresponding to their ASME Code Classes except reactor vessel stud bolts, for which the detailed description is provided in paragraph 5.3.1.7.

3.13.1 Design Considerations

3.13.1.1 Materials Selection

ASME Section III Class 1, 2, and 3 component fasteners are fabricated using the materials that are prescribed in ASME Section III or ASME Code Cases as allowed by NRC RG 1.84 (Reference 2). Threaded fasteners, except the stud bolts for the reactor vessel head and reactor coolant pump (RCP) casing, which consist of the reactor coolant pressure boundary (RCPB) or are in contact with the primary coolant, are made of primary water corrosion resistant materials such as austenitic stainless steels, martensitic stainless steels, precipitate hardening stainless steels, and nickel based alloys. In designing threaded fastener joints, consideration is given for the prevention of galvanic corrosion, except when the design or material of the fasteners has been demonstrated to be acceptable through satisfactory operation in the OPR 1000 plants, where any primary coolant leakage can be automatically identified if it occurs, or where periodic inspections for leakage and verification of the integrity of threaded fasteners are performed as a countermeasure for leakage.

Table 3.13-1 lists the applicable criteria in ASME Section III paragraphs relevant to the material selection and testing of threaded fasteners in Class 1, 2, and 3 components. Materials used in threaded fasteners are selected for their compatibility with the environmental conditions to which they are exposed.

3.13.1.2 Special Materials Fabrication Processes and Special Controls

APR1400 DCD TIER 2

Special process and controls such as heat treatment, which affects the material properties, and tests for material property evaluation of threaded fasteners procured or fabricated, are in accordance with ASME Section II (Reference 3) and III. Table 3.13-1 identifies the appropriate Subparagraphs NB-2200, NC-2200, ND-2200 of the ASME Code regarding material heat treatment and tensile test coupons preparation criteria for ferritic materials (e.g., carbon steel, high strength low alloy steel). The criteria of ASME Section III are applied rather than the criteria of the material specification of ASME Section II applicable to the mechanical testing if there is a conflict between the two sets of criteria.

In addition, threaded fasteners are fabricated using the materials, fabrication practices, and special processes that have been proven for the sensitivity of the stress corrosion cracking or other forms of material degradations through the previous experience and/or laboratory data.

Threaded fasteners are cleaned in accordance to NRC RG 1.37 (Reference 4) to provide reasonable 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.

Reactor vessel closure studs and nuts are surface-treated with a manganese based phosphate coating for protection against corrosion effects.

3.13.1.2.1 Fabrication Inspection

ASME Section III Class 1, 2, and 3 component fasteners are inspected during fabrication in accordance with ASME Section III, NB-2580, NC-2580, and ND-2580 for the corresponding ASME Code Class (see Table 3.13-1) and material specification.

3.13.1.2.2 Lubricants and Sealants

Lubricants used during installation of ASME Section III Class 1, 2, and 3 component fasteners are those that meet the requirements prescribed in the relevant design documents to provide reasonable assurance of the compatibility with the fasteners. Lubricants are selected in accordance with the guidance provided in NUREG-1339. Acceptable lubricants are Loctite N-5000, Neolube, and Never Seez Pure Nickel Special Nuclear Grade.

APR1400 DCD TIER 2

These lubricants have shown satisfactory performance in OPR 1000 plants. MoS₂ is not allowed for use with code class fasteners in any circumstance. A single type of lubricant is used at the site, if possible, for easy control. Sealants are not used for the threaded fasteners.

Reactor vessel closure studs and nuts are surface treated with manganese base phosphate coating for protection against the possibility of incurring corrosion effects.

3.13.1.3 Fracture Toughness Requirements for Threaded Fasteners Made of Ferritic Materials

ASME Section III Class 1, 2, and 3 component fasteners with diameters that are greater than 25 mm (1 in) are impact tested in accordance with ASME Section III NB 2300, NC 2300, or ND 2300 (as appropriate for the assigned ASME Code Class) at a temperature no higher than the lowest service temperature or preload temperature, whichever is less, and meet the acceptance criteria described in ASME Section III, NB 2330, NC 2330, or ND 2330 as for the corresponding Code Class (see Table 3.13-1).

In addition, 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.

3.13.1.3.1 Prevention of Brittle Fracture and Failure due to Fatigue and Structural Stress

ASME Section III Class 1, 2, and 3 component fasteners are designed in accordance with ASME Section III NB 3000, NC 3000, and ND 3000, respectively, to endure the stresses resulting from operation of the corresponding components where the fasteners are installed. In addition, they are evaluated for fatigue and are designed to have enough toughness to prevent brittle fracture during the operation in accordance with ASME Section III, NB-3000, NC-3000, or ND-3000 as for the corresponding code class.

3.13.1.4 [Reserved]

3.13.1.5 Certified Material Test Reports

APR1400 DCD TIER 2

Quality records such as certified material test reports (CMTRs), which are associated with ASME Section III Class 1, 2, and 3 component fasteners, are controlled, maintained, and stored in accordance with the quality assurance program to meet the requirements of 10 CFR 50, Appendix B; ASME NQA-1; and ASME NCA. The CMTRs contain the contents required by ASME Section III, NCA 3860.

The combined license (COL) applicant is to maintain quality records including CMTRs on ASME Section III Class 1, 2, and 3 component threaded fasteners in accordance with the requirements of 10 CFR 50.71 (COL 3.13(1)).

3.13.2 Inservice Inspection Requirements

As required by 10 CFR 50.55a, except where written relief has been granted by the NRC, the relevant requirements of ASME Section XI Division 1 (Reference 5) are followed for the plant preservice and inservice inspection of ASME Section III Class 1, 2, and 3 threaded fasteners (see Table 3.13-2).

The COL applicant is to submit the preservice and in-service inspection program for ASME Section III Class 1, 2, and 3 component threaded fasteners to the NRC RG prior to performing the inspection (COL 3.13(2)). The in-service inspection program identifies the applicable edition and addenda of ASME Section XI and provides reasonable assurance of compliance with the requirements of 10 CFR 50.55a(b)(2)(xxvi).

3.13.3 Combined License Information

COL 3.13(1) The COL applicant is to maintain quality records including CMTRs on ASME Section III Class 1, 2, and 3 component threaded fasteners in accordance with the requirements of 10 CFR 50.71.

COL 3.13(2) The COL applicant is to submit the preservice and inservice inspection programs for ASME Section III Class 1, 2, and 3 component threaded fasteners to the NRC prior to performing the inspections.

3.13.4 References

APR1400 DCD TIER 2

1. ASME Boiler and Pressure Vessel Code, Section III, “Rules for Construction of Nuclear Facility Components,” 2007 Edition with 2008 Addenda.
2. NRC RG 1.84, “Design, Fabrication, and Material Code Case Acceptability,” Rev. 35, U.S. Nuclear Regulatory Commission, October 2010.
3. ASME Boiler and Pressure Vessel Code, Section II, “Materials,” Part A, “Ferrous Material Specifications,” 2007 Edition with 2008 Addenda.
4. NRC RG. 1.37, “Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants,” March 2007.
5. ASME Boiler and Pressure Vessel Code, Section XI, Division 1, “Rules for Inspection and Testing of Components of Light-Water Cooled Plants,” 2007 Edition with 2008 Addenda.

Table 3.13-1

ASME Section III Criteria for Selection and Testing of Bolting Materials⁽¹⁾

Code Category		ASME Class 1 Components	ASME Class 2 Components	ASME Class 3 Components
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 coupon requirements for 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

(1) Section III paragraphs listed in this table represent those specified in the 2007 Edition of ASME 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 Secured by Threaded Fasteners⁽¹⁾

Examination Type	ASME Class 1 Components	ASME Class 2 Components	ASME Class 3 Components
Specific bolting inspections	Table IWB-2500-1, Exam. Cat. B-G-1 for bolting greater than 5.08 cm (2 in) in diameter	Table IWC-2500-1, Exam. Cat. C-D for bolting greater than 5.08 cm (2 in) 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 5.08 cm (2 in) 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

(1) Section XI paragraphs listed in this table represent those specified in the 2007 Edition of ASME Section XI.