RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.: **26-7948**

SRP Section: **05.02.01.02 - Applicable Code Cases**

Application Section: **5.2.1.2**

Date of RAI Issued: **6/15/2015**

Question No. 05.02.01.02-1

SRP Section 5.2.1.2 cites Regulatory Guides (RGs) 1.84, 1.147, and 1.192 to provide a list of acceptable Code Cases related to ASME Boiler and Pressure Vessel Code (BPV Code) Section III, Division 1 on component design and materials; BPV Code Section XI, Division 1 on tests and inspections; and Operations and Maintenance of Nuclear Power Plants (OM Code) on operation and maintenance of nuclear power plant components. According to the SRP, the NRC staff reviews the table provided by the applicant to confirm that the Code Cases listed conform to the list of acceptable Code Cases in these RGs. In performing this review, the NRC staff has found several instances where the relevant table (Tier 2, Table 5.2-4) is incomplete or inconsistent with other DCD text. Therefore, additional information is needed to enable the staff to make a finding on compliance with General Design Criterion 1 and 10 CFR 50.55a, which incorporates these regulatory guides by reference. Several examples are as follows:

- In DCD Tier 2, Section 3.12.2.2, Code Case N-122-2 is mentioned as being used for piping systems and pipe supports; however, this Code Case is not mentioned in DCD Tier 2, Table 5.2-4, “ASME Section III Code Cases.”
- DCD Tier 2, Section 3.13 also states that ASME Section III Class 1, 2, and 3 component fasteners are fabricated using materials prescribed in ASME Code Cases allowed by RG 1.84, but does not mention any specific ASME Code Cases.
- In DCD Tier 2, Section 3.9.3.4, it states that ASME Section III Class 1, 2, and 3 component supports are designed and constructed in accordance with ASME Section III and ASME Code Case(s), but this section does not reference any specific ASME Code Cases. DCD Tier 2, Sections 6.0 and 5.4.2.1.1 also have the same issue.
- DCD Sections 6.6.3 and 6.6.1 discuss ASME Code Cases used in accordance with RG 1.147. However, no Code Cases in RG 1.147 are mentioned in DCD Section 5.2.1.2.
- In the DCD markups enclosed with the applicant’s letter MKD/NW-15-0020L dated June 1, 2015, ASME Code Cases OMN-1, 3, and 11 are mentioned in Insert C of MEB AI 3-11,12,13

(14/26) for DCD Tier 2, Section 3.9.6.3.1. However, this letter did not include associated markups to DCD Tier 2, Section 5.2.1.2.

The staff requests the applicant to update Table 5.2-4 to be comprehensive in including all ASME Code Cases referenced to support the design certification application, and to clarify in the application which specific ASME Code Cases are used when mentioned. Combined license (COL) items 5.2(1), 5.2(2), and 5.2(3) should also be revised to clarify that they address the scope outside the design certification application (e.g., developing and executing an operational program such as inservice testing).

Response

Section C.I.5.2.1.2 of RG 1.206 indicates that applicants should provide a list of ASME Code Cases that will be applied to components within the RCPB. Table 5.2-4 addresses ASME Section III Code Cases applicable to components within the RCPB. DCD section 5.2.1.2 will be revised to identify the relevant DCD sections related with the applications of ASME Code Cases which are not covered by Table 5.2-4, as indicated on the attached markup.

DCD sections 3.13.1.1 and 5.4.2.1.1, which do not specify Code Cases applicable to the APR1400 design, will be revised to delete the statements regarding ASME Section III Code Cases.

EFS component design in DCD section 6.0 may use any ASME Section III Code Cases but the specific Code Cases cannot be defined until the actual component supplier is selected. The COL Applicant is to address the ASME Code Cases that are approved in the NRC RG 1.84 per COL item 5.2(1).

For clarity, COL items 5.2(1), 5.2(2) and 5.2(3) will be revised as indicated on the attached markup. ASME Code Cases that the COL Applicant intends to implement as part of their inservice inspection (ISI) program and operations and maintenance program for a specific plant are identified.

Impact on DCD

DCD Table 1.8-2 and Sections 3.13.1.1, 3.13.4, 5.2.1.2, 5.2.3.1, 5.2.6, 5.4.2.1.1, and 6.0 will be revised as indicated in Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical or Environmental Reports.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Table 1.8-2 (7 of 29)

Item No.	Description
COL 3.12(6)	The COL applicant is to perform the piping stress analysis including thermal stratification effects on SCS suction line.
COL 3.12(7)	The COL applicant is to determine maximum radial thermal expansion at its design temperature.
COL 3.13(1)	The COL applicant is to maintain quality assurance 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 the inspections.
COL 5.2(1)	The COL applicant is to address the addition of ASME Code cases that are approved in NRC RG 1.84.
COL 5.2(2)	The COL applicant is to address the ASME Code cases, ~~which are~~ invoked for the ISI program of specific plant.
COL 5.2(3)	The COL applicant is to address the Code cases invoked for operation and maintenance activities.
COL 5.2(4)	The COL applicant is to address the material specifications 5.2-2, as necessary.
COL 5.2(5)	The COL applicant is to specify the version of EPRI's, "Primary Water Chemistry Guidelines," that will be implemented.
COL 5.2(6)	The COL applicant is to address the actual, as-procured, fracture toughness data of the RCPB materials to the staff at a predetermined time by an appropriate method.
COL 5.2(7)	The COL applicant is to submit the actual, as-procured yield strength of the austenitic stainless steel materials used in RCPB to the staff at a predetermined time agreed-upon by the regulatory body.

at the time of the application

approved in NRC RG 1.147 at the time of the application and

ASME

of a specific plant.

approved in NRC RG 1.192 at the time of the application and

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 Part 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

Delete

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, precipitation-hardened 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.

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

1. ASME Boiler and Pressure Vessel Code, Section III, “Rules for Construction of Nuclear Facility Components,” The American Society of Mechanical Engineers, the 2007 Edition with the 2008 Addenda

Deleted

2. ~~NRC RG 1.84, "Design, Fabrication, and Materials Code Case Acceptability, ASME Section III," Rev. 36, U.S. Nuclear Regulatory Commission, August 2014.~~

3. ASME Boiler and Pressure Vessel Code, Section II, “Materials,” Part A, “Ferrous Material Specifications,” The American Society of Mechanical Engineers, the 2007 Edition with the 2008 Addenda.

4 NRC RG 1.28, "Quality Assurance Program Criteria (Design and Construction)," Rev. 4, U.S. Nuclear Regulatory Commission, June 2010.

5. ASME Boiler and Pressure Vessel Code, Section XI, Division 1, “Rules for Inspection and Testing of Components of Light-Water Cooled Plants,” The American Society of Mechanical Engineers, the 2007 Edition with the 2008 Addenda.

ESF	engineered safety feature
DVI	direct vessel injection
EDT	equipment drain tank
EOL	end of life
EPRI	Electric Power Research Institute
ERVC	external reactor vessel cooling
FCAW	flux cored arc welding
FEI	fluid elastic instability
GDC	general design criteria (of 10 CFR Part 50, Appendix A)
GL	Generic Letter
GTAW	gas tungsten arc weld
GWMS	gaseous waste management system
HAZ	heat-affected zone
HJTC	heated junction thermocouple
HT	holdup tank
HX	heat exchanger
ICI	in-core instrumentation
IEEE	Institute of Electrical and Electronics Engineers
IHA	integrated head assembly
IPS	information processing system
IRWST	in-containment refueling water storage tank
ISI	inservice inspection
ISLOCA	intersystem loss of coolant accident
IST	inservice testing
ITAAC	inspections, tests, analyses, and acceptance criteria
IWSS	in-containment water storage system
LBB	leak before break
LOCA	loss of coolant accident
LOCV	loss of condenser vacuum
LST	lowest service temperature
LTOP	low temperature overpressure protection

of the ASME Code for Operation and Maintenance of Nuclear Power Plants (OM Code) (Reference 7) to the RCPB.

The components and code classes that are listed in Table 5.2-1 are in accordance with the provisions o
the APR140
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and acceptar
addressed in

Subsection 3.12.2.2 and Section 6.0 provide descriptions of the application of ASME Section III Code Cases for safety-related piping systems and ESF components, respectively. Subsection 5.2.4 and Section 6.6 provide descriptions of the application of ASME Section XI Code Cases that are in conformance with the requirements of 10 CFR 50.55a and that are invoked for the ISI program. Subsection 3.9.6 provides descriptions of the application of the ASME OM Code Cases that are in conformance with the requirements of 10 CFR 50.55a and that are invoked for operation and maintenance activities.

5.2.1.2 Compliance with Applicable Code Cases

RCPB components are designed and fabricated in accordance with ASME Section III.

Section III

at the time of the application

The applicable ASME Code Cases that are in conformance with the requirements of GDC 1 and 10 CFR 50.55a and that are used in the plant design and manufacturing are listed in Table 5.2-4. NRC RGs 1.84 (Reference 9), 1.147 (Reference 10), and 1.192 (Reference 11) are used in determining the applicable ASME Code Cases. The COL applicant is to address the addition of ASME Code Cases that are approved in NRC RG 1.84 (COL 5.2(1)). The COL applicant is to address the ASME Code Cases invoked for the ISI program of a specific plant (COL 5.2(2)). The COL applicant is to address the ASME Code Cases invoked for operation and maintenance activities (COL 5.2 (3)).

approved in NRC RG 1.147 at the time of the application and

approved in NRC RG 1.192 at the time of the application and

5.2

of a specific plant.

Overpressure protection systems include all pressure-relieving devices for the following systems:

a. Reactor coolant system (RCS)

b. Primary side of auxiliary or emergency systems connected to the RCS

c. Secondary side of steam generators (SGs)

5.2.3 Reactor Coolant Pressure Boundary Materials

5.2.3.1 Material Specification

This subsection describes material issues common to the reactor coolant pressure boundary (RCPB) components. RCPB materials are fabricated in accordance with the requirements of GDC 1 and GDC 30 of 10 CFR Part 50, Appendix A; NRC RG 1.84; and 10 CFR 50.55a.

A list of specifications for the principal ferritic materials, austenitic stainless steels, bolting and weld materials, which are part of the RCPB, is given in Table 5.2-2. The COL applicant is to address the list of material specifications, which are not shown in Table 5.2-2, as necessary (COL 5.2(4)). The materials used in the RCPB meet the applicable material requirements of ASME Section III and conform to the applicable ASME Section II (Reference 16) material specifications or ASME Code Cases permitted or approved by the NRC. The COL applicant is to address the addition of ASME Code Cases that are approved in NRC RG 1.84 (COL 5.2(1)).

at the time of the application

Austenitic stainless steel base materials for RCPB applications are solution-heat-treated to prevent sensitization and primary water stress corrosion cracking (SCC). Alloy 600 base metal and Alloy 82/182 weld metal are not used in RCPB applications. Only alloy 690 base metal and Alloy 52/52M/152 weld metals are used for RCPB applications. Alloy 690 base metals are thermally treated to enhance their resistance to primary water stress corrosion cracking (PWSCC).

All carbon and low alloy steel materials including weld materials used within the RCPB are limited to maximum sulfur (S) content of equal to or less than 0.010 wt%.

Studies referenced in NRC RG 1.99, Revision 02 (Reference 17), have shown that irradiation-induced mechanical property changes of SA-508 materials can depend significantly on the amount of residual elements present in the compositions (i.e., copper, nickel, phosphorous, and vanadium). Residual sulfur has also been found to affect the initial toughness of SA-508 materials. Controls are placed on the residual chemistry of RV materials and the as-deposited welds used to join these materials to limit the maximum predicted increase in the RT_{NDT}, which is described in Subsections 5.3.1.6 and 5.3.2.1.1,

5.2.6 Combined License Information

COL 5.2(1) The COL applicant is to address the addition of ASME Code Cases that are approved in NRC RG 1.84 at the time of the application and approved in NRC RG 1.147 at the time of the application and

COL 5.2(2) The COL applicant is to address the ASME Code Cases invoked for the ISI program of a specific plant.

COL 5.2(3) The COL applicant is to address the Code Cases invoked for operation and maintenance activities of a specific plant and approved in NRC RG 1.192 at the time of the application and

COL 5.2(4) The COL applicant is to address the material specifications, which are not shown in Table 5.2-2, as necessary.

COL 5.2(5) The COL applicant is to specify the version of EPRI's, "Primary Water Chemistry Guidelines," that will be implemented.

COL 5.2(6) The COL applicant is to address the actual, as-procured, fracture toughness data of the RCPB materials to the staff at a predetermined time by an appropriate method.

COL 5.2(7) The COL applicant is to submit the actual, as-procured yield strength of the austenitic stainless steel materials used in RCPB to the staff at a predetermined time agreed-upon by the regulatory body.

COL 5.2(8) The COL applicant is to provide and develop the implementation milestones for the inservice inspection and testing program for the RCPB, in accordance with ASME Section XI and 10 CFR 50.55a.

COL 5.2(9) The COL applicant is to address the provisions to accessibility of Class 1 components for ISI if the design of the APR1400 Class 1 component is changed from the DCD design.

COL 5.2(10) The COL applicant is to provide the list of Code exemptions in the ISI program of the specific plants, if it exists.

COL 5.2(11) The COL applicant is to prepare and provide any requests for relief from the ASME Code requirements that are impracticable as a result of limitations of component design, geometry, or materials of construction for the specific plants, if necessary. The request will contain the information on applicable Code requirements, alternative ISI method, and justification.

The steam generator tube material is thermally treated NiCrFe Alloy 690 (ASME SB-163). The outside diameter is 19.05 mm (0.75 in) with 1.0668 mm (0.042 in) nominal wall thickness. An analysis is performed to establish the maximum allowable tube wall degradation for the steam generator tubes in accordance with the requirements of NRC RG 1.121 (Reference 8). Load conditions considered are maximum tube differential pressures during normal operation and faulted load conditions. The margin of safety against tube rupture under normal operating condition is not less than 3.0, and the margin of safety against tube failure under postulated accidents, such as a loss of coolant accident, main steam line break, or feedwater line break concurrent with an SSE, are consistent with the margin of safety determined by the stress limits specified in the ASME Code.

The more probable modes of tube failure, which result in smaller break areas, are the results from involving the occurrence of pinholes or small cracks in the tubes and of cracks in the seal welds between the tubes and tubesheet. Detection and control of steam generator tube leakage are described in Subsection 5.2.5.

The concentration of radioactivity in the secondary side of the steam generators is dependent on the concentration of radionuclides in the reactor coolant, the primary-to-secondary leak rate, and the rate of steam generator blowdown. The specific activities that are expected in the secondary side of the steam generators during normal operation are given in Section 11.1.

The recirculation water within the steam generators contains volatile additives necessary for proper chemistry control. These and other chemistry considerations for the steam generators are discussed in Subsection 10.3.5.

5.4.2.1 Steam Generator Materials

5.4.2.1.1 Selection, Processing, Testing, and Inspection of Materials

The pressure boundary materials used in the construction of the steam generators are listed in Table 5.2-2. These materials are in accordance with ASME Section III. ~~The Code Cases used in the fabrication of the steam generators are described in Subsection 5.2.1.~~

Delete

CHAPTER 6 – ENGINEERED SAFETY FEATURES

6.0 Engineered Safety Features

Engineered safety features (ESFs) mitigate the consequences of design basis accidents (DBAs) by maintaining long-term core cooling and the integrity of the containment building and by limiting offsite releases of radioactive materials. This section describes the following ESFs of the APR1400:

a. Containment systems

b. Safety injection systems

c. Habitability systems

d. Fission product removal and control systems

The components in ESF systems are safety-related and fabricated to standards that are commensurate with the importance of their safety functions in conformance with 10 CFR 50.55a (Reference 1).

ESF systems meet the following General Design Criteria (GDC) from Appendix A of 10 CFR Part 50 (Reference 2).

a. GDC 1: The ESF components are fabricated of materials selected in accordance with the applicable portions of ASME Section III, Division 1 or Division 2 (References 3 and 4), or an ASME Code Case in NRC Regulatory Guide (RG) 1.84 (Reference 5).

b. GDC 4: The containment and ESF components are designed to accommodate the environmental and dynamic effects associated with normal plant operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents (LOCAs).

GDC 1: The ESF components are fabricated of materials selected in accordance with the applicable portions of ASME Section III, Division 1 or Division 2 (References 3 and 4). ASME Code Cases listed in NRC RG 1.84 (Reference 5) may be used.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.: **26-7948**

SRP Section: **05.02.01.02 - Applicable Code Cases**

Application Section: **5.2.1.2**

Date of RAI Issued: **6/15/2015**

Question No. 05.02.01.02-2

Table 5.2-4 lists certain Code Cases that have been conditionally accepted by the NRC staff in RG 1.84, but does not explicitly state that the Code Cases will be used with the conditions as mentioned in RG 1.84, Table 2, "Conditionally Acceptable Section III Code Cases." The staff requests the applicant to clarify in the DCD that the conditions as stated in RG 1.84 will be used for the conditionally accepted Code Cases in Table 5.2-4, such that the NRC staff can make a finding on compliance with 10 CFR 50.55a, which incorporates these regulatory guides by reference. Additional information should be provided in the RAI response to describe how the Code Cases are implemented in accordance with these conditions. For example N-71-18 Condition 4 states that Paragraph 15.2.2 is not acceptable as written and must be replaced with the following: "When not exempted by 15.2.1 above, the postweld heat treatment must be performed in accordance with NF-4622 except that ASTM A-710 Grade A Material must be at least 1000°F (540°C) and must not exceed 1150°F (620°C) for Class 1 and Class 2 material and 1175°F (640°C) for Class 3 material."

Response

Among the conditionally acceptable Section III Code Cases listed in Table 2 of RG 1.84, Code Cases N-60-5, N-71-18, and N-249-14 are used for the APR1400 design. The following table shows the corresponding components that the each Code Case is applied to.

Conditionally Acceptable Section III Code Case (Material Specification)	Component
N-60-5 (SA-193 Grade B8M Cl.2)	Reactor vessel internals
N-71-18 (A588 Grade A)	Integrated head assembly
N-71-18 (ASTM A 148 Grade 90/60)	Support skirt on reactor coolant pump
	Upper support bracket of steam generator support
	Clevis of reactor coolant pump support
N-71-18 (ASTM A 500 Grade B)	Pipe supports in contact with the piping which is not RCPB
N-71-18 (ASTM A 514 Grade E or Q)	Base sliding support of steam generator
N-71-18 (ASTM A 572 Grade 50)	Lateral support of reactor vessel
N-249-14 (AISI 4340)	Steam generator support

These materials of Code Cases N-60-5, N-71-18, and N-249-14 are applied in conformance with RG 1.84, Rev.36.

- N-60-5
  (1) The minimum yield strength for SA-193 Gr.B8M Cl.2 (Strain Hardened) of Code Case N-60-5 and ASME Section II Part D is 65,000 psi. The maximum yield strength does not exceed 90,000 psi.

- N-71-18
  (1) The ultimate tensile strengths of the materials do not exceed 170 Ksi.
  (2) This condition is not applicable.
  (3) Paragraph 5.5 in Regulatory Guide 1.84 Rev.36 would be paragraph 4.2. The paragraph 4.2 of Code Case N-71-18 describes the condition of using SMAW electrode (E70XX, E80XX, E90XX and E100XX). There are two weld joints between middle cooling shroud shell and seismic ring beam of IHA. However, these two weld joints are welded by GTAW or FCAW, not SMAW. This condition is not applicable.
  (4) This condition is not applicable.
  (5) The weld joint is postweld heat-treated according to a heat treatment work instruction ruled by Condition (5) in Code Case N-71-18.
  (6) The fracture toughness requirements as listed in Code Case N-71-18 apply only to piping supports (ASTM A 500 Grade B) and not to Class 1 component supports.

- N-249-14
  (1) AISI 4340 is used for Class 1 component support.
  (2) The ultimate tensile strength of AISI 4340 does not exceed 170 ksi.

Impact on DCD

DCD Table 5.2-4 will be revised as indicated in Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical or Environmental Reports.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Table 5.2-4

ASME Section III Code Cases

Code Case	Title
N-4-13 (1), (2)	Special Type 403 Modified Forgings or Bars, Section III, Division 1, Class 1 and CS
N-60-5 (1), (3)	Materials for Core Support Structures, Section III, Division 1
N-71-18	Additional Materials for Subsection NF, Classes 1, 2, 3, and MC Component Supports Fabricated by Welding, Section III, Division 1
N-249-14 (1), (4)	Additional Materials for Subsection NF, Class 1, 2, 3, and MC Component Supports Fabricated without Welding, Section III, Division 1
N-759-2	Alternative Rules for Determining Allowable External Pressure and Comprehensive Stress for Cylinders, Cones, Spheres, and Formed Heads, Section III, Division 1

(1) The conditions as stated in NRC RG 1.84 will be used for the conditionally accepted Code Cases.
(2) SA-193 Grade B8M Cl.2 for Reactor vessel internals
(3) ASTM A 148 Grade 90/60 for Support skirt on reactor coolant pump, Upper support bracket of steam generator support, and Clevis of reactor coolant pump support
ASTM A 500 Grade B for Pipe supports in contact with the piping which is not RCPB
ASTM A 514 Grade E or Q for Base sliding support of steam generator
ASTM A 572 Grade 50 for Lateral support of reactor vessel
(4) AISI 4340 for Steam generator support