NRC staff talking points and applicant draft responses for public meeting to discuss responses to request for additional information (RAI) No. 311-8278; Questions 3.12-4, 3.12-6, 3.12-8 and 3.12-9 - RAI Response - ADAMS Accession No. ML16020A507 -

RAI 3.12-4

In regard to RAI 3.12-4, related to the design control document (DCD)'s statement in Section 3.12.5.3.3 that thermal anchor movements of 1/16" or less are excluded from the piping analysis when acceptable gaps in pipe supports allow, the applicant's response stated that gaps in pipe supports are identified on the piping drawings and provided the following acceptance criterion when the piping analysis excludes pipe restraint movements.

> If adequate gaps in the as-built pipe supports cannot be satisfied to the support drawings, either re-analysis will be performed to accept the as-built gaps or the piping supports will be re-constructed to meet the required gap.

This acceptance criterion is acceptable to the staff because it provides reasonable assurance for avoiding an unanalyzed condition. The staff though notes that when a nominal 1/16" clearance is specified on each side of the pipe in the pipe support drawing, as stated in DCD Section 3.12.6.11, and the support is erected with a maximum of 1/8" total clearance of both sides, this as-built condition is by common industry practice reconciled as acceptable. This could potentially create a situation where only a see through "passing light" clearance exist on one side for cold condition gap. Subsequently, this could create an unanalyzed condition.

The staff request the applicant to discuss how the above applicant's stated acceptance criterion for excluding 1/16" pipe restraint movements in the piping analysis will be met to satisfy the DCD 3.12.5.3.3 requirement that this can take place when acceptable gap exist in the pipe supports, since an inspection, test, analysis and acceptance criterion (ITAAC) does not exist for it.

Draft Response

In accordance with NRC Bulletin 79-14, piping system reconciliation (PSR) including supports is performed in the construction stage to verify that as-built support configuration (including the location, orientation, size, gap, etc.) is reconciled with the as-designed support configuration. Through this piping system reconciliation, the pipe support gaps are checked to ensure they are constructed in accordance with design to avoid any thermal binding. The gaps indicated in the piping support drawings can be identified during PSR if clearance of both sides exists. A related statement is included in DCD Tier 1 ITAAC for each system that an inspection of the as-built piping including supports be performed as documented in the ASME design report or data report. ASME Section III requires that design reports for all ASME Class 1, 2, and 3 piping systems demonstrating and documenting that the as-built piping system and pipe support configurations adhere to the requirements of the design specification. The inspection procedure will provide the detail on the specific acceptance criteria for uneven gaps and situations where "passing light" conditions exist. It is felt that this level of detail is not necessary to add to DCD section 3.12.5.3.3.

RAI 3.12-6

The applicant's response to RAI 3.12-5 states that:

> 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.

This statement needs clarification because the decoupling criteria recommended in SRP 3.7.2 and SRP 3.12, as specified in DCD Subsection 3.7.2.3.2, can be applied for decoupling branch piping with known geometry.

The applicant has responded only to one of the three requests that were made in RAI 3.12-6, Request No. 3. The applicant's response shows compliance with the WRC BL 300, Ir/Ib >/= 24, decoupling criterion, which as shown in WRC BL 300 is based on engineering experience. The NRC's guidance for decoupling criteria, as stated in SRP 3.12, is presented in SRP 3.7.2 and are specified in DCD Subsection 3.7.2.3.2. These criteria provide protection against resonance and, therefore, are preferred over the WRC BL 300 criterion for known branch sizes and geometry. The applicant is requested to fully respond to all three requests that were made in RAI 3.12-6.

Draft Response

1. The response does 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.
   The correct statement is as follows:
   > "Since the branch piping geometry is **unknown**, the decoupling criteria specified in DCD Subsection 3.7.2.3.2 cannot be applied to the piping systems."

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 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.

RAI 3.12-8

RAI 3.12-8 was detailed and explicit in its three numbered requests for additional information. The applicant's response was general and it did not cover all three request.

The main issue in this RAI, which was described in detail, is the combined use of seismic regulatory guides (RG) 1.92 of the 1970's era and RG 1.61 of 2007. Both seismic regulatory guides RG 1.92 and RG 1.61 where issued in the 1970's and were revised in the 2000's. The applicant chose to use RG 1.92 from the 1970's era with caveats from the 2000's RG 1.92 and RG 1.61 from the 2000's era. Whenever this type of choosing and picking takes place it

creates the potential for an issue. In this case, as it was explained in the RAI, the main issue is with closely spaced modes.

By using the relaxed damping values of 4% for SSE for piping of RG 1.61 Rev 1 – 2007, the closely spaced modes defined in RG 1.92 Rev 2 of 2006 (and the following Rev 3) are considered those that are within 20% of each other. The "Grouping Method" of RG 1.92 Rev 1 – 1976, which the applicant is using, considers closely spaced modes those that are within 10% of each other and it is more suitable for the damping values for piping specified in RG 1.61 Rev 0 – 1973. As stated in the RAI, according to NRC guidance, the use of 4% damping requires to consider closely spaced modes those that are within 20% of each other and not just 10% of each other. The 10% definition for closely spaced modes, utilized in the "Grouping Method" of RG 1.92 Rev 1, is applicable only at low damping ratios of </= 2%.

In contrast, the APR 1400 DCD in Section 3.7.2.7 shows that RG 1.92 Rev 3 (2012) is utilized for the combination of modal responses and RG 1.61 Rev 1 (2007) for damping values. These regulatory guides used in DCD 3.7.2 are of comparable era, while the ones used in DCD 3.12 are not. In DCD 3.12 one regulatory guide is from 1976 and the other from 2007. This issue was addressed in RAI request # 1 for which the applicant has not provided a response.

The applicant's statement in its response that: "Since the grouping method and the definition of closely spaced modes defined in RG 1.92 Revision 1 for the piping analysis in the APR1400 are applied, the closely spaced modes defined in RG 1.92 Revision 3 relating to the critical damping value are not necessary for the combination of modal responses" is not justifiable. The staff wants to bring the applicant's attention to NUREG/CR-6645 of 1999, which made the recommendations for the changes that went to RG 1.92 R2 (with subsequent Rev 3) and SRP 3.7.2 R3 (with subsequent Rev 4). One of the NUREG/CR-6645 recommendations was that because of its extensive prior use, the RG 1.92 R1 "NRC Grouping Method" can be retained but the damping ratio should be limited to 2% because the 10% definition of closely spaced modes is not applicable at higher damping levels. The applicant though has used the RG 1.92 R1 "NRC Grouping Method," which considers closely spaced modes those that are within 10% of each other, with a damping value of 4%, which requires to consider closely spaced modes those that are within 20% of each other. By doing so modes with frequencies between 10%-20% from each other are combined by the SRSS method, which is not the correct method for 4% damping.

The applicant has not responded to all three requests that were made in RAI 3.12-8. The applicant is requested to fully respond to all three requests that were made in RAI 3.12-8.

Draft Response

1. DCD Section 3.7, "Seismic Design," describes the general methodology of the seismic design applied to all SSCs and DCD Section 3.12, "Piping Design Review," only describes the piping design methodology. In particular, DCD Section 3.12.3.2.4, "Modal Combination" defines the combining of modal responses of low-frequency modes and modes greater than the zero period acceleration (ZPA) cutoff frequency as high frequency or rigid range modes. This DCD section also describes response analysis of spatial components based on RG 1.92, R3. The piping design described in Section 3.12.3.2.4 is based on the requirements of RG 1.92 R3 since it stipulates that the analyses to address the residual rigid response of the missing mass modes are performed on the condition that the R1 methods for combining modal responses are chosen.

   RG 1.92, R3 defines the combination of periodic modal responses using the double sum ("CQC, complete quadratic combination") equation. The Rosenblueth Correlation Coefficient or Der Kiureghian Correlation Coefficient is used with closely spaced frequencies and is a function of the critical damping ratio. However, RG

1.92, R3 does not stipulate the grouping method of RG 1.92, R1 with any additional condition.

The latest RG 1.92, R3 and RG 1.61, R1 were used for the seismic analysis in the piping design. The methods of combining modal responses described in R1 were applied based on the RG 1.92, R3.

[KHNP would like to know if the RG 1.92 R1 and RG 1.61 R0 defined 2% damping for small diameter piping systems equal to or less than 12 in. and 3% damping for large diameter piping systems greater than 12 in. including the alternate damping values of ASME Code Case N-411 are acceptable for use in the piping seismic analysis.]

2. As stated in the previous response, RG 1.92, R3 allows the methods of R1, but does not stipulate the grouping method of R1 with any additional conditions. RG 1.61, R1 (2007) defines the damping value for piping systems to be 4% for SSE and approves the alternate damping values of ASME Code Case N-411, “Alternative Damping Value for Response Spectra Analysis of Class 1, 2, and 3 Piping.” The definition for closely spaced modes in the program PIPESTRESS will be confirmed by the program vendor and the effects of the closely spaced modes according to the applicable damping values will be evaluated.

3. The left-out-force method applied to PIPESTRESS is based on the Left-Out-Force (LOF) Theorem which defines a frequency, f_r, called rigid mode cutoff frequency. The response with natural frequencies above f_r resemble the applied load at each instant of time. The left-out-force vector, $\{ Fr \}$, is calculated at lower modes:

$\{ Fr \} = [1-\sum Me_j e_j^T]f(t)$
Where: f(t)= the applied load vector
M= Mass Matrix
e_j= eigenvector
Note that $\sum$ only represents the flexible modes, not including the rigid modes.

In the response spectra analysis, the total inertia force contribution of higher modes can be interpreted as follows:

$\{ Fr \} = A_m[M] [\{ r \}-\sum P_j e_j]$
Where: A_m = the maximum spectral acceleration beyond the flexible modes
[M] = the mass matrix
{ r } = the influence vector or displacement vector due to unit displacement

P_j = participation factor, where
$P_j = e_j^T [M] \{ r \}$, $\{ F_r \} = A_m [M] \{ r \} [1 - \Sigma M e_j e_j^T]$

The detailed information for the LOF method is described in the “PIPESTRESS Theory Manual.”

RAI-3.12-9

The applicant's general response to staff's RAI did not cover the two itemized RAI requests.

The response shows that the piping will be evaluated in the DCD stage for hard rock high frequency (HRHF). As noted in RAI 3.12-9 Item No. 1, the DCD currently states that the evaluation for HRHF for piping will be performed by the combined operating license (COL) applicant. The DCD applicant is requested to respond to the RAI Item No. 1 and if necessary revise the DCD appropriately.

With regard to RAI's No. 2 request, the applicant's response shows that the DCD and technical report APR1400-E-S-NR-14004-P "Evaluation of Effects of HRHF Response Spectra on SSCs" will be revised to include the HRHF evaluation of piping systems and will be completed in the second quarter of 2016. The RAI response though shows that "There is no impact on the DCD." The applicant is requested to review its response for needed corrections.

Draft Response

1. The HRHF for some Central and Eastern United States rock sites show higher amplitude at high frequency than the certified seismic design response spectra (CSDRS). 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 technical report, those additional changes will be proposed after completion of the analyses.