REVISED 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 – (Rev.1)

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.

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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.

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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).~~

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.

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 × 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.

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Question No. 19-81

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 containment performance goal for the period following the initial 24 hours after the onset of core damage.

The staff noted inconsistencies in the plots of maximum pressures for the large-break loss-of coolant accident (LBLOCA) scenarios between Figure 19.2.3-21 and the Containment Building Capacity Evaluation on Severe Accident (Global) Calculation #1-316-C304-006. The staff requests that the applicant clarify the differences between the two scenarios and explain why the accident scenarios considered are actually those with the most significant pressure loading histories.

Response – (Rev. 1)

Regarding Regulatory Position 3, Response to Chapter 19 RAI 433-8363 Question 19-71 item 1 addresses a basis for the accident selection and the calculated bounding pressure. Briefly it can be classified into the following steps.

- Selection of more likely accident sequences: Based on the core damage frequency ranking from PRA Level 1 study, the top ten sequences are selected. Also a number of typical sequences which are important in deterministic approach are added in the calculation matrix, as listed in Table 2-1, page 6 of

Calculation note “Containment Performance Analysis,” 1-035-N389-501, Rev. 4.

- Evaluation of the plant response by using MAAP code: For the selected sequences the plant response are evaluated by using MAAP code. The pressure and temperature transient are determined in each case.

- Decision of bounding pressure load: Based on the plant response, the pressure profile is selected such that it can envelop the selected sequences. TS Consequently the pressure curve obtained on the LBLOCA sequence, as shown in Figure 19.2.3-21 in DCD, is then applied to the containment structural strain analysis.

The revised Calculation notes (1-316-C304-006 Rev.3 and 1-316-C304-007 Rev.3) clearly indicates that the bounding pressure selected from the more likely severe accident sequences are employed as the input load profile.

Impact on DCD

There is no impact on DCD.

Impact on PRA

There is no impact on PRA.

Impact on Technical Specifications

There is no impact on Technical Specifications.

Impact on Technical/Topical/Environmental Reports

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