ArevaEPRDCPEm Resource

From: WELLS Russell D (AREVA US) [Russell.Wells@areva.com]
Sent: Monday, December 15, 2008 7:30 PM
To: Getachew Tesfaye
Cc: John Rycyna; Pederson Ronda M (AREVA US); BENNETT Kathy A (OFR) (AREVA US); DELANO Karen V (AREVA US)
Subject: Response to U.S. EPR Design Certification Application RAI No. 109, FSAR Ch 3
Attachments: RAI 109 Response US EPR DC.pdf

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 109 Response US EPR DC.pdf" provides technically correct and complete responses to 4 of the 7 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 109 Questions 03.04.01-1, 03.04.01-2, 03.04.01-3, 03.05.01.01-1, and 03.05.01.02-1.

The following table indicates the respective pages in the response document, "RAI 109 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 109 — 03.04.01-1	2	2
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A complete answer is not provided for 3 of the 7 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 109 — 03.05.01.01-1.a	February 13, 2009
RAI 109 — 03.05.01.01-1.c	February 13, 2009
RAI 109 — 03.05.01.01-1.e	February 13, 2009
RAI 109 — 03.05.01.01-1.g	February 13, 2009
RAI 109 — 03.05.01.02-1.b	February 13, 2009
RAI 109 — 03.05.01.03-2.a	February 20, 2009
RAI 109 — 03.05.01.03-2.b	February 20, 2009
RAI 109 — 03.05.01.03-2.c	February 20, 2009
RAI 109 — 03.05.01.03-2.d	February 20, 2009

Sincerely,

(Russ Wells on behalf of)

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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
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To: ZZ-DL-A-USEPR-DL
Cc: Chang Li; Stephen Campbell; David Shum; John Segala; John Honcharik; David Terao; Michael Miernicki; Joseph Colaccino; John Rycyna; Tarun Roy
Subject: U.S. EPR Design Certification Application RAI No. 109 (1523, 1524,1525, 1128, 1129, 1419), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on October 20, 2008, and discussed with your staff on November 4, 2008. No change was made to the draft RAI as a result of that discussion. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
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Response to

Request for Additional Information No. 109 (1523, 1524, 1525, 1128, 1129, 1419), Revision 0

11/14/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.04.01 - Internal Flood Protection for Onsite Equipment Failures
SRP Section: 03.05.01.01 - Internally Generated Missiles (Outside Containment)
SRP Section: 03.05.01.02 - Internally Generated Missiles (Inside Containment)
SRP Section: 03.05.01.03 - Turbine Missiles
Application Section: FSAR Ch. 3

QUESTIONS for Balance of Plant Branch 2 (ESBWR/ABWR) (SBPB)
QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)

Question 03.04.01-1:

FSAR Section 3.4.3.3 states that all the safety-related SSCs are located above the flood level. If safety-related SSCs must be located below the flood level, these SSCs are either qualified for submerged operation or justification be provided for admissibility.

The staff finds that the above statement does not recognize the need for the staff review of the operability of submerged SSCs. In accordance with SRP Section 3.4.1, Review Procedure No. 5, the safety-related SSCs being located below the flood level should be identified in the FSAR, and the qualification program should be described in the FSAR for the staff review. Exceptions, if any, should be justified in the FSAR.

Clarify whether the U.S. EPR flood protection design intends to include the option of submerged SSCs operation in the design certification stage or in the COL application stage. If it is in the DC stage, provide the above information in the FSAR for the DC. However, if it is in the COL stage, identify a COL information item that requires the applicant provide the above information, if the applicant will locate safety-related SSCs below the flood level. Without an adequate staff review, the option of submerged SSCs operation is not acceptable.

Response to Question 03.04.01-1:

There are no safety-related structures, systems, and components (SSC) required to perform a safety-related function while being completely or partially flooded. The U.S. EPR flood protection design does not include an option of submerged SSC operation.

The subject statement currently in U.S. EPR FSAR Tier 2, Section 3.4.3.3 will be revised to state there are no safety-related SSC required to perform a safety-related function while being completely or partially flooded.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Section 3.4.3.3 will be revised as described in the response and indicated on the enclosed markup.

Question 03.04.01-2:

The staff reviewed the flood protection in EPGBs, which house the emergency diesel generators, fuel oil storage, and the associated Class 1E electrical equipment. FSAR Tier 2, Section 3.4.3.8, EPGB Flooding Analysis, states that postulated pipe breaks in water-carrying systems were considered in the flood analysis for the maximum flood level determination. The staff requests the applicant to clarify in the FSAR what are the "water-carrying systems" being considered for breaks; which system is the bounding one; what the value of maximum flood level is; and what are the elevations for the SSCs subject to the flood protection. Provide the calculation with all the assumptions for the maximum flood level in the EPGBs.

Response to Question 03.04.01-2:

The Emergency Power Generating Power Generating Buildings (EPGB) flooding analysis considered water-carrying piping systems in the buildings, which include the essential service water system, fire water distribution system, demineralized water distribution system, and potable and sanitary water distribution system. The fire water distribution system is the bounding internal flooding source. The maximum internal flood level in an EPGB is estimated to be 17 feet. The internal flood is restricted to one EPGB and it is assumed the associated safety-related SSC in the flooded division are lost. The flooding analysis for the EPGB is available for inspection at AREVA offices.

U.S. EPR FSAR Tier 2, Section 3.4.3.8 will be revised by adding:

"The flooding analysis considers postulated pipe breaks in water-carrying systems within the EPGB, which include the essential service water system, fire water distribution system, demineralized water distribution system, and potable and sanitary water distribution system. The bounding internal flooding source is a pipe break in the fire water distribution system, which produces a maximum flood level of 17 ft. The divisional separation wall between the EPGB, is designed as a flood barrier and is higher than the bounding maximum flood level. Piping and cable penetrations between EPGB are watertight. Internal flooding is restricted to one EPGB and the associated safety-related SSC in the flooded division are assumed lost."

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.4.3.8 will be revised as described in the response and indicated on the enclosed markup.

Question 03.04.01-3:

The main control room (MCR), and remote shutdown station (RSS) are located in the safeguard buildings (SB). FSAR Section 3.4.3.4 addresses the flood protection for the MCR and RSS, the applicant indicated that potential flooding water from upper level can be directed through multiple openings, and flow paths to lower building level. In addition, the FSAR discussed the line isolation, leak detection, alarms, and drains for the flood protection. However, it is not clear whether there is a watertight door to protect the MCR and RSS from the external water source. The FSAR discussion does not distinguish the external water source from internal water source relative to the rooms and the flood protection for each. The applicant is requested to provide the following information to clarify the discussion of the flood protection for the MCR and RSS.

A. Clarify whether there are watertight doors being designed to prevent the external water sources entering into the MCR and RSS. If not, demonstrate the adequacy of the flood protection measures to protect the safety-related SSCs in the MCR and RSS. It should be noted that the flow paths may direct the flooding water into the MCR and RSS through doors.

B. The FSAR does not distinguish the source of water being external or internal relative to the rooms. Identify all the potential sources of flooding water inside MCR and RSS. Identify all the measures for the flood protection for the internal water sources.

C. Are the floor drains inside MCR and RSS the necessary equipment for the flood protection? If not, provide a flood analysis to show the flood level in the MCR and RSS and the location levels of all SSCs in the MCR and RSS. If yes, upgrade the floor drains in the MCR and RSS from being nonsafty-related to safety-related. Or justify the adequacy for being nonsafety-related. It should be noted that current FSAR treats the floor drain as non-safety-related equipment because it is not taking into account for any safety analysis.

Response to Question 03.04.01-3:

A. Thresholds are provided for doors entering the MCR. Water-carrying piping systems are not located within the MCR and flood water is directed away from the MCR via flow paths consisting of large openings (i.e., equipment openings and stairwells). The large openings preclude flood water from accumulating to a depth greater than the height of the thresholds. In addition, as described in U.S. EPR FSAR Tier 2, Section 3.4.3.4, the expected volume of released water from a break in the potable and sanitary water distribution system in the operator's toilets adjacent to the MCR can be stored in the affected area without flooding into safety-related areas.

   Water-carrying piping systems are not located in the RSS. Water resistant doors are provided for the two entry doors to the RSS. Flow paths consisting of nearby large openings (i.e., equipment openings and stairwells) direct flood water to lower building levels and preclude water from accumulating to a depth to exceed the capabilities of the water resistant doors.

   U.S. EPR FSAR Tier 2, Section 3.4.3.4 will be revised by adding:

"No water-carrying piping systems are located in the MCR or RSS. Thresholds are provided for doors entering the MCR and water resistant doors are provided for entry doors to the RSS."

B. There are no sources of water inside the MCR or RSS and therefore measures are not required for flood protection from water sources within these rooms. Potential sources of flooding for the MCR and RSS are external to these rooms.

C. Floor drains are not relied upon for flood protection of the MCR or RSS. The flood protection strategy for these rooms is to prevent water from entering these rooms. Therefore, there is no expected flood level within these rooms and no requirement for designating floor drains as safety related.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.4.3.4 will be revised as described in the response and indicated on the enclosed markup.

Question 03.05.01.01-1:

a. GDC 4, in part, requires SSCs to be protected from internally generated missiles. Maintenance equipment that is not secured or removed from an area is a potential gravitational missile source. However, evaluation of internal missiles outside containment resulting from failures of plant equipment and components, and unsecured maintenance equipment has not been provided.

   Provide an assessment of potential gravitational missiles generated outside containment and discuss the measures provided to prevent the impact of a falling object on safety-related SSCs. Also, revise the FSAR Tier 2 Table 1.8.2, "U.S. EPR Combined License Information items," to include a COL information item to establish/provide procedures which ensure that equipment, such as a hoist that is required during maintenance, be either removed or seismically restrained following maintenance to prevent it from becoming a missile. Include this information in the FSAR and provide a markup in your response.

b. To ensure that the EPR design minimizes potential missile generation, in FSAR Tier 2 Section 3.5.1.1.3 AREVA states that high energy fluid systems and components are designed according to the requirements of the ASME BPV Code, Section III or VIII. ASME BPV Code, Section III specifies that valves with removable bonnets be the pressure seal-type or have bolted bonnets; therefore, valves that only have threaded connections between the body and bonnet are not used in high energy systems. The above statement is valid for Section III, Division 1, Class 1 components, however, Section III, Division 1, Class 2 Components allow threaded connections (NC-3266) and threaded bonnets on pressure relief valves with inlet connections NPS 2 and less (Section NC-3595.4 & ND-3595.4). In FSAR Tier 2 Table 3.2.2-1, AREVA shows Class 2 and 3 components located in high energy applications.

   Clarify the above FSAR discrepancy on valve bonnet connection types allowed in high energy systems. Include this information in the FSAR and provide a markup in your response. This RAI also applies to systems inside containment. Include this information in the FSAR and provide a markup in your response.

c. GDC 4, in part, requires SSCs to be protected from internally generated missiles. FSAR Tier 2 Section 3.5.1.1.3 states that portable and temporary gas cylinders, as well as gas cylinders that are periodically replaced in safety-related areas, are built in compliance with the regulations for seamless steel cylinders, as required by the U.S. Department of Transportation. As discussed in NUREG/CR-3551, portable compressed gas cylinders pose a significant missile hazard if not properly controlled, secured or restrained. However, evaluation of internal missiles outside containment resulting from unsecured and non-seismically restrained compressed gas cylinders during a seismic event has not been provided.

   Provide an assessment of potential missiles generated outside containment resulting from unsecured and non-seismically restrained compressed gas cylinders during a seismic event and discuss the measures provided to prevent the impact of such missiles on safety-related SSCs. Also, revise the FSAR Tier 2 Table 1.8.2 to include a COL information item to establish/provide procedures which ensure that pressurized gas cylinders be either removed or seismically restrained during power operation to prevent them from becoming missiles. Include this information in the FSAR and provide a markup in your response.

d. GDC 4, in part, requires SSCs to be protected from internally generated missiles. Missiles resulting from piping failures have not been addressed. A guillotine break of a high energy line could cause the piping attachments to become missile sources. Provide a discussion regarding if a postulated guillotine break of a high-energy line outside containment could become a potential missile source, and discuss the measures provided to prevent the impact of such missiles on safety-related SSCs. Include this information in the FSAR and provide a markup in your response.

e. GDC 4, in part, requires SSCs to be protected from internally generated missiles. Acceptance, in part, is based on adequately identifying credible missile sources. FSAR Tier 2 Section 3.5.1.1.3 states missile generation from hydrogen gas sources are minimized by equipment placement, line routing and adequate ventilation. However, FSAR Tier 2 Table 3.2.2-1 indicates that hydrogen piping and components are non-safety related and non-seismic. Failure of these hydrogen piping and components during a seismic event could cause hydrogen to accumulate in area of stagnant air flow, explode and generate a missile.

   Discuss the impact of hydrogen piping failures in the areas where the piping is routed for missile generation. Provide an evaluation to verify that no stagnant air pockets exist in areas that have hydrogen piping. Include this information in the FSAR and provide a markup in your response.

f. GDC 4, in part, requires SSCs to be protected from internally generated missiles. Where barriers are used to protect SSCs from internal missiles, the design is considered acceptable if it meets RG 1.115 Position C.3. Compliance to Position C.3 includes submittal of dimensioned plans and elevations that include wall and slab thickness and materials of pertinent structures. Provide drawings to show the above cited information. Include this information in the FSAR and provide a markup in your response.

g. Per Section II of SRP 3.5.1.1, regulation 10 CFR 52.47(b) (1) requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

   FSAR Tier 2 Section 3.5.1.1 describes the Areva's approach to identify potential missiles, determine the statistical significance of potential missiles, and provide measures for SSCs requiring protection against the effects of missiles outside containment. However, Sections 2.1 - Structures, 2.2 – Nuclear Island Systems, 2.3 – Severe Accident Systems, 2.4 – Instructmentation and Control Systems, 2.5 – Electric Power, 2.6 – HVAC Systems, 2.7 – Support Systems , 2.8 – Steam and Power Conversion Systems, 2.9, - Radioactive Waste Management, and 2.10 – Other systems of the FSAR Tier 1 Chapter 2.0, "System based design Descriptions and ITAAC," do not contain design commitments or inspections, tests, analyses, and acceptance criteria to verify that SSCs outside containment are designed and constructed in accordance with the requirements as described in FSAR Tier 2 Section 3.5.1.1 to prevent or mitigate the effects of internally generated missiles outside containment.

   Therefore, provide an ITAAC that requires the COL applicant to perform a walk-down of the SSCs and to ensure that SSCs described in the above cited sections are protected from internally generated missiles (outside containment) in accordance with the requirements as described in FSAR Tier 2 Section 3.5.1.1. Also, identify which of the

SSCs are outside and which of the SSCs are inside the containment. Include this information in the FSAR and provide a markup in your response.

Response to Question 03.05.01.01-1:

a. The response to this question will be provided by February 13, 2009.

b. In high energy systems designed to ASME Section III, Class 1, Class 2, or Class 3, valves with removable bonnets for valve sizes larger than two-inches, will be the pressure seal-type or have bolted bonnets. In high energy systems designed to ASME Section III, Class 1, Class 2 or Class 3, valves sized two-inches and smaller with removable bonnets, except for Class 2 or Class 3 relief valves, will be the pressure seal-type or have bolted bonnets. Relief valves with an inlet piping connection two-inches and smaller may have threaded body-to-bonnet connections in accordance with ASME Section III, Division 1, Sections NC-3595.4 and ND-3595.4.

   ASME Section III, Division 1, Section NC-3266 deals with the connection between a pipe or tube to a pressure vessel, not with allowing threaded connections between a valve body and bonnet. U.S. EPR FSAR Tier 2, Section 3.5.1.1.3 states that thermowells and other instrument wells, vents, drains, test connections, and other fittings in high energy systems are welded to the piping or pressurized equipment.

   Valve body-to-bonnet connections for ASME Section III valves will be the same for inside and outside containment.

c. The response to this question will be provided by February 13, 2009.

d. Missiles generated from high energy line breaks (HELB) have not been specifically addressed in U.S. EPR FSAR Tier 2, Section 3.5.1. U.S. EPR FSAR Tier 2, Sections 3.5.1.1.1 and 3.5.1.2.1 each refer to U.S. EPR FSAR Tier 2, Section 3.6, which describes protection against dynamic effects of HELB.

   SRP 3.6.1 and 3.6.2, as well as BTP 3-3 and 3-4 describe the requirements to perform rupture evaluations and provide the required protection, where needed. These documents do not specifically address missiles created by the dynamic effects of HELBs. They do, however, require the evaluation of these dynamic effects on essential system SSC. As a result of any jet impingement or pipe whip impact to intermediate items of significant size or weight, such potential missiles due to these intermediate items coming loose would need to be considered in these evaluations.

e. The response to this question will be provided by February 13, 2009.

f. In compliance with RG 1.115, Position C.3, the dimensioned plans and elevations showing wall and slab thicknesses for the standard plant structures are included in U.S. EPR FSAR Tier 2, Appendix 3B. The materials for these structures are provided in U.S. EPR FSAR Tier 2, Section 3.8.

g. The response to this question will be provided by February 13, 2009.

FSAR Impact:

a. N/A

b. U.S. EPR FSAR Tier 2, Section 3.5.1.1.2 and Section 3.5.1.1.3 will be revised as described in the response and as indicated on the enclosed markup.

c. N/A

d. The U.S. EPR FSAR will not be changed as a result of this question.

e. N/A

f. The U.S. EPR FSAR will not be changed as a result of this question.

g. N/A

Question 03.05.01.02-1:

a. GDC 4 requires that SSCs are protected from internally generated missiles. In FSAR Tier 2, Revision 1, Section 3.5.1.2.3 the applicant states, "Even though potential CRDM missiles are deemed non-credible as described in Section 3.5.1.2.2, the Closure Head Equipment (CHE) is designed to retain the CRDMs so that they are prevented from becoming a missile should the CRDM nozzle flange or pressure housing fail. Therefore, SSCs inside containment are designed to withstand a postulated CRDM missile, even though this event is deemed non-credible." Clarify in the FSAR if the in containment SSCs are capable of withstanding a CRDM missile impact.

b. In accordance with SRP Section 3.5.1.2, regulation 10 CFR 52.47(b) (1) requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (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 plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

FSAR Tier 2, Revision 1, Section 3.5.1.2 describes the AREVA's approach to identify potential missiles, determine the statistical significance of potential missiles, and provide measures for SSCs requiring protection against the effects of missiles inside containment.

However, FSAR Tier 1, Revision 1, Chapter 2.0, "System Based Design Description of ITAAC" does not contain design commitments or inspections, tests, analyses, and acceptance criteria to verify that SSCs inside containment are designed and constructed in accordance with the requirements as described in FSAR Tier 2, Revision 1, Section 3.5.1.2 to prevent or mitigate the effects of internally generated missiles inside containment.

Therefore, provide an ITAAC that requires the COL applicant to perform a walk-down of the SSCs and to ensure that SSCs are protected from internally generated missiles (inside containment) in accordance with the requirements as described in FSAR Tier 2, Revision 1, Section 3.5.1.2. Include this information in the FSAR and provide a markup in your response.

Response to Question 03.05.01.02-1:

a. In compliance with GDC 4, U.S. EPR design provides a concrete missile shield over the refueling canal to absorb impact of control rod ejection due to postulated failure of a control rod drive mechanism (CRDM) housing as stated in U.S. EPR FSAR Tier 2, Section 3.8.3.1.7. The missile shield provides a barrier between CRDM and other SSC inside containment such that SSC beyond the missile shield are not required to be designed to withstand a CRDM missile impact.

U.S. EPR FSAR Tier 2, Section 3.5.1.2.3 will be revised by adding:

"Even though potential CRDM missiles are deemed non-credible as described in Section 3.5.1.2.2, the concrete missile shield over the refueling canal is designed to absorb impact of a control rod ejection due to postulated failure of a CRDM nozzle flange or pressure housing thereby providing adequate protection of other SSC inside containment."

Therefore, the containment SSC are properly protected from a CRDM missile impact.

b. The response to this question will be provided by February 13, 2009.

FSAR Impact:

a. U.S. EPR FSAR Tier 2, Section 3.5.1.2.3 will be revised as described in the response and as indicated on the enclosed markup.

Question 03.05.01.03-2:

The U.S. EPR FSAR, Tier 2 Section 3.5.1.3 states that all safety-related structures, except for two of the four essential service water buildings (ESWBs) and a portion of one of the four emergency power Generating buildings (EPGBs) are located outside of the low-trajectory missile strike zone, as defined in RG 1.115. Therefore, the U.S. EPR FSAR considers the turbine generator is favorably positioned, because most of the safety-related SSCs are located outside the low-trajectory missile strike zone. In addition, the supporting turbine missile analysis evaluates that the probability of a turbine missile being ejected will be less than 1 $x10^{-4}$. Based on this information, provide the following to ensure that safety-related structures, systems and components are protected against missiles in accordance with GDC 4 of 10 CFR Part 50, Appendix A:

a. Discuss in detail how the turbine generator is favorably positioned when the ESWBs and the EPGBs are considered safety-related structures and systems (which are used to safely shutdown and maintain the reactor in a safe shutdown condition) and are located in the low-trajectory missile strike zone. Otherwise, the turbine generator should be considered in an unfavorable position in accordance with RG 1.115, and the probability of turbine failure resulting in ejection of turbine rotor fragments (P1) should be less than 1×10^{-5} in lieu of 1 $x10^{-4}$.

b. It appears from Figure 2.1.2-1 in Tier 1 of the U.S. EPR FSAR that more than one EPGB may be within the low-trajectory missile strike zone. Which EPGB is located in the low-trajectory missile strike zone, and discuss why the other EPGBs are not considered in the low-trajectory missile strike zone.

c. Since ESWBs 3 and 4 are in the low-trajectory missile strike zone, discuss whether the reactor can be shutdown and maintained in a safe condition with ESWBs 1 and 2 only?

d. Since the switch-gear building (SWGB) is adjacent to the turbine building and in the low-trajectory missile strike zone, discuss how a turbine missile strike in the SWGB would affect safety-related components and systems (e.g., offsite power buses, etc.) that could prevent the reactor from being safely shutdown and maintained in a safe condition.

Response to Question 03.05.01.03-2:

A response to this question will be provided by February 20, 2009.

Question 03.05.01.03-3:

COL applicant information item No. 3.5-2 in Table 1.8-2 of the U.S. EPR FSAR, Tier 2 states that the COL applicant will confirm the evaluation of the probability of turbine missile generation. However, Section 3.5.1.3 of the U.S. EPR FSAR, Tier 2 does not provide a turbine missile analysis for the either turbine generator design specified in Section 10.2. 10 CFR 52.47 requires that the application for a design certification must contain a level of design information sufficient to enable the Commission to judge the applicant's proposed means of assuring that construction conforms to the design and to reach a final conclusion on all safety questions associated with the design before the certification is granted. Therefore, the staff can not make a final conclusion of the safety issues associated with the turbine design and the potential of generating turbine missiles without a turbine missile probability analysis. The staff requests that a bounding turbine missile analysis be provided in the U.S. EPR FSAR for each turbine design in order for the staff to reach a final conclusion, as required by 10 CFR 52.47, on the safety issues associated with the turbine design and the prevention of generating missiles that may affect safety-related structures, systems and components to ensure the requirements of GDC 4 of Appendix A to 10 CFR Part 50 are met.

Response to Question 03.05.01.03-3:

RAI 18, Question 03.05.01.03-1 also requested turbine missile analysis. Refer to the response to RAI 18 in conjunction with the following:

Selection of the turbine manufacturer, model, and design revision level to be installed ("as-built") determines design characteristics that are critical factors in calculating turbine missile generation probability. The choice of a turbine manufacturer and design is the responsibility of the COL applicant.

In conformance with RG 1.115 and NUREG-0800, AREVA has accepted the value of $1\text{x}10^{-3}$ provided by the staff for the product of P_2 x P_3 in the equation $P_4 = P_1 \text{ x } P_2 \text{ x } P_3$, where P_4 is the probability of unacceptable damage from turbine missiles and must be $1\text{x}10^{-7}$ or less. Consistent with regulatory guidance, AREVA has stipulated in the U.S. EPR FSAR that turbines selected by COL applicants will be favorably oriented and have a turbine missile generation probability of $P_1 = 1\text{x}10^{-4}$ or less, which when applied to the staff provided equation satisfies regulatory guidance for $P_4 = 1\text{x}10^{-7}$.

As calculation of a turbine missile analysis must be based upon specific design characteristics of the as-built turbine, the U.S. EPR FSAR provides, in accordance with guidance of RG 1.206, Section C.III, C.I.3.5.1.3, "Turbine Missiles," an ITAAC that requires COL applicants to submit the results of their plant-specific probability calculations of turbine missile generation. COL applicants will provide their turbine missile analyses to the NRC to confirm that their as-built turbines have a probability of producing a turbine missile (P_1) that is less than $1\text{x}10^{-4}$. This ITAAC provides confirmation that as-built turbines, in accordance with guidance of SRP 2.2.3 and RG 1.115, will have a probability of unacceptable damage from turbine missiles of less than or equal to 1 in 10 million per year for an individual plant, or a P_4 of $1\text{x}10^{-7}$ per year per plant or less.

U.S. EPR FSAR Tier 1, Table 2.8.1-3—Turbine-Generator System Inspections, Tests, Analyses, and Acceptance Criteria, provides the ITAAC necessary to confirm that COL applicant selected turbines conform to the U.S. EPR bounding turbine-missile-generation probability criterion and comply with NRC regulatory requirements. The relevant design commitment from this table states that, “The probability of turbine material and overspeed related failures resulting in external turbine missiles is < $1x10^{-4}$ per turbine year.” The specific analysis for this commitment says that, “A material and overspeed failures analysis will be performed on the as-built turbine design.” The acceptance criterion states that “An analysis exists that documents that the probability of turbine material and overspeed related failures resulting in external turbine missiles is < $1x10^{-4}$ per turbine year.”

Each specific turbine missile analysis is a function of the selected turbine, thus is necessarily a COL applicant provided analysis. Once a specific turbine design has been selected, the COL applicant provides a design-specific turbine missile analysis as required by the ITAAC referenced above and COLA Information Item 3.5-2. With respect to the U.S. EPR FSAR, this RAI question is answered by provision of a bounding probability of turbine failure resulting in ejection of a turbine rotor (or internal structure) fragments through the turbine casing being $P_1 \le 1x10^{-4}$, which conforms to regulatory guidance.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

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- Postulated pipe break in a main steam line.
- Postulated pipe break in a main feedwater line.
- Postulated pipe break in the fire water distribution system ring header.

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The postulated pipe break in the fire water distribution system ring header is considered the bounding case for the maximum released water volume in containment. This water volume results from an assumed complete separation of piping ends, a flow rate limited by the maximum possible pump capacity, and an MCR operator action time of thirty minutes before closing the containment isolation valves and the fire water distribution system isolation valves at the entrance to Safeguard Buildings (SB) 1 and 4. The resulting water level is estimated to be at elevation -4 feet, 7 inches. There are no safety-related SSC required to perform a safety-related function while being completely or partially submerged.~~If safety-related equipment must be located below this maximum flood level, it is either qualified for submerged operation or justification is provided for admissibility.~~

Inside containment, leakages are integrally detected by measuring humidity, temperature, condensate flow, and water levels in drain and vent collection tanks or sumps. Depending on the leak and break size and the affected system, the protection system initiates automatic measures as required to cope with the event (e.g., LOCA, main steam line break, or main feedwater line break).

To avoid water ingress into the corium spreading area, which could produce a steam explosion in case of an accident, the venting area from the spreading compartment has a watertight door.

The released water from fire fighting by hose streams or a deluge system is enveloped by the higher flow rates and released water volumes from the relevant postulated pipe failures.

Reactor Building Annulus

Below elevation +0 feet, the annulus between the Shield Building and the Containment Building is a single volume; therefore, it is considered one room for flooding protection purposes. Water released from a specific location flows down in the annulus and collects on the bottom level. Because high-energy piping (e.g., main steam lines and main feedwater lines) is routed inside guard pipes, there is no water accumulation in the annulus due to their failure. Therefore, the analysis is focused on water-carrying systems without guard pipes. The case that results in the largest water volume released in the annulus is a postulated pipe break in the fire water distribution system. The volume of released water is based on an assumed full break in the piping, a flow rate limited by the maximum pump capacity, and an operator action time of thirty minutes to isolate the system after receiving the first alarm in the MCR. The

~~The new fuel stores in FB-1 and FB-2 are protected from flooding using a threshold and means to drain water away from the rooms.~~The New Fuel Storage Facility (NFSF) is protected from flooding by door thresholds and the nearby equipment opening in the floor outside the NFSF which drains away any released water in the vicinity of the NFSF. Water is also prevented from entering the NFSF from above by hatch covers and curbing. The water released during manual fire fighting by hose streams is enveloped by the higher flow rates and released water from postulated pipe breaks. Individual extinguishing areas are limited to one safety fire zone (i.e., FB-1 or FB-2); therefore manual fire fighting will be performed from one safety fire zone. Divisional separation for flooding exists for assumed manual fire fighting by hose streams.

3.4.3.6 Nuclear Auxiliary Building Flooding Analysis

There are no safety-related structures, systems or components that must be protected from flooding in the Nuclear Auxiliary Building (NAB). Physical separation exists below elevation +0 feet between the NAB and the FB and between the NAB and SB-4. The building arrangement directs released water from potential internal flood sources to the lowest level of the NAB. Water flows to the lower levels via the building drain system, stairways, and additional drain openings without passing to the FB or SB-4.

Water carrying systems with respect to internal flooding include the fuel pool purification system, steam generator blowdown system, fire water distribution system, CCWS, and the SCWS. Tanks with the highest flooding potential are located below elevation +0 feet.

3.4.3.7 Radioactive Waste Building Flooding Analysis

There are no safety-related structures, systems or components that must be protected from flooding in the Radioactive Waste Building (RWB). The RWB is connected to the NAB below elevation +0 feet. The arrangement of the RWB directs water released from potential sources of internal flooding to the lower levels of the RWB, where it is stored.

3.4.3.8 Emergency Power Generating Buildings Flooding Analysis

The Emergency Power Generating Buildings (EPGBs) house the emergency diesel generators. The station blackout diesels and associated generators are located in the switchgear buildings, which are adjacent to the EPGBs.

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The flooding analysis considers postulated pipe breaks in water-carrying systems within the EPGB, which include the ESWS, fire water distribution system, demineralized water distribution system, and potable and sanitary water distribution system. The bounding internal flooding source is a pipe break in the fire water distribution system, which produces a maximum flood level of 17 feet. The divisional separation wall between the EPGB, is designed as a flood barrier and is higher than the

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bounding maximum flood level. Piping and cable penetrations between EPGB are watertight. Internal flooding is restricted to one EPGB and the associated safety-related SSC in the flooded division are assumed lost.~~The flooding analysis considers postulated pipe breaks in the water-carrying systems located within the EPGBs. Based on the maximum volume of released water, the divisional separation wall between the EPGBs, which includes piping and cable penetrations, is designed as a flood barrier up to the maximum flood level. The penetrations between the EPGBs are watertight.~~

The level measurements in the building sumps provide leak detection. The water released during fire fighting within one EPGB is enveloped by the higher flow rates and released water volumes in the postulated pipe failures.

3.4.3.9 Essential Service Water Pump Buildings and Essential Service Water Cooling Tower Structures Flooding Analysis

The ESW Pump Buildings are physically separated by division and connected to their respective ESW cooling tower. The flooding analysis considers a postulated pipe failure in the ESWS piping to be the bounding internal flooding source. In the event of an ESWS piping failure in the building, the affected division of the ESWS is considered unavailable, leaving the remaining divisions to perform the system safety function.

3.4.3.10 Ultimate Heat Sink Makeup Water Intake Structure Flooding Analysis

A COL applicant that references the U.S. EPR design certification will perform a flooding analysis for the ultimate heat sink makeup water intake structure based on the site-specific design of the structure and the flood protection concepts provided herein.

3.4.3.11 Permanent Dewatering System

The U.S. EPR design does not have a permanent dewatering system. A COL applicant that references the U.S. EPR design certification will define the need for a site-specific permanent dewatering system.

3.4.4 Analysis Procedures

The analytical methodology used to perform the flooding analyses for external and internal flooding events is described in Section 3.4.3. Section 3.8 provides additional information on the design of Seismic Category I structures against external flooding.

3.4.5 References

1. ANSI/ANS-2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites," American Nuclear Society, 1992.

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nonclosure of the heat exchanger or a large break in the ESWS piping, the pump must be stopped and the isolation in the discharge line of the affected ESWS train must be closed to limit the flooding volume in the affected SB.

Non safety-related detection and isolation signals are provided in the nuclear island drain and vent system in each SB to isolate the ESWS. The alarm that actuates the isolation is above the floor level so only large flooding events can activate the alarm. Two level sensors in a one-out-of-two logic activate the alarm. If a level instrument fails that sensor is not considered for the voting, and the signal is activated when one sensor alarms.

Flooding protection measures mitigate consequences resulting from a postulated failure in the fire water distribution system. A watertight physical protection door prevents water ingress into neighboring divisions through the interconnecting passageway between SB-1 and SB-2. This door is provided with position indication and monitoring of the locking and bolting status for control of the closed position. In the event of flooding, the door is considered closed. A flooding pit with a burst panel below the interconnecting passageway allows water to flow to lower building levels. This arrangement also exists for the passageways between SB-3 and SB-4 and between SB-2 and SB-3.

Elevation +15 Feet and Above

Physical separation for flooding is not provided for elevations +15 feet and above. Therefore, protection measures restrict flooding to the SB where the flooding event was initiated. Sufficient openings and thresholds direct water flow to the lower building levels.

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Potential sources of flooding located on these building levels include the demineralized water distribution system, safety chilled water system (SCWS), fire water distribution system, CCWS including surge tank, and the potable and sanitary water disposal system. These systems have been reviewed for possible effects on the MCR and remote shutdown station (RSS) because they are located above the MCR, and measures are provided to protect the MCR and RSS from flooding. No water-carrying piping systems are located in the MCR or RSS. Thresholds are provided for doors entering the MCR and water resistant doors are provided for entry doors to the RSS. For the fire water distribution system, demineralized water distribution system, and the CCWS, multiple openings and flow paths direct flood water from pipe breaks to lower building levels. Surge tank water tightness is provided by a steel liner and leak detection system.

Each division of the SCWS contains a limited volume of water that can either be stored in the area where it was released or drained to the building sump or to the lowest building level. At higher building elevations (e.g., elevation +69 feet), the pumps are components are designed to have insufficient energy to move the mass of potential missiles generated from rotating parts through the housings in which the components are contained.

- Missiles originating in non-high-energy fluid systems are not credible because these systems have insufficient stored energy to generate missiles.

- Pressure-seal, bonnet-type valves with bonnets designed in accordance with ASME Boiler and Pressure Vessel (BPV) Code, Section III (Reference 8), are non-credible missiles. Retaining rings prevent valve bonnets from becoming missiles. The retaining rings would have to fail in shear, and the valve yokes would capture an ejected bonnet or significantly reduce its energy. These factors combine to make the potential ejection of the bonnets non-credible.

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- Valves with bolted bonnets, such as those used in gate, globe, check and large bore (larger than two inches) safety relief valves in high energy systems, are designed and fabricated in accordance with ASME BPV Code, Section III, Reference 8, and are non-credible missiles. Bolted bonnets are prevented from becoming missiles by limiting the stresses in the bonnet-to-body bolting material. The likelihood of all bonnet-to-body bolts experiencing a simultaneous complete severance failure if a bolt failure were to occur is not credible. The low historical occurrence of complete severance failure, along with the widespread use of valves with bolted bonnets, confirms that bolted valve bonnets are not credible missiles.

- In addition to valve stem threads, at least one other feature is included in the design of valves in high-energy systems to prevent ejection of the stems. Thus, valve stems are non-credible missiles. Such features prevent valve stems with back seats from becoming missiles. Stems of valves with power actuators, such as air- or motor-operated valves, are restrained by the valve actuators. Valve systems in rotary-motion valves, ball valves (except single-seat ball valves), butterfly valves, and diaphragm-type valves are determined to be non-credible missiles. These types of valves do not have a large reservoir of pressurized fluid acting on the valve stem, and not enough stored energy is present to eject a missile.

- Nuts, bolts, nut-and-bolt combinations, and nut-and-stud combinations have such a small amount of stored energy that they are non-credible missiles.

- Thermowells and similar fittings are non-credible missiles because they are welded onto high energy piping and pressurized equipment, so that the completed joint has greater design strength than the parent metal. Threaded connections are not used for connecting instrumentation to high energy systems or components.

- Instrumentation, such as pressure, level and flow transmitters and associated piping and tubing, are non-credible missiles. The quantity of high energy fluid in these components is not sufficient to generate missiles.

- Ruptures of ASME BPV Code, Section III, Reference 8 pressure vessels and ruptures of gas storage vessels constructed without welding using ASME BPV Code, Section VIII (Reference 9) criteria are non-credible. This determination is based on the conservative design requirements, material characteristics, inspections, quality control during fabrication and erection, and prudent operation of the components.

- Rotating components that operate less than two percent of the time are non-credible sources for missiles. Motors on valve operators and pumps in systems that rarely operate are deemed non-credible as potential missiles by this exclusion criterion. This exclusion is similar to an exclusion of lines that have limited operating time in high energy conditions.

- Components or portions of components that are not credible missile sources are also non-credible sources of missiles when struck by a falling object.

3.5.1.1.3 Missile Prevention and Protection Outside Containment

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Missile generation is prevented to the extent practical throughout the U.S. EPR by implementing the design requirements described in this section. Safety-related equipment is designed to contain rotating parts in the equipment housing in the event that a component fails. High energy fluid systems and components are designed according to the requirements of the ASME BPV Code, Sections III or VIII, References 8 or 9. In high energy systems, valves with removable bonnets, for valve sizes larger than 2 inches, will be the pressure seal-type or have bolted bonnets. In high energy systems, valves sized 2 inches and smaller with removable bonnets, except for Class 2 and Class 3 relief valves, will be the pressure seal-type or have bolted bonnets. Relief valves with an inlet piping connection 2 inches and smaller may have threaded body-to-bonnet connections in accordance with ASME Section III, Division 1, Sections NC-3595.4 and ND-3595.4. Valves with threaded body-to-bonnet connections will be used only in non-high energy systems.~~ASME BPV Code, Section III, Reference 8 requires that valves with removable bonnets be the pressure seal-type or have bolted bonnets; therefore, valves that only have threaded connections between the body and bonnet are not used in high energy systems.~~ Valves located in high energy systems have at least two stem retention features. Besides having threads, acceptable features for missile prevention on the valve stem include back seats or power actuators, such as air or motor operators. Thermowells and other instrument wells, vents, drains, test connections, and other fittings in high energy systems are welded to the piping or pressurized equipment. Completed joints are required to have greater design strength than the parent metal.

Permanent high-pressure gas cylinders installed in safety-related areas are designed in accordance with ASME BPV Code, Sections III or VIII, References 8 or 9. Portable and temporary gas cylinders, as well as gas cylinders that are periodically replaced in safety-related areas, are built in compliance with the regulations for seamless steel cylinders, as required by the U.S. Department of Transportation.

Missiles from hydrogen gas sources that could potentially interfere with safe-shutdown equipment or release significant amounts of radioactivity are minimized by careful placement of equipment, supply line routing, and proper ventilation. The

- The housings are individually hydrotested to 125 percent of system design pressure after they are installed on the reactor vessel to the head adapters. The housings are checked again during the hydrotest of the completed RCS.
- The housings are made of austenitic or martensitic stainless steel, which both exhibit excellent notch toughness.
- System thermal transients do not affect stress levels in the control rod drive mechanisms at power, and the CRDMs are not affected by thermal movements of the reactor coolant piping loops.
- Pressure boundary welds in the CRDMs meet identical design, procedure, examination, and inspection requirements as welds on other ASME BPV Code, Section III, Class 1 components (Reference 8).

- Hydrogen is supplied to the RCS by the chemical and volume control system. However, since the hydrogen is added to the reactor coolant outside of containment, there are no sources of hydrogen gas inside containment.

3.5.1.2.3 Missile Prevention and Protection Inside Containment

The methodology for missile prevention inside containment is the same as that described in Section 3.5.1.1.3 for rotating parts, valves, pressure-retaining components and piping, and combustible and pressurized gas sources. The effects of potential internally generated missiles are minimized by separation and redundancy throughout the containment. Four trains of safety-related systems are provided for operability of vital plant systems.

To the extent possible, missile barriers are provided between redundant trains of equipment that are housed adjacent to one another. Section 3.5.3 describes missile barrier design procedures. Components within one train of a system with redundant trains need not be protected from missiles originating from the same train.

The U.S. EPR is designed so that a postulated missile from the RCS does not cause a loss of integrity of the primary containment, main steam, feedwater, or any other loop of the RCS. In addition, a postulated missile from any other system will not cause a loss of integrity of the primary containment or RCS pressure boundary.

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Even though potential CRDM missiles are deemed non-credible as described in Section 3.5.1.2.2, the ~~Closure Head Equipment (CHE) is designed to retain the CRDMs so that they are prevented from becoming a missile should the CRDM nozzle flange or pressure housing fail.~~ concrete missile shield on top of the refueling canal walls is designed to absorb the impact of a control rod ejection due to the postulated failure of a CRDM nozzle flange or pressure housing thereby providing adequate protection of other SSC inside containment.