# 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.:** | **433-8363** |
| **SRP Section:** | **19 – Probabilistic Risk Assessment and Severe Accident Evaluation Section: 19** |
| **Application Section:** | **19** |
| **Date of RAI Issue:** | **03/08/2016** |

---

## Question No. 19-71

10 CFR 50.44(c)(5) and SECY-93-087 require a deterministic analysis that demonstrates containment structural integrity under internal pressure loads. Regulatory Guide 1.216, Regulatory Position 3 discusses the methods acceptable to the staff to address the Commission's performance goal related to the prevention and mitigation of severe accidents. Specifically, RG 1.216 states that "an acceptable way to identify the more likely severe accident challenges is to consider the sequences or plant damage states that, when ordered by percentage contribution, represent 90 percent or more of the core damage frequency".

APR1400 design control document (DCD) Tier 2, Section 19.2.4, "Containment Performance Capability," does not clearly explain how the more likely severe accidents were identified. The staff reviewed the information contained in the DCD, and in supporting calculations 1-316-C304-006 and 1-316-C304-007. The staff identified information that needs to be explained in the DCD to complete its evaluation. In accordance with RG 1.216, Regulatory Position 3, the applicant is requested to address the following in the DCD:

1. Provide the technical basis for identifying the more likely severe accident challenges. In Section 19.2.4, the methodology for selecting the more likely severe accident challenges is not clearly explained. In calculation #1-316-C304-006, Table 4-1, the maximum pressures and temperatures corresponding to severe accident scenarios station blackout (SBO), large-break loss-of-coolant accident (LBLOCA), and total loss of feed water (TLOFW) are provided. The basis for selecting these severe accidents is not clear to the staff.

2. In Section 19.2.3.3.7.2.2, the applicant states that the bounding containment pressure expected during a severe accident is 95.3 psig (110 psia). This section does not explain which severe accident corresponds to this accident pressure, which is greater than those accident pressures provided in calculation #1-316-C304-006 stated to produce the most significant pressure loading histories. Additionally, in calculation #1-316-C304-

006 the highest pressure generated is a result of the LLOCA scenario. The staff requests that the bounding severe accident and pressure are included in DCD Section 19.2.4. This is consistent with RG 1.216 Regulatory Position 3, Section 3.1b, “From the set of pressure and temperature transient loadings… identify which pair of pressure and corresponding temperature loadings envelope the entire set of pressure and temperature loadings.”

The staff also requests the applicant explain why SBO was selected as the representative severe accident, since it is not bounding, and describe how the analysis would have been different had a different severe accident been selected as the representative severe accident.

3. In calculation #1-316-C304-006, the results of the analysis are presented for SBO loading. Clarify what pressure load corresponds to the results provided in Table 5-2. Confirm that the results presented in calculation #1-316-C304-007 Section 5 correspond to the same pressure load.

4. In calculation #1-316-C304-006, the applicant describes a process using a pressure amplification factor between Tables 4-1 and 4-2. It is not clear what is meant by pressure amplification factor. Please explain what is meant by pressure amplification factor and explain how it is related to the ratio between the pressure obtained for each severe accident scenario and the maximum pressure and temperature for performance assessment. Please also explain how the maximum pressure provided in Table 4-2 was determined.

## Response

1. Regarding RG 1.216 Regulatory Position 3.1 a, selection of accident sequences based on Level 1 probabilistic risk assessment (PRA) study is made in the following way. The more likely severe accident sequences to be analyzed for the containment performance are selected using a combination of deterministic and probabilistic approaches.

   The top ten dominant sequences contributing to the core damage frequency (CDF) are selected from the Level 1 PRA results at the time of performing the analysis. Accident initiators for these sequences include: station blackout (SBO), large break LOCA (LLOCA), small break LOCA (SLOCA), loss of feedwater (LOFW), and steam generator tube rupture (SGTR). These ten sequences account for 87.6% of the cumulative CDF. The applicant believes this to be an acceptable approach to identifying the more likely severe accident challenges since the probabilistic sequences and the dominant sequences from the deterministic approach are included. Details regarding the identification of the more likely severe accident challenges are given in Section 3.1.2 of “Containment Performance Analysis”, 1-035-N389-501, Rev. 04, which has been provided in the ERR. Response to Action Item 19-171 Section 19.2 Issue #SA-10 (AI-19-171) also includes the description on the accident selection and provides the DCD subsection 19.2.4.1 markup accordingly.

TS

The pressure and temperature response of the selected more likely severe accident sequences is employed as the input loads profiles in the finite element study.

TS

2.

Additional description on the basis of bounding pressure is given in DCD 19.2.3.3.7.2.2 like attachment.

3. The calculations #1-316-C304-006 and #1-316-C304-007 was revised and will be uploaded to the ERR system. Calculation #1-316-C304-006 shows conservative results in the global model which also includes local parts such as equipment hatch and personnel airlocks. Calculation #1-316-C304-007 also shows the results in only the local part. The loading conditions of calculation #1-316-C304-007 are identical to those of calculation #1-316-C304-006. Only the results of the analysis are checked in a different perspective (global or local). As shown, the revised calculations for the results of #1-316-C304-006 envelope the results of 1-316-C304-007.

4. In the revised calculation #1-316-C304-006, a pressure amplification factor is not used. The transient pressure response given from MAAP analysis for the selected more likely severe accident sequence is directly applied to the input load in the structural analysis.

---

**Impact on DCD**

DCD Section 19.2.3.3.7.2.2 will be revised as indicated on the attached 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, or Environmental Report.

used to assess survivability of individual equipment. Severe accident temperature environments can be classified as severely challenging, highly challenging, quite challenging, moderately challenging, or nominally challenging, depending on the magnitude and duration of extreme conditions. Severely challenging environments are identified by highly confined extreme conditions for a relatively long duration, such as in the reactor cavity and the IRWST. Highly challenging environments are areas close to a combustible gas source such as the steam generator compartments or the annular compartment above the IRWST. Quite challenging and moderately challenging environments are areas where combustible gas may accumulate such as the containment dome. Nominally challenging environments are compartments where the containment atmosphere can be considered well-mixed and is inerted by a high steam concentration. The equipment survivability curves constructed for each of the five types of environments are shown in Figures 19.2.3-16 through 19.2.3-20. The bounding temperature profile expected in each containment node during a severe accident is summarized in Table 19.2.3-5.

19.2.3.3.7.2.2 Bounding Pressure Environment

~~Based on the MAAP results, the bounding containment pressure expected during a severe accident is 7.75 kg/cm$^2$ (110 psia).~~

19.2.3.3.7.2.3 Bounding Radiation Environment

MAAP4-DOSE (Reference 29) is used to determine the bounding radiation dose during a severe accident. MAAP4-DOSE is a radiation dose calculation code that reads input from MAAP output. The maximum radiation dose that equipment in the containment is expected to receive during a severe accident is $4.4 \times 10^5$ Gy, predicted in the steam generator compartment for the LOFW sequence.

19.2.3.3.7.3 Analysis Methodology

ES is assessed by comparing reliable EQ information such as equipment suppliers' documents, research results, and experimental data with severe accident environmental conditions at the locations where the equipment is installed.

Based on the MAAP study for the selected more likely severe accident sequences, in the viewpoint of the equipment survivability assessment, the containment pressure of 7.75 kg/cm$^2$ (110 psia) in SBO can envelop the pressure histories from the selected sequences.

# 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.:** | **433-8363** |
| **SRP Section:** | **SRP 19** |
| **Application Section:** | **19.1** |
| **Date of RAI Issue:** | **03/08/2016** |

---

## Question No. 19-77

10 CFR 52.47(a)(27) states that a design certification (DC) application must contain an FSAR that includes a description of the design-specific PRA and its results. SECY 93-087 approves an alternative approach to seismic PRA for the DC application and interim staff guidance (ISG) 20 provide guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC.

Design Control Document (DCD) Section 19.1.5.1, Table 19.1-43, lists the high confidence in low probability (HCLPF) capacities resulting from several qualification methods (i.e. analysis, generic data, generic DB, and test data). The staff requests the applicant describe what is meant by the entries: analysis, Generic DB, Generic, and Test.

The staff requests the applicant describe the methodology used to calculate seismic fragilities for strictures, systems, and components (SSCs). For the components screened out, the staff requests the applicant provide a basis for screening out these structures and components. These include components identified as screened out based on the assumption of seismically rugged capacity in Section 19.1.5.1.1.1 to develop the seismic equipment list (SEL) and those components identified as screened out in Table 19.1-43. As per the guidance in ISG-20, screening of rugged SSCs can be performed based on the DC's certified seismic design response spectra (CSDRS) with its peak ground acceleration (PGA) scaled by a factor of 1.67.

For capacities that are determined using seismic qualification testing, the staff requests the applicant to demonstrate how seismic qualification by testing or by type testing will satisfy the SECY-093-087 requirement of 1.67 times safe shutdown earthquake (SSE). As per the guidance in interim staff guidance (ISG) 20, for equipment on the seismic equipment list (SEL), which is to be qualified by seismic qualification tests, the procedure described in E.5 of the EPRI Report 1002988 is acceptable for developing fragilities. Further, when implementing this method for developing fragilities, there should be less than a 1 percent probability of failure at a ground motion equal to 1.67 times the CSDRS, including consideration of testing uncertainties.

As applicable, the staff requests the applicant to provide basis and justification for alternate methods relative to the guidance in ISG-20.

## Response

As shown in the response to RAI 19-75, Table 19.1-43 and Section 19.1.5.1.1.2 have been revised. In that revision, HCLPF values for several buildings and reactor coolant system (RCS) related failures are presented and the basis for those calculations summarized. All other components along with the ESW intake structure and the CCW heat exchanger building are assumed to have a HCLPF of at least 1.67 times CSDRS. COL item 19.1 (17) was added to address this assumption. As a result of the revisions documented in RAI 19-75, the information requested in this RAI is no longer relevant to the analysis.

---

**Impact on DCD**

There is no impact on the DCD.

**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, or Environmental Report.

# 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.:** | **433-8363** |
| **SRP Section:** | **SRP 19** |
| **Application Section:** | **19.1** |
| **Date of RAI Issue:** | **03/08/2016** |

---

## Question No. 19-78

10 CFR 52.47(a)(27) states that a design certification (DC) application must contain an FSAR that includes a description of the design-specific PRA and its results. In SECY 93-087, the Commission approved use of the seismic margin approach (SMA) for DC applications. ASME/ANS RA-Sa-2009 Part 5 and interim staff guidance (ISG) 20 provide guidance acceptable to the staff for the SMA. The industry standard, ASME/ANS RA-SA-2009, requires a peer review to promote consistency among similar PRAs and reasonableness in the numerical results and risk insights. ISG 20 endorses the performance of a peer review for the SMA.

The APR1400 DCD does not identify whether the peer review was performed. The staff considers this an essential element in the assessment of the quality of the PRA. Clarify whether a peer review has been performed as part of the SMA. If it has, document the results in DCD Section 19.1.5. If it has not, provide a detailed technical basis for concluding that it is not necessary.

## Response

A peer review of the SMA was not performed. For the seismic hazard, a design certification SMA is to use the CSDRS. Therefore, review of that aspect of the SMA is not needed. Additionally, other aspects of the SMA, for example soil structure interaction, is applicable to a specific site only and, therefore, cannot be determined or reviewed for the APR1400 DC. Component fragility values used in the SAM are based entirely on assumptions and left as a COL item. Seismic interactions and walkdowns, by definition, cannot be performed or determined for a DC analysis. The elements of a SMA mentioned above have the most significant impact on SMA results. However, these elements are based on assumptions or prescribed inputs. A review of those elements could produce no insights relevant to a DC SMA. Therefore, it is considered acceptable to not perform a peer review of the SMA.

---

**Impact on DCD**

There is no impact on the DCD.

**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, or Environmental Report.

# 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.:** | **433-8363** |
| **SRP Section:** | **SRP 19** |
| **Application Section:** | **19.1** |
| **Date of RAI Issue:** | **03/08/2016** |

---

## Question No. 19-79

10 CFR 52.47(a)(27) states that a design certification (DC) application must contain an FSAR that includes a description of the design-specific PRA and its results. SECY 93-087 approves an alternative approach to seismic PRA for the DC application and interim staff guidance (ISG) 20 provides guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a DC.

Design control document (DCD) FSAR Section 19.1.5.1, Table 19.1-43, lists the high confidence in low probability of failure (HCLPF) capacities for APR1400 Structures, Systems and Components (SSCs). Some HCLPF values in this table were derived using the approach referenced in EPRI Utility Requirements Document (URD) (Reference 37). The URD uses local (i.e., actual component location) spectral acceleration capacities which are derived from generic equipment ruggedness spectra (GERS).The fragility and corresponding HCLPF capacity of a specific component, relative to ground motion peak ground acceleration (PGA), can vary significantly depending upon the stiffness of the structure and the location of the component within the structure.

To verify that the HCLPF capacities based on generic capacities and generic structural amplifications are reasonable and achievable for design certification of the APR1400, and consistent with the guidance in ISG-20 Section 5.1.2, the staff requests the applicant provide justification that demonstrates the generic data used to estimate the HCLPF capacities are consistent and applicable to SSCs within the scope of the standard design.

## Response

As shown in the response to RAI 19-75, Table 19.1-43 and Section 19.1.5.1.1.2 have been revised. In that revision, HCLPF values for several buildings and reactor coolant system (RCS) related failures are presented and the basis for those calculations summarized. All other components along with the ESW intake structure and the CCW heat exchanger building are assumed to have a HCLPF of at least 1.67 times CSDRS. COL item 19.1 (17) was created to address this assumption. As a result of the revisions documented in RAI 19-75, the information requested in this RAI is no longer relevant to the analysis.

---

**Impact on DCD**

There is no impact on the DCD.

**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, or Environmental Report.