KHNPDCDRAIsPEm Resource

From: Ciocco, Jeff
Sent: Tuesday, October 20, 2015 2:05 PM
To: KHNPDCDRAIsPEm Resource
Subject: FW: APR1400 Design Certification Application RAI 253-8300 (03.07.01 - Seismic Design Parameters)
Attachments: APR1400 DC RAI 253 SEB1 8300.pdf

From: Ciocco, Jeff
Sent: Monday, October 19, 2015 8:34 AM
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Subject: APR1400 Design Certification Application RAI 253-8300 (03.07.01 - Seismic Design Parameters)

KHNP,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs. However, KHNP requests, and we grant, a 60 day response to the RAI. We may adjust the schedule accordingly.

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

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United States Nuclear Regulatory Commission
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REQUEST FOR ADDITIONAL INFORMATION 253-8300

Issue Date: 10/19/2015
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 03.07.01 - Seismic Design Parameters
Application Section: 3.7.1

QUESTIONS

03.07.01-5

10 CFR 50 Appendix S requires that the horizontal component of the Safe Shutdown Earthquake Ground Motion in the free field at the foundation level of the structures must be an appropriate response spectrum with a peak ground acceleration of at least 0.1g. DCD Section 3.7.1.1.1, Design Ground Motion Response Spectra, and Appendix 3.7A.2.3, Strain-Compatible Free-Field Seismic Response Motions, state that Figures 3.7A-12 and 3.7A-13 in Appendix 3.7A show that the horizontal components of the CSDRS in the free-field at the foundation level ($CSDRS_{ff}$) of all APR1400 Seismic Category I structures satisfy the Appendix S 0.1g requirement. These two figures show the envelop of the $CSDRS_{ff}$ for all nine generic soil profiles for the Nuclear Island (NI) structures, the emergency diesel generator building (EDGB), and the diesel fuel oil tank (DFOT), compared to the design time history response spectra at the ground surface, and the CSDRS scaled to 0.1g PGA. For the standard design of APR1400, the nine soil profiles S1 through S9 represent a wide range of potential sites, with fundamental site frequencies in the range from 1.27 Hz to 12.01 Hz, as shown in Table 5-21 of APR1400-E-S-NR-14001-P, Rev. 0. In order for the staff to assess whether the CSDRS in the free field at the foundation level of the NI, EDGB, and DFOT structures meets the Appendix S 0.1g requirement, the applicant is requested to provide the following additional information:

a) Plots comparing the $CSDRS_{ff}$ for each soil profile

i) Since each of the nine soil profiles can potentially be a valid COL site, these generic soil profiles should be assessed separately when comparing to the Appendix S 0.1g requirement. The use of the envelope, as shown in Figures 3.7A-12 and 3.7A-23, is not sufficient to show that all soil cases satisfy Appendix S. The staff notes that individual $CSDRS_{ff}$ are available in APR1400-E-S-NR-14001-P, Rev. 0; however, this technical report is not incorporated by reference (IBR) in the DCD, and the figures in the report do not show a direct comparison to an appropriate response spectrum with a peak ground acceleration of at least 0.1g. Therefore, the applicant is requested to supplement Figures 3.7A-12 and 3.7A-13, to show that each of the 9 $CSDRS_{ff}$ for the NI, EDGB, and DFOT structures satisfies the Appendix S 0.1g requirement.

[NOTE: In supplementing Figures 3.7A-12 and 3.7A-13, figures should be provided separately for each building; otherwise the figures would be too crowded. In addition, the curves should be rendered with different line styles/weights, in addition to different colors, to accommodate black-and-white copying.]

ii) The CSDRS are defined in DCD Section 3.7.1.1.1 as linearly interpolated on a log-log scale between the control points. The CSDRS scaled to 0.1g in Figures 3.7A-12, 3.7A-13, and 3.7A-14 are not correct because they are interpolated on a log-linear scale. Therefore, the CSDRS scaled to 0.1g should be corrected in Figures 3.7A-12 through 3.7A-14 of the DCD.

iii) Some of the labels in Figures 3.7A-12 and 3.7A-13 do not appear to be in the correct order. For example, labels for EDGB and DFOT appear to be switched in Figure 3.7A-12, and the labels for NI, EDGB, and DFOT seemingly should be EDGB, DFOT, and NI, respectively, in Figure 3.7A-13 (based on comparison to Figures 5-25 through 5-31 in APR1400-E-S-NR-14001-P, Rev. 0). In this report, Figure 5-26 appears to be exactly the same as Figure 5-25. The applicant is requested to correct these incorrect labels and figures in the DCD and report.

[NOTE: Given the mistakes cited above, all other figures and tables in the DCD and technical reports referenced in the DCD should be checked for accuracy, and any required revisions should be submitted to the staff as soon as possible, to facilitate an efficient staff review.]

b) Differences in $CSDRS_{ff}$ for Soil Profiles S6 and S7

Figures 5-25 and 5-26 of APR1400-E-S-NR-14001-P, Rev. 0 show that the $CSDRS_{ff}$ in the horizontal directions for soil profiles S6 and S7 appear to be significantly different from the other soil cases for the NI structure. Figure 5-27 shows that the $CSDRS_{ff}$ in the vertical direction for these two soil cases are also different but not as significant. The variation in the strain-compatible soil profiles among the 9 layered soil profiles are gradual, as shown in Figures 5-14 through 5-22, and as shown by the approximately linear behavior of the soil fundamental frequency on a log scale in Figure 5-24. The transfer functions shown in Figure 5-23 also indicate that amplification effect occurs at various frequency points below 50 Hz for all soil cases. It is not obvious to the staff why only $CSDRS_{ff}$ for S6 and S7 show the large dips as shown in Figures 5-25 and 5-26 and why other soil profiles for the NI structure (and all soil cases for EDGB and DFOT) do not show any dips at their fundamental frequencies. The applicant is requested to explain in detail (1) the method to calculate the $CSDRS_{ff}$ and (2) why soil cases S6 and S7 for the NI behave differently

from the remaining soil cases, and if the results presented in the technical report are not accurate, to include the corrected results for all soil cases, for all 3 structures.

03.07.01-6

DCD Table 3.7-8 includes the foundation embedment for the Nuclear Island structures (53'-8"), Emergency Diesel Generator Building (EDGB) (8'-6"), and Diesel Fuel Oil Tank (DFOT) (4'-0"). However, staff review of the associated technical reports found different values for the embedments of the same buildings. For the NI structures, other embedment values are 54', 53'-6", and 55' (APR1400-E-S-NR-14002-P, APR1400-E-S-NR-14003-P, and APR1400-E-S-NR-14005-P, respectively). For EDGB, the other value is 9' (approximate, APR1400-E-S-NR-14005-P). For DFOT, the other value is 39' (APR1400-E-S-NR-14005-P). Since the embedment value is an important parameter in seismic soil-structure interaction (SSI) analysis and structure-soil-structure interaction (SSSI) analysis to meet 10 CFR 50 Appendix S requirements, the applicant is requested to make these values consistent among the computer models, the DCD, and the referenced technical reports.

03.07.01-7

DCD Section 3.7.1.1.2 states that "V/A and AD/V^2 should be consistent with characteristic values for the magnitude and distance of appropriate controlling events defining the uniform hazard response spectra." The staff consider a check of V/A and AD/V^2 to be not appropriate for DC because the standard design is based on postulated site parameters and there are no characteristic events and other site-specific information associated with the synthetic acceleration time histories. The discussion of V/A and AD/V^2 in the SRP is intended to be used for site-specific applications. Therefore, the applicant is requested to remove the information related to the check of V/A and AD/V^2 from the APR1400 DCD and referenced technical reports (APR1400-E-S-NR-14001-P, Rev. 0 and APR1400-E-S-NR-14004-P, Rev. 1), or provide justification on why this information is included in these documents.

[NOTE: In the conference call on 08/20/2015, the applicant indicated that the CSDRS and HRHF time histories are based on seed motions (Northridge earthquake and Nahanni earthquake, respectively) and the comparison of V/A and AD/V^2 to target values is to double check the consistency between seed motions and CSDRS or HRHF time histories. However, since the seed records are modified to match the CSDRS and HRHF spectra, the earthquakes for the seed motions are not necessarily meaningful for the CSDRS and HRHF spectra.]

Provided that an adequate justification will be provided by the applicant to the question above and the description of the V/A and AD/V^2 will be maintained in the DCD and the referenced technical reports, the staff also requests that the applicant provide the following additional information to assist the staff's evaluation of the information related to V/A and AD/V^2 check:

Section 3.2.3 of APR1400-E-S-NR-14001-P, Rev. 0, Seismic Design Bases, describes the development of target and target ranges for V/A and AD/V^2, which references RG 1.60, NUREG-0003, and NUREG/CR-6728. The report indicates that the target median values are determined from NUREG-0003, which is the basis for the RG 1.60 design response spectra, while the standard deviations used to define the target ranges are based on NUREG/CR-6728 (considering both WUS sites and CEUS sites). Since the design response spectra resulted from NUREG-0003 and NUREG/CR-6728 are different, the applicant is requested to justify why the standard deviations from NUREG/CR-6728 are applicable to the response spectrum targets taken from NUREG-0003.

Since the CSDRS are not the same as RG 1.60 design response spectra, the peak values A, V, D and their ratios V/A and AD/V^2 are not necessarily the same as those for the RG 1.60 spectra. As such, the applicant is requested to justify why the target median values from NUREG-0003, which are applicable to the RG 1.60 spectra, are also applicable to the APR1400 CSDRS.

In DCD Section 3.7.1.1.2, Section 3.2.3 of APR1400-E-S-NR-14001-P, and Section 3.3.4 of APR1400-E-S-NR-14004-P, Rev. 1, Evaluation of Effects of HRHF Response Spectra on SSCs, the notations of "$m+\sigma$", "$m-\sigma$", or "$m\pm\sigma$" are used to represent the range of the variation in the target values. However, as described in Section 3.3.4 of APR1400-E-S-NR-14004-P, Rev. 1, the actual meaning of "$m+\sigma$" is $m\times\exp(\sigma)$, which indicates that σ is not standard deviation but log-standard deviation. As such, the applicant is requested to revise the notations in the DCD and the technical reports to properly reflect the mathematical meaning.

03.07.01-8

In accordance with 10 CFR 50 Appendix S, the staff reviewed the development of the nine generic soil profiles for the seismic analysis/design of the APR1400 Seismic Category I structures, which is described in Section 5, Generic Site Soil Profile, of APR1400-E-S-NR-14001-P, Rev. 0, Seismic

Design Bases. To assist the staff's evaluation of the nine generic soil profiles, the applicant is requested to provide the following additional information:

a) Definition of average shear-wave velocity

The report indicates that the nine generic soil profiles are developed based on five "average shear-wave velocity" categories; however, it does not define the term "average shear-wave velocity" and does not describe how it is calculated. To assist the staff review of the generic soil profiles, the applicant is requested to define the term "average shear-wave velocity"; explain how it is calculated for each "average shear-wave velocity" category, in the context of the nine generic soil profiles (e.g., average over depth, slowness, or other); and update the technical report as appropriate to incorporate this information.

b) Definition and application of design/extreme groundwater tables.

Section 5.1 of this report indicates that for the APR1400 standard design, the design ground water table is two feet below the ground surface (at El. 96'-8") and the extreme groundwater table is at the ground surface (at El. 98'-8"). The report does not specify how these two different water tables are used in the design/analysis of the APR1400 standard design. The applicant is requested to explain under what conditions is the design ground water table used and under what conditions is the extreme ground water table used, and to update the report as appropriate to incorporate this information.


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