## MCB Issue List Regarding APR-1400, FSAR Section 3.13

### Issue #1

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criterion 14 specifies that the reactor coolant pressure boundary will 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. One element of nuclear power plant design that supports achieving this objective is the selection of threaded fasteners (bolts, studs, etc.) appropriate for their specific application and not susceptible to known, or expected, degradation mechanisms.

One such known, or expected, degradation mechanism is galvanic corrosion. The APR-1400 Final Safety Analysis Report (FSAR) Section 3.13 states,

> 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...

Identify all reactor coolant pressure boundary threaded fastener joints in the APR-1400 design, if any, for which the design or material of the fasteners has been justified to be acceptable through satisfactory operation in the OPR 1000 plants and provide your assessment of OPR 1000 operational experience that supports this demonstration.

Response

The materials for reactor coolant pressure boundary threaded fastener joints are provided in the following Table. These materials have been used for many years in the OPR 1000 plants and will be used in APR 1400 plants. Those materials have been used successfully without any materials issues in Korea.

## MCB Issue List Regarding APR-1400, FSAR Section 3.13

| Component | Item | Part | Material | | Size | |
|---|---|---|---|---|---|---|
| | | | APR1400 | OPR1000 | APR1400 | OPR1000 |
| RV | Closure Bolting | Stud | SA-540 Gr.B24 Cl.3 | SA-540 Gr.B24 Cl.3 | 7.375" Modified 8 Pitch Thread | 6.75" Modified 8 Pitch Thread |
| | | Nut | SA-540 Gr.B24 Cl.3 | SA-540 Gr.B24 Cl.3 | 7.375" Modified 8 Pitch Thread | 6.75" Modified 8 Pitch Thread |
| | Vent Pipe Flange Bolting | Stud | SA-193 Gr.B8M Cl.2 | SA-193 Gr.B8M Cl.2 | 0.75-10UNC-2A | 0.75-10UNC-2A |
| | | Nut | SA-193 Gr.B8M Cl.2 | SA-193 Gr.B8M Cl.2 | 0.75-10UNC-2B | 0.75-10UNC-2B |
| SG | Primary Manway | Stud | SB-637 UNS N07718 | SB-637 UNS N07718 | 1.75-8UN-2A | 1.625-8UN-2A |
| | | Nut | SB-637 UNS N07718 | ASME SB-637 UNS N07718 | 1.75-8UN-2B | 1.625-8UN-2B |
| | Secondary Manway | Stud | SA-540 Gr.B24 Cl.4 | SA-540 Gr.B24 Cl.4 | 1.5-8UN-2A | 1.5-8UN-2A |
| | | Nut | SA-540 Gr.B24 Cl.4 | SA-540 Gr.B24 Cl.4 | 1.5-8UN-2B | 1.5-8UN-2B |
| | Handhole | Stud | SA-540 Gr.B24 Cl.4 | SA-540 Gr.B24 Cl.4 | 1-8UNC-2A | 1-8UNC-2A |
| | | Nut | SA-540 Gr.B24 Cl.4 | SA-540 Gr.B24 Cl.4 | 1-8UNC-2B | 1-8UNC-2B |
| | Inspection Hole | Stud | SA-540 Gr.B24 Cl.4 | N/A[(1)] | 1-8UNC-2A | N/A |
| | | Nut | SA-540 Gr.B24 Cl.4 | N/A | 1-8UNC-2B | N/A |
| PZR | Manway | Stud | SB-637 UNS N07718 | SB-637 UNS N07718 | 1.5-8UN-2A | 1.5-8UN-2A |
| | | Nut | SB-637 UNS N07718 | SB-637 UNS N07718 | 1.5-8UN-2B | 1.5-8UN-2B |
| CEDM | Upper Pressure Housing Assembly | Vent Stem Housing Nut | SA-479 Type 316 | SA-479 Type 316 | 1-12UNF-2A | 1-12UNF-2A |
| | | Upper End Fitting | SA-479 Type 316 | SA-479 Type 316 | 1-12UNF-2B | 1-12UNF-2B |
| | | Lower End Fitting | SA-479 Type 316 | SA-479 Type 316 | 5-11/32-6ACME-2G | 5-11/32-6ACME-2G |
| | Motor Housing Assembly | Upper End Fitting | SA-182 F347 | SA-182 F347 | 5-11/32-6ACME-2G | 5-11/32-6ACME-2G |
| | | Lower End Fitting | SB-166 UNS N06690 | SB-166 UNS N06690 | 5.25-5ACME-2G | 5.25-5ACME-2G |
| Component | Item | Part | Material | | Size | |
| | | | APR1400 | OPR1000 | APR1400 | OPR1000 |
| Small Piping [(2)(3)] | | Bolts | ASME SA-193 Gr. G7 | ASME SA-193 Gr. G7 | various | various |
| | | Nuts | ASME SB-194 Gr. 2H | ASME SB-194 Gr. 2H | various | various |

Notes)

(1) As described in Section 5.4.2.16 in the DCD Tier 2, two 5 inches inspection holes are provided to remove the foreign objects trapped in the feedwater box for APR1400 SG design. There is no inspection hole for OPR1000 SG design except the recent RSG (Replacement Steam Generator).

(2) Reactor Primary Coolant Piping does not have any fasteners.

(3) Spiral wound metallic gasket is applied. In addition, stainless steel shim plate is placed between stainless steel flange and nuts to prevent direct contact.

**Issue #2**

APR-1400 FSAR Section 3.13 does not cite how the 10 CFR Part 50, Appendix G requirements for reactor vessel closure studs and nuts will be met, information which is detailed in FSAR Section 5.2.3.6. This leaves the information in FSAR Section 3.13 incomplete.

Revise FSAR Section 3.13 to reference FSAR Section 5.2.3.6 regarding specific requirements for reactor vessel closure studs and nuts to meet 10 CFR Part 50, Appendix G.

Response

The following statement will be added at the end of FSAR Section 3.13.1.2. However, FSAR Section 5.3.1.7 will be referenced instead of FSAR Section 5.2.3.6 since 10 CFR Part 50, Appendix G is in FSAR Section 5.3.1.7 more clearly.

"The reactor vessel closure studs and nuts are fabricated to meet 10 CFR Part 50, Appendix G requirements as stated in FSAR Section 5.3.1.7."

**Issue #3**

APR-1400 FSAR Section 3.13.1.2 states:

> 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.

The staff interprets that the intent of this statement is to convey that threaded fasteners will be fabricated using the materials, fabrication practices, and special processes that will minimize the potential for stress corrosion cracking or other forms of material degradation, but the statement as written is problematically ambiguous. As written, the staff could not make a clear safety finding regarding this issue of threaded fastener design.

Revise this section to clearly indicate materials for threaded fasteners will be selected to minimize stress corrosion cracking or other forms of material degradation.

Response

In order to clearly describe the resistance of threaded fasteners materials to stress corrosion cracking and other forms of material degradations, the second paragraph of FSAR Section 3.13.1.2 will be revised as follows:

"In addition, threaded fasteners are designed and fabricated using materials and processes that have been selected to minimize stress corrosion cracking or other forms of material degradation."

**Issue #4**

APR-1400 FSAR Section 3.13.1.5 does not explicitly state that for ASME Code Class 1, 2 and 3 threaded fastener materials, documentation related to fracture toughness testing results, when required, are to be retained as part of quality assurance (QA) records, in compliance with the requirements of the American Society of Mechanical Engineers (ASME Code), Section III, which is invoked by reference in 10 CFR 50.55a.

Documentation relating to fracture toughness testing results for ASME Code Class 1, 2 and 3 threaded fastener materials, when required, should explicitly be required to be maintained as part of QA records. Revise FSAR 3.13.1.5 accordingly.

Response

The following statement will be added at the end of the first paragraph of FSAR Section 3.13.1.5:

"Documentation related to fracture toughness testing results for ASME Code Class 1, 2 and 3 component threaded fastener materials, when required, is to be maintained as part of QA records in compliance with the requirements of the American Society of Mechanical Engineers (ASME) Code, Section III."

**Issue #1**

APR-1400 FSAR Section 6.2.7 states that:

The ferritic materials of carbon steel liner plate, carbon steel, and low alloy steel attachments and appurtenances identified in ASME Section III, Division 2, meet the fracture toughness criteria of ASME Section III, Division 2, Article CC 2520. The ferritic materials used for attachments and appurtenances identified in ASME Section III, Division 1 (Reference 38), meet the fracture toughness criteria of ASME Section III, Division 1, Article NE 2300 (Reference 39).

The staff interprets that the intent of this statement is to convey that the ferritic materials found in the containment pressure vessel and all related penetrations will comply with the appropriate American Society of Mechanical Engineers (ASME) Code requirements pertaining to fracture toughness but the statement as written is problematically ambiguous. As written, the staff could not make a clear safety finding regarding this issue of fracture toughness.

Revise this section to clearly indicate that the materials for the containment pressure vessel and all related penetrations will meet the fracture toughness requirements of ASME Code, Section III, Division 2, Article CC-2520 or ASME Code, Section III, Division 1, Article NE-2300 as appropriate for the individual components.

Response

Section 6.2.7 will be revised to clearly indicate that the fracture toughness requirements of the design code that is applied to the materials for containment pressure vessel and all related penetrations will be met.

**Impact on DCD**

DCD Section 6.2.7 will be revised as indicated on the attached MEB-CQ-201505 6.2.7 #1 markup.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

There is no impact on the Technical Specifications.

**Impact on Technical/Topical/Environmental Reports**

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

**Issue #2**

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criterion 51 specifies that the reactor containment boundary shall be designed with sufficient margin to assure that under operating, maintenance, testing, and postulated accident conditions (1) its ferritic materials behave in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized.(EQ)

Neither APR-1400 FSAR Section 6.2.7 nor FSAR Table 6.1-1 positively identifies which weld filler materials are to be used to weld the containment liner plates. As the welds form part of the containment pressure vessel, the staff requires information pertaining to their composition to reach a safety conclusion regarding the fracture prevention of the containment pressure vessel and all related penetrations.

Identify which weld filler materials are to be used by their ASME Code designation, as appropriate. If these materials are not in FSAR Table 6.1-1, revise APR-1400 FSAR Section 6.2.7 or FSAR Table 6.1-1 to include the provided information.

**Response**

In the construction stage, specific weld filler materials will be selected to meet the requirements of ASME Code Section III, Section II, and Section IX. Therefore, fracture toughness requirements for weld filler materials of ASME Code Section III will be also met. A COL Item will be added in Section 6.2.7 to identify the weld filler materials to be provided by the COL applicant.

**Impact on DCD**

DCD Sections 6.2.7, 6.2.8 and Table 1.8-2 will be revised as indicated on the attached MEB-CQ-201505 6.2.7 #2 markup.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

There is no impact on the Technical Specifications.

**Impact on Technical/Topical/Environmental Reports**

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

The test volume is pressurized to the test pressure, $P_a$, as specified in Technical Specifications. The pressure regulator maintains the test volume at a minimum of $P_a$. The airflow rate into the test volume is recorded, as is the pressure reading, at the intervals specified on the data form. Fixed test connections used for Type C testing are shown on the respective system flow diagrams.

Type C test methods and techniques are consistent with NEI 94-01 and ANSI/ANS-56.8. The combined leakage rate for all penetrations and valves test are less than 0.6 $L_a$.

6.2.6.4 Scheduling and Reporting of Periodic Tests

Periodic Type A, B, and C leakage rate tests are performed in which the requirements of the schedule and report contents are in accordance with NRC RG 1.163, which endorses NEI 94-01. The preoperational and periodic Type A, B, and C test report contains a schematic of the leak measuring system, instrumentation used, supplemental test method, and test program.

6.2.6.5 Special Testing Requirements

Ferritic steel parts of containment pressure boundary consist of the ferritic portions of the containment pressure vessel and all penetration assemblies or appurtenances attached to the containment vessel. The ferritic containment pressure materials meet the fracture toughness criteria and requirements for testing identified in Article NE 2300 of ASME Section III, Division 1 (Reference 39) or Article CC 2520 of ASME Section III, Division 2 (Reference 38).

6.2.7 Fracture Prevention of Containment Pressure Vessel

The ferritic materials of carbon steel liner plate, carbon steel, and low alloy steel attachments and appurtenances identified in ASME Section III, Division 2, meet the fracture toughness criteria of ASME Section III, Division 2, Article CC 2520. The ferritic materials used for attachments and appurtenances identified in ASME Section III, Division 1 (Reference 38), meet the fracture toughness criteria of ASME Section III, Division 1, Article NE 2300 (Reference 39).

The test volume is pressurized to the test pressure, $P_a$, as specified in Technical Specifications. The pressure regulator maintains the test volume at a minimum of $P_a$. The airflow rate into the test volume is recorded, as is the pressure reading, at the intervals specified on the data form. Fixed test connections used for Type C testing are shown on the respective system flow diagrams.

Type C test methods and techniques are consistent with NEI 94-01 and ANSI/ANS-56.8. The combined leakage rate for all penetrations and valves test are less than 0.6 $L_a$.

6.2.6.4 Scheduling and Reporting of Periodic Tests

Periodic Type A, B, and C leakage rate tests are performed in which the requirements of the schedule and report contents are in accordance with NRC RG 1.163, which endorses NEI 94-01. The preoperational and periodic Type A, B, and C test report contains a schematic of the leak measuring system, instrumentation used, supplemental test method, and test program.

6.2.6.5 Special Testing Requirements

The APR1400 design does not have a subatmospheric primary containment or a secondary containment or isolation valve seal systems and fluid-filled systems, and there are therefore no special testing requirements beyond the testing described in Subsections 6.2.6.1 through 6.2.6.4.

6.2.7 Fracture Prevention of Containment Pressure Vessel

The ferritic materials of carbon steel liner plate, carbon steel, and low alloy steel attachments and appurtenances identified in ASME Section III, Division 2, meet the fracture toughness criteria of ASME Section III, Division 2, Article CC 2520. The ferritic materials used for attachments and appurtenances identified in ASME Section III, Division 1 (Reference 38), meet the fracture toughness criteria of ASME Section III, Division 1, Article NE 2300 (Reference 39).

The weld filler materials meet the applicable requirements of ASME Code Section III and conform to the applicable ASME Code Section II material specifications or ASME Code Cases permitted or approved by the NRC.

The COL Applicant is to provide the weld filler material in the supplier specification (COL 6.2(2)).

6.2.8 Combined License Information

COL 6.2(1) The COL applicant is to identify the implementation milestone for the CILRT program.

COL 6.2(2) The COL Applicant is to provide the weld filler material in the supplier specification.

6.2.9 Ref

1. APR1400-E-N-NR-14001-P (Proprietary) & NP (Non-Proprietary), "Design Features to Address GSI-191," Rev. 0, KHNP, December 2014.

2. GOTHIC Thermal Hydraulic Analysis Package User Manual, Version 8.0(QA), NAI 8907-02, Rev. 20, Numerical Applications, Inc., January 2012.

3. APR1400-Z-A-NR-14007-P (Proprietary) & (Non-Proprietary), "LOCA Mass and Energy Release Methodology," Rev. 0, KHNP, November 2014.

4. Final Safety Evaluation For FRAMATOME ANP Topical Report BAW-10252(P), "Analysis of Containment Response to Postulated Pipe Ruptures Using GOTHIC" (TAC NO. MC3783), Rev. 0, August 31, 2005.

5. APR1400-F-A-NR-14002-P (Proprietary) & NP (Non-Proprietary), "The Effect of Thermal Conductivity Degradation on APR 1400 Design and Safety Analyses," Rev. 0, KHNP, September 2014.

6. COMPARE-MOD1A Code Addendum, NUREG/CR-1185, Scientific Los Alamos Laboratory, June 1980.

7. J. Moody, "Maximum Two-Phase Vessel Blowdown from Pipes," Journal of Heat Transfer, Volume 88, August 1966.

8. H.K. Fauske, "Contribution to the Theory of Two-Phase, One-Component Critical Flow," ANL-6633, Argonne National Laboratory, Argonne, Illinois, 1962.

9. CENPD-133P (Proprietary), "CEFLASH-4A, A FORTRAN-IV Digital Computer Program for Reactor Blowdown Analysis," Combustion Engineering, Inc., August 1974.

Table 1.8-2 (9 of 29)

| Item No. | Description |
|---|---|
| COL 6.1(1) | The COL applicant is to identify the implementation milestones for the coatings program. |
| COL 6.2(1) | The COL applicant is to identify the implementation milestone for the CILRT program. |
| COL 6.3(1) | The COL applicant is to prepare operational procedures and maintenance programs as related to leak detection and contamination control. |
| COL 6.3(2) | The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations. |
| COL 6.4(1) | The COL applicant is to provide automatic and manual operating procedures for the control room HVAC system, which are required in the event of a postulated toxic gas release. |
| COL 6.4(2) | The COL applicant is to provide the details of specific toxic chemicals of mobile and stationary sources and evaluate the MCR habitability based on the recommendations in NRC RG 1.78 to meet the requirements of TMI Action Plan Item III.D.3.4 and GDC 19. |
| COL 6.4(3) | The COL applicant is to identify and develop toxic gas detection requirements to protect the operators and provide reasonable assurance of the MCR habitability. The number, locations, sensitivity, range, type, and design of the toxic gas detectors are to be developed by the COL applicant. |
| COL 6.5(1) | The COL applicant is to provide the operational procedures and maintenance program as related to leak detection and contamination control. |
| COL 6.5(2) | The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations. |
| COL 6.6(1) | The COL applicant is to identify the implementation milestones for ASME Section Xl inservice inspection program for ASME Code Section III Class 2 and 3 components. |
| COL 6.6(2) | The COL applicant is to identify the implementation milestone for the augmented inservice inspection program. |
| COL 6.8(1) | The COL applicant is to provide the operational procedures and maintenance program for leak detection and contamination control. |
| COL 6.8(2) | The COL applicant is to provide the preparation of cleanliness, housekeeping, and foreign materials exclusion program. |
| COL 6.8(3) | The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations. |
| COL 6.8(4) | The COL applicant is responsible for the establishment and implementation of the Maintenance Rule program in accordance with 10 CFR 50.65. |
| COL 7.5(1) | The COL applicant is to provide a description of the site-specific AMI variables such as wind speed, and atmosphere stability temperature difference. |
| COL 7.5(2) | The COL applicant is to provide a description of the site-specific EOF. |

COL 6.2(2) The COL Applicant is to provide the weld filler material in the supplier specification.