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.:	**311-8278**
SRP Section:	**03.12 – ASME Code Class 1, 2, and 3 Piping Systems and Piping Components and Their Associated Supports**
Application Section:	**DCD Tier 2 Section 3.12**
Date of RAI Issue:	**11/16/2015**

Question No. 03.12-6

Standard Review Plan (SRP) Section 3.12 specifies that when a piping system is to be broken up into two parts with the input from the larger piping system used to analyze the smaller piping system, the decoupling criteria provided in SRP Section 3.7.2 are applicable. APR1400 DCD Tier 2, Subsections 3.7.2.3.2 and 3.7.2.3.3 specify decoupling criteria for piping similar to those in SRP Section 3.7.2. DCD Subsection 3.12.4.4 specifies a choice of two decoupling criteria for piping that are different from the guidance in SRP Section 3.7.2 and those specified in DCD Subsection 3.7.2.3.2.

The following is requested from the applicant:

1. If the branch piping geometry is known, the applicant should clarify whether the branch piping is included in the piping analysis model with the header. If it is not included, the applicant should provide a technical justification for decoupling the branch from the header.

2. For branch piping with known geometry for which decoupling is justified based on the item above, SRP Section 3.12 indicates that decoupling criteria from SRP Section 3.7.2 should be used. The applicant is requested to justify why the decoupling criteria in DCD Subsection 3.7.2.3.2 were not applied for piping.

3. DCD Section 3.12.4.4 includes as one of the decoupling criteria that, if only the size of the branch pipe is known, the branch pipe may be decoupled from the run pipe if the ratio of run to branch pipe moment of inertia is 25 to 1 or more. The Welding Research Council (WRC) Bulletin (BL) 300, “Technical Position on Damping and on Industry Practice,” provides the technical justification for using the moment of inertia ratio of 25 for decoupling with exceptions, which has been accepted by the NRC when justified in certain applications. Since this decoupling criterion is in DCD Section 3.12.4.4, the applicant is requested to refer to and add WRC BL 300 in the DCD Section 3.12 list of references and also show in DCD 3.12.4.4 that, as shown in WRC BL 300, if either of

the two factors listed below apply, piping cannot be decoupled. If an alternative approach is selected, the applicant is requested to provide a technical justification.

i. If an anchor or fixed restraint on the branch pipe is located near the run pipe and significantly restrains the movement of the run pipe, the branch pipe should be included with the model of the run pipe, up to the anchor (or up to and including the series of fixed restraints that effectively permits termination of the problem at some point remote from the run pipe).

ii. The branch pipe should be included in the computer model of the run pipe if more precise magnitudes of reactions are required at terminal points (i.e., equipment, penetrations, etc.) to determine their (the reactions) acceptability.

Response – (Rev. 1)

In the APR1400, the graded approach is applied to the piping design. Since the branch piping geometry is known, the decoupling criteria specified in DCD Subsection 3.7.2.3.2 cannot be applied to the piping systems. The decoupling criteria used is based on the ratio of run to the branch pipe moment of inertia being 25 to 1 or more in accordance with the Welding Research Council (WRC) Bulletin (BL) 300, "Technical Position on Damping and on Industry Practice." The other criteria, the ratio of run to branch pipe diameter, is almost the same as the ratio of run to the moment inertia based on the schedule of the piping for the APR1400. To clarify the decoupling criteria, the ratio of diameter will be deleted.

This revision to the original response is being submitted to address the issues discussed during the recent clarification call. A revised response to items 1 - 3 are as follows:

1. The original response did not correctly describe the decoupling criteria applied to piping analysis in the APR1400. When the branch piping geometry is known, DCD Subsection 3.7.2.3.2 is applied for the decoupling criteria. When the branch piping geometry is unknown, the decoupling criteria is applied, as shown in WRC BL 300.

2. As the design progresses, the small bore branch piping systems are designed after the large bore (LB) piping systems are completed. In general, the LB piping systems are designed when the geometry of the branch piping systems have not been determined. Therefore, the decoupling criteria in DCD Subsection 3.7.2.3.2 cannot be applied at the time the LB piping systems are designed.

3. As stated in the proposed revised DCD (Rev. 0) Subsection 3.12.4.4, the branch piping systems are designed including piping support type and location, considering the influence of the LB piping systems. Such conditions include that no restraints on the branch are located near the LB pipe for the flexibility or no precise magnitudes of the reactions are required at the terminal points. When the branch piping systems affect a LB piping system previously design, the LB piping systems including branch piping systems are re-analyzed.

Base on the response above, the basis for using WRC Bulletin 300 decoupling criterion in the APR1400 will be added in DCD Subsection 3.12.4.4 and reference to Subsection 3.7.2.3.2 for the application of the decoupling criterion for branch piping.

Impact on DCD

DCD Tier 2, Subsection 3.12.4.4 will be revised as shown in the Attachment.

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.

In general, pipe supports are modeled as rigid with the rigidity verified by checking support deflection in the restrained direction, if springs with actual stiffness values for the restrained degrees of freedom. Pipe support hardware weight for snubbers, struts, and spring hangers supported by the piping system is considered in the piping analysis. The weight added by the component support is included in the piping analysis when it is greater than 10 percent of the total mass of the adjacent pipe span including pipes, contents, insulations, and in-line components.

In general, an entire piping system cannot be modeled and analyzed as a single model; the piping system is therefore conveniently divided into multiple, smaller piping subsystems that satisfy the analysis size limitations of the computer program used for the piping system analysis. Branch piping that does not have a significant effect on the run piping is decoupled from the run pipe analysis based on the branch decoupling criteria defined in Subsection 3.12.4.4. Intermediate pipe anchors such as wall or slab penetration sleeve anchors and structural anchor supports may also be used for subdividing the piping systems.

3.12.4.3 Piping Benchmark Program

The computer programs used for the piping system analysis are verified in accordance with NRC benchmark problems.

The piping benchmark problems prescribed in NUREG/CR-1677, Volumes 1 and 2 (Reference 16), are used to validate the PIPESTRESS and ADLPIPE computer programs used in piping system analysis.

3.12.4.4 Decoupling Criteria

Small branch lines including instrument connections may be decoupled from the analysis model of the larger run pipe provided that ~~either the ratio of the branch pipe mean diameter to the run pipe mean diameter (D_b/D_r) is less than or equal to 1/3 or~~ the ratio of the moments of inertia of the two lines (I_b/I_r) is less than or equal to 1/25~~.~~ , under such conditions that no restraints on the branch are located near the run pipe for the flexibility or no precise magnitudes of reactions are required at terminal points (Reference 31).
In the case that the branch piping geometry is known, piping systems are consider in accordance with the decoupling criteria described in Subsection 3.7.2.3.2.

In the run pipe analysis, the applicable stress intensification factors (SIFs) and/or stress indices are incorporated. The mass effects of the branch line, where the mass of half the span of the branch pipe is greater than 10 percent of the mass of the pipe run span, are also

28. IEEE Std. 344-2004 (R2009), "Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, 2005.

29. Welding Research Council Bulletins 353, "Position Paper on Nuclear Plant Pipe Support," May 1990.

30. SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water (ALWR) Designs," U.S. Nuclear Regulatory Commission, 1993.

31. Welding Research Council Bulletin 300, "Part 4: Technical Position on Industry Practice," December 1984.

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Question No. 03.12-9

ASME BPV Code Section III, as mandated by 50.55a, requires that piping be evaluated for seismic loads. DCD Section 3.7B.7.3 shows that ASME Class 1, 2, and 3 piping systems are evaluated for the hard rock high frequency (HRHF) seismic response spectra. DCD Section 3.7B.1 identifies that the HRHF response spectra exceed the certified seismic design response spectra (CSDRS) for frequencies above approximately 10 Hz.

1. DCD Section 3.7B.7 discusses the HRHF evaluation of selected SSCs. DCD Sections 3.7B.1 and 3.7B6 show that piping is among the SSCs that were selected to be evaluated for the effects of HRHF as part of the design certification application. DCD 3.7B.7.3 though shows that HRHF effects are to be evaluated by the combined license (COL) applicant. The applicant is requested to provide a justification for this inconsistency.

2. For the piping that was selected to be evaluated in the graded approach identified in DCD Section 14.3.2.3, the applicant is requested to clarify whether both CSDRS and HRHF response spectra are included in the completed piping analyses. In the event that the HRHF response spectra was not included in the piping analysis, the applicant is requested to provide a technical justification for its exclusion from the scope of the design certification application.

Response – (Rev. 1)

Since the graded approach is applied to the piping design, the HRHF evaluation of piping systems will be performed by KHNP in accordance with the scope of the graded approach; including, ASME Class 1 piping (RCS main loop, pressurizer surge line, direct vessel injection line, and shutdown cooling lines) and specific Class 2 and 3 piping systems (main steam and main feedwater piping located inside containment and in the main steam valve house). Technical report, APR1400-E-S-NR-14004-P, “Evaluation of Effects of HRHF Response Spectra

on SSCs" and DCD Tier 2, Subsection 3.7B is being revised to include the HRHF evaluation of the listed piping systems and will be completed in the second quarter of 2016.

This revision to the original response is being submitted to address the issues discussed during the recent clarification call. A revised response to items 1 - 2 is as follows:

1. The HRHF for some Central and Eastern United States rock sites show higher amplitude at high frequency than the CSDRS (certified seismic design response spectra). The responses of piping systems for HRHF are expected to be higher than CSDRS at frequencies higher than approximately 10 Hz, but the displacement of the building which is evaluated by SAM (seismic anchor motion) analysis are smaller than CSDRS. Therefore, it is expected that the response of CSDRS will cover the HRHF. The HRHF piping evaluations to be performed by KHNP will be those systems within the scope of the graded approach as listed in the initial response.

   The intent of the DCD statement in 3.7B.7.3 was for the COL applicant to perform HRHF analyses for piping systems other than those within the scope of the graded approach. The intention stated in the original RAI response was to clarify the DCD after the KHNP performed analyses were completed. However, since adopting the graded approach, the piping systems within the scope of the graded approach are the only systems requiring HRHF analyses. Upon further review, COL item 3.7B(1) can be deleted at this time, prior to completion of the analyses. In addition, the sentence prior to COL Item 3.7B(1) that references the use of design acceptance criteria will also be deleted since it is not applicable.

2. The statement "There is no impact on the DCD" meant that there was no revision to any DCD content as a result of the submitted response at the time of the initial response; however, there would be after the HRHF evaluations are completed in the second quarter of 2016 when the specific information could be included. As stated in the response to sub-item 1, the DCD can be changed at this time and should there be additional information to be incorporated into the DCD and applicable TeR, those additional changes will be proposed after completion of the analyses.

Impact on DCD

DCD Tier 2, Subsection 3.7B.7.3 will be revised as shown in the Attachment.

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

The technical report, APR1400-E-S-NR-14004-P, “Evaluation of Effects of HRHF Response Spectra on SSCs” will be revised in the second quarter of 2016.

~~In the APR1400 plant, the design acceptance criteria are applied to the piping design area. The combined license (COL) applicant is to evaluate the HRHF response spectra (COL 3.7B(1)).~~

3.7B.7.4 Safety-Related Electrical Equipment

Safety-related electrical equipment was evaluated for the effect of high frequency input motion for safety of the plant. Representative items were selected for the evaluation because they are susceptible to high frequency seismic inputs. Susceptibility to excitation caused by high frequency input depends on the presence of the following factors:

a. The local HRHF ISRS exceed the APR1400 CSDRS ISRS in the high frequency range.

b. Safety-related equipment has modes or natural frequencies in the high frequency range.

c. Safety-related components have potential failure modes involving a change of state, chatter, signal change/drift, and/or connection problems.

Equipment with modes in the range of the high frequency response excitation is expected to experience higher loads and amplifications than equipment with modes outside a high frequency range. To support this expectation and determine the effect of high frequency seismic motion on the APR1400 safety-related electrical equipment, the equipment configuration, location, stress analysis methodology, and equipment qualification testing procedures were reviewed.

The COL applicant is to evaluate the representative items listed in Table 3.7B-3 (COL 3.7B(2)).

3.7B.8 Combined License Information

~~COL 3.7B(1) The COL applicant is to evaluate the HRHF response spectra.~~

COL 3.7B(2) The COL applicant is to evaluate the representative items listed in Table 3.7B-3.