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.:	**359-8448**
SRP Section:	**03.06.02 – Determination of Rupture Locations and Dynamics Effects Associated with the Postulated Rupture of Piping**
Application Section:	**3.6.2**
Date of RAI Issued:	**01/11/2016**

Question No. 03.06.02-6

The applicant submitted a technical report, APR1400-E-N-NR-14003-P, "Evaluation Methodology of Jet Impingement Loads on SSCs," on October 6, 2015, to support DCD Tier 2, Section 3.6.2. In Appendix A of this report, the applicant describes the modeling approach and verification and validation using industry standards. The subject was also discussed in a meeting on December 1-2, 2015 between the staff and the applicant. The relevant discussion was later documented in the applicant's December 9, 2015, letter (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15343A398).

Based on its review of the information provided in Appendix A of the report and the applicant's December 9, 2015 letter, the staff determined that the following additional information is needed on the verification and validation of the model used to determine that it meets the requirements of 10 CFR Part 50, Appendix B, and GDC 1, as described in the relevant SRP Section 3.9.1, Subsection II, SRP Acceptance Criterion 2.

1. The applicant is requested to provide an explanation of the data used to generate the tables presented in the Appendix A of the report, including how the results as shown in the table demonstrate the convergence of different solutions.

2. The staff noted that numerous statements or equations included in the report refer to either literature or test data. However, the report does not identify the respective literature or test data in the list of references. The applicant is requested to provide a more detailed explanation of the references pertaining to Appendix A of the report.

3. The applicant is requested to clarify how the uncertainty in the overall approach is addressed, how uncertainties are combined and carried forward to the application, and how specific reference information was applied (such as convergence to the desired goal). The applicant was requested to provide clarifications in other sections (e.g., Subsections 11 and 12 of Appendix A) to support the wording in Section A.15.0, Bullet A.2 regarding the validation of uncertainty with respect to CFD modeling.

Response – (Rev. 1)

1. APR1400-E-N-NR-17001-P replaces APR1400-E-N-NR-14003-P in its entirety; it does not include the earlier report's Appendix A tables. APR1400-E-N-NR-17001-P contains considerable discussion of the source of the information used to inform the assessment. For the CFD analyses, mesh refinement studies were performed to determine an appropriate mesh size at which the calculated pressure load due to the blast is insensitive to additional changes in mesh size.

2. As noted above, APR1400-E-N-NR-17001-P contains considerable discussion of the source of the information used to inform the assessment. To facilitate review, where authorized under copyright, APR1400-E-N-NR-17001-P includes figures from the references that are most directly applicable to the phenomena being discussed.

3. There are a large number of physical variables that determine blast effects, as discussed in Section 5.6.1 of APR1400-E-N-NR-17001-P. Because of the numerous combinations of these variables, identifying a factor of safety is not meaningful. Instead, the methodology includes conservative assumptions. Please refer to Section 5.6 of APR1400-E-N-NR-17001-P for discussion of these conservatisms and to Appendix B which demonstrates considerable margin in most cases of application of the correlation to get bounding results relative to detailed CFD modeling. The verification and validation of the CFD modeling is amenable to assessing quantitative uncertainty since it involves predefined experimental conditions, and Table 5-8 of APR1400-E-N-NR-17001-P documents the results for the seven cases as ranging from 1% to 21% for the various parameter values calculated (e.g., pressure force, temperature, Mach number).

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

APR1400 High Energy Line Break Jet Impingement (APR1400-E-N-NR-17001-P, Rev.1) is issued to replace the Evaluation Methodology of Jet Impingement Loads on SSCs (APR1400-E-N-NR-14003-P, Rev.0).

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Question No. 03.06.02-7

To address the APR1400 design's compliance with GDC 4 requirements, the applicant describes the criteria and methods of analysis used in the APR14000 design to assess the dynamic effects of jet impingement and blast wave pressure in Appendix B of APR1400-E-N-NR-14003-P. The subject was also discussed in a closed meeting on December 1-2, 2015, between the staff and the applicant. The relevant discussion was later documented in the applicant's December 9, 2015, letter (ADAMS Accession No.ML15343A398).

Based on its review of the information provided in Appendix B of the report and the applicant's December 9, 2015, letter, the staff determined that the following additional information (discussed in the previously referenced meeting) is needed to determine that the proposed methodology is bounding and representative for the APR1400 design to mitigate the dynamic effects of blast wave pressure as described in Appendix B of the technical report.

1. In Section B.3.3 and Section B.4.0 of the report, the applicant referred to literature and experimental data for determining the blast wave overpressure correlation. However, the report does not identify the respective literature or test data in the list of references. The applicant is requested to provide a more detailed explanation with references pertaining to the information presented in Appendix B of the report.

2. The applicant is requested to clarify in Appendix B which data is used and where the experimental data came from. Also, the applicant is requested to explain how equations (e.g., those on Page B19 in the report) were derived and used in the analysis.

3. In determining the maximum positive impulse correction, the applicant referred to specific experiments. The applicant is requested to describe on the applicability of the experiments to the APR1400 design.

4. The applicant is requested to provide a more detailed explanation of how the recommended factor of safety for blast wave overpressure and maximum positive static pressure impulse were derived.

5. The applicant is requested to provide more clarification on shock wave propagation in Section B.3.3.

6. The applicant is also requested to add a discussion of the comparison of the blast wave correlation to the results in Section B.5.4.

7. The applicant is requested to correct the referenced section (3.1.3) on page 65 and correlate it to the associated equations (e.g., B-19, B-12a).

8. The applicant is requested to explain the dominant force in the methodology depicted in Figure B-1 of the technical report and in the Modified Moody jet zone.

9. The applicant is requested to provide an explanation of the steps that are taken in Section B.5.5 to obtain the dynamic load factor and pressure ratios.

Response – (Rev. 1)

APR1400-E-N-NR-17001-P replaces APR1400-E-N-NR-14003-P in its entirety. The NRC requests noted above were considered in preparing the new report.

1. The occurrence and consequences of dynamic amplification and blast effects are discussed in APR1400-E-N-NR-17001-P. The report contains considerable discussion of the source of the information used to inform the assessment. For blast effects, computational fluid dynamics (CFD) modeling was used to justify the specified blast wave overpressure correlation. Verification and validation of the CFD modeling is also discussed in the report.

2. APR1400-E-N-NR-17001-P uses a different methodology. The source of data and basis for equations are identified.

3. The maximum positive impulse correction has been eliminated.

4. There are a large number of physical variables that determine blast effects, as discussed in Section 5.6 of APR1400-E-N-NR-17001-P. Because of the numerous combinations of these variables, identifying a factor of safety is not meaningful. Instead, the methodology includes conservative assumptions. Appendix B demonstrates considerable margin in most cases of application of the correlation to get bounding results relative to detailed CFD modeling. Please refer to Section 5.6 of APR1400-E-N-NR-17001-P for discussion of conservatisms.

5. Shock wave propagation is discussed in detail in Section 5.1 of APR1400-E-N-NR-17001-P.

6. Appendix B of APR1400-E-N-NR-17001-P provides a quantitative comparison of the results from the shock wave correlation to results from CFD analysis. Validation and verification of the CFD approach is discussed in Section 5.7.

7. Not applicable to APR1400-E-N-NR-17001-P.

8. Section 3 of APR1400-E-N-NR-17001-P discusses the methodology for the different HELB blowdown conditions.

9. Section 3 of APR1400-E-N-NR-17001-P discusses the methodology for the different HELB blowdown conditions.

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

APR1400 High Energy Line Break Jet Impingement (APR1400-E-N-NR-17001-P, Rev.1) is issued to replace the Evaluation Methodology of Jet Impingement Loads on SSCs (APR1400-E-N-NR-14003-P, Rev.0).

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Question No. 03.06.02-8

The staff's guideline as delineated in Appendix A of mPower DSRS 3.6.2 recommends that the effect of potential oscillatory jet loads (i.e., resonance) should be considered when the impingement surface is within 10D of the jet opening. In Sections 4.2.1.2.3 and 4.2.1.2.2 of APR1400-E-N-NR-14003-P, the applicant provides information to support excluding certain jet impingement oscillatory loads with reference to additional studies. The uncertainties in the calculation of this range, however, are unclear. The staff noted that there are certain conservatisms in the applicant's proposed jet impingement load evaluation methodology. Therefore, it may be justifiable for the applicant to use a different distance than staff's recommendation of 10D for excluding the potential oscillatory jet loads for the APR1400 design. The applicant is requested to provide further justification, including a discussion of uncertainty and the location of critical components, for its proposed distance criterion for considering oscillatory jet loads.

Response – (Rev. 1)

APR1400 High Energy Line Break Jet Impingement (APR1400-E-N-NR-17001-P, Rev.1) provides a detailed discussion of the jet-induced resonance issue in Section 4.3.

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

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