SUPPLEMENTAL 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.:	**327-8354**
SRP Section:	**06.02.01.01.A – PWR DRY CONTAINMENTS, INCLUDING SUBATMOSPHERIC CONTAINMENTS**
Application Section:	**6.2.1.1.**
Date of RAI Issue:	**12/03/2015**

Question No. 06.02.01.01.A-6

As stated in the TeR Section 3.6, “Description of Core Reflood Model,” following the termination of critical flow, the containment backpressure is assumed to be 58 psia that would remain constant throughout the reflood phase. Please specify the basis for selecting this pressure for input to the FLOOD3 code, and explain whether a lower value for containment back pressure would be more conservative for break flow rate during the reflood phase of the design basis LOCA.

Response

The containment back pressure is the assumed input to the LOCA mass and energy (M/E) release analysis and the containment peak pressure is the calculated output from the containment pressure and temperature (P/T) analysis which uses the M/E data as the input.

Qualitatively, it is known that a lower value for the containment back pressure results in a higher M/E release, and subsequently, a higher containment peak pressure during the post-blowdown phase. Thus, for the conservative M/E analysis, a low value is assumed for the containment back pressure input.

If the assumed containment back pressure is lower than the calculated containment pressure during the time between the EOB and the time at which the containment peak pressure is reached, the assumed containment back pressure is considered to be a conservative input to the M/E analysis. The range of the time duration is limited to the containment peak pressure time since the final concern of the analysis is for the containment peak pressure.

The assumed value of 58 psia for the APR1400 containment back pressure is based on the above condition. Since the calculated containment pressure is not available at the start time of the M/E analysis, the P/T result of the reference plant (Shin Kori 3&4) which is performed

using the CONTEMPT-LT/028 code is shown in Table 1. The calculated containment pressures at EOB time and peak pressure time and the minimum containment pressure between the two time points for each LOCA cases are presented in Table 1. Based on Table 1, the containment back pressure is assumed to be less than the minimum containment pressures between the two time points, which is determined to be 58 psia for the LOCA M/E analysis of the APR1400 DC.

The final result of the P/T analysis is calculated using the GOTHIC code and shown in the Figure 6.2.1-1 through 6.2.1-4 in the DCD. The final containment pressures at the times of EOB, minimum pressure and peak pressure are tabularized in Table 2. The final P/T results show that the assumed back pressure of 58 psia is lower than the calculated containment pressure during the time between the EOB and the peak pressure time. Even though the minimum containment pressures in DEDLSB with maximum SI case and DEDLSB with minimum SI case are slightly lower than the assumed 58 psia, the calculated containment pressures are higher than the assumed 58 psia in the whole duration from the EOB time to the peak containment pressure time. Thus, the assumed 58 psia is considered to be a conservative input to the M/E analysis.

Table 1. LOCA P/T Results using CONTEMPT-LT/028 Code (Shin Kori 3&4)

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Table 2. Final LOCA P/T Results using GOTHIC Code (APR1400 DC)

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A lower value for containment back pressure would be more conservative for containment peak pressure during the post-blowdown phase of the design basis LOCA. However, since the assumed back pressure of 58 psia is already conservative as mentioned above, the lower assumed back pressure than the 58 psia will result the excessive conservatism, which is not considered to be necessary for the LOCA M/E analysis of the APR1400 DC.

Supplemental Questions

Public Teleconference (July 7, 2016)

The staff needs some clarifications about the data provided in Table 1 and Table 2. The staff would like to understand what it means that using CONTEMPT-LT/028 led to a peak containment pressure of 68.34 psia for DEDSLB as given in Table 1, which is significantly higher than the expected 65.79 psia licensing basis value obtained from GOTHIC for the same break, as given in Table 2. Why are the results so different and what does that imply?

Secondly, Table 2 shows that the lowest containment pressure is 57.157 psia, which is even lower than the 58 psia used for the LOCA M/E analysis of the APR1400 DC. So, why was 57 psia not used, even though it would be more conservative?

Public Teleconference (August 9, 2016)

The staff requests the applicant to update the RAI response with the supplemental material provided by the applicant's updated document for the previous telecon. Please also include the reasons as to why the break flow model used in the licensing basis calculations is conservative. What discharge coefficients were used for the analyzed LOCA and MSLB breaks?

Public Teleconference (September 22, 2016)

The staff issued RAI 8354, Question 28473 (06.02.01.01.A-6) asking the applicant to specify the basis for selecting the containment back pressure value of 58 psia for input to the FLOOD3 code. The applicant's response, dated February 3, 2016, states that the assumed constant backpressure value is selected such that it is lower than the calculated containment pressure during the end of blowdown (EOB) and the when the containment peak pressure is reached. The applicant also provided two tables summarizing the peak, minimum, and EOB pressures for DEDLSB and DESLSB with minimum and maximum SI, calculated for APR1400 DCD design (using GOTHIC code) and Shin Kori 3&4 design (using CONTEMPT-LT/028 code). However, the staff noted that the lowest containment pressure is 57.157 psia, which is even lower than the 58 psia used for DEDLSB with maximum SI for APR1400 DC. In the July 7, 2016 public teleconference, the staff asked the applicant to justify not using a more conservative 57 psia value for the M&E release during the reflood phase of the design basis LOCA. The applicant admitted that the containment pressure does drop below 58 psia around 50 seconds for DEDLSB with maximum SI, but pointed that the duration for the pressure drop below 58 psia is very short compared to the period from the EOB to the time of peak containment pressure. The applicant also pointed that the pressure difference between the assumed minimum pressure of 58 psia and the actual minimum pressure of 57.157 psia is much smaller than the one between the assumed minimum pressure and the containment peak pressure of 65.79 psia. The staff noted that the calculated minimum pressure of 57.157 psia occurs past the end of blowdown (EOB) and, thus, would not significantly affect the M&E release to the containment. The staff would accept the assumed value of 4.078 kg/cm^2A (58 psia) of containment back pressure to be acceptable, when the applicant submits the updated response to RAI 8354, Question 28473 (06.02.01.01.A-6) on the docket. So, this is tracked as an open item.

Supplemental Response

Public Teleconference (July 7, 2016)

Conservatism of 57 psia Input :

As shown in DCD Figure 6.2.1-3 (1 of 2: DEDLSB with maximum SI Flow), the containment pressure drops below 58 psia at around 50 seconds. It is understood that when the calculated containment pressure is lower than the assumed input pressure of 58 psia, the assumed input is no longer conservative. However, the duration time when the containment pressure is below 58 psia is relatively small when compared to the time period starting from the end of blowdown (EOB) to the time of peak containment pressure. In addition, the pressure difference between the minimum containment pressure of 57.157 psia and the assumed pressure of 58 psia is relatively small when compared with the pressure difference between the maximum containment pressure of 65.79 psia and the assumed pressure of 58 psia. Based on the behavior of the containment pressure described above, the assumed input of 58 psia is lower than the containment pressure during most of the time period from the EOB to the time of peak containment pressure and thus, is considered to be conservative for the DEDLSB with the maximum SI case analysis of the APR1400 DC.

The same discussion and results regarding the containment pressure input are applicable to the DEDLSB with minimum SI case, as shown in - DCD Figure 6.2.1-4 (1 of 2).

In conclusion, the use of 57 psia as input for the containment pressure in the LOCA M/E analysis can result in more conservative output as compared to the output when 58 psia is used. However, since using 58 psia as input is already conservative as mentioned above, additional conservatism is not considered necessary.

Public Teleconference (August 9, 2016)

The conservatism of the break flow model and discharge coefficients is discussed in the paragraphs below.

- LOCA :
  As mentioned in the response to the RAI 8460 Question 06.02.01.03-5, the mass release calculation model in the CEFLASH-4A code during blowdown period has been demonstrated to be conservative by comparison to experimental data in the reference, Section III.C.1.b.(4) of CENPD-132P (Calculative Methods for the C-E Large Break LOCA Evaluation Model, Aug. 1974). The comparison was performed between the CEFLASH-4A analytical results and the experimental results of LOFT semi-scale test 850. The three separate critical flow formulations are considered for the mass release calculation model in the CEFLASH-4A, the Moody, the modified Henry/Fauske, and a combination of the modified Henry/Fauske and Moody. The detailed descriptions are provided in CENPD-132P.

  During reflood/post-reflood periods, no critical break flow is predicted and the mass release calculation in the FLOOD3 code is performed using the flow resistances in the hydraulic network, as presented in Figure 1 of Reference 10 in DCD Section 6.2.9. Since the flow

resistances in the hydraulic network were conservatively considered in the calculation of the break flow (i.e. minimized) and although the experimental data of reflood break flow is not available, the mass release calculation in the FLOOD3 code is conservative.

The discharge coefficient used for blowdown phase and post-blowdown phase is 1.0.

- MSLB :
  As stated in SRP 6.2.1.4, the Moody critical flow model is taken into account for MSLB analysis. In the MSLB, the break size spectrum analysis has been performed to determine the most conservative M/E release result. Therefore, the effect of the discharge coefficients was already considered in MSLB analysis.

Public Teleconference (September 22, 2016)

This supplemental response to RAI 8460, Question 06.02.01.01.A-6, provides answers to NRC staff questions based on the July 7, 2015 and August 9, 2016 public teleconferences.

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 Environment Report.