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.:	**255-8285**
SRP Section:	**03.08.05 – Foundations**
Application Section:	**03.08.05**
Date of RAI Issue:	**10/19/2015**

Question No. 03.08.05-9

10 CFR 50.55a and 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of the seismic Category I structures. Standard Review Plan (SRP) Section 3.8.5.II.4.H.E, states, “Detailed explanation of how settlement is evaluated, including potential effects of static or dynamic differential settlement, dependence on time (i.e., short term vs. long term), effect of the soil type (i.e., granular vs. cohesive), and effect of the foundation type and size (e.g.,basemats, spread footings). Evaluation of the effects of settlement on construction procedures. Evaluation of the allowable settlement (total and differential) that can be accommodated in the foundation/structures.” Also, SRP Section 3.8.5.II.4.H.J, states, “Explanation of how loads attributable to construction are evaluated in the design. Some examples of items to be discussed include the excavation sequence and loads from the construction sequence of the mat foundation and walls, as well as the potential for loss of subgrade contact (e.g., because of loss of cement from a mud mat) that may lead to a differential pressure distribution on the mat.” SRP Section 3.8.5.II.4.H.K, states “An essential aspect of the design and analysis procedures for seismic Category I foundations is the stiffness modeling of the soil material under and to the sides of the structures. Soil stiffness can be represented by means of analytical or numerical (e.g., solid finite elements, distributed springs) formulations that are appropriate for the loading conditions as well as for the soil type, foundation type and size, and time scale being considered.”

In DCD Tier 2, Section 3.8.5.4.2, “Analysis of Settlement during Construction,” the applicant provided limited description as to how settlement is evaluated. In the applicant’s technical report (TR) APR1400-ES-NR-14006-P, Rev 1, “Stability Check for NI Common Basemat,” the applicant describes the evaluation of the settlement of the NI basemat; however, Section 3.8.5.4 of the DCD does not reference the report. Furthermore, it is not clear to the staff how the criteria in SRP 3.8.5.II.4 E, J, and K are implemented.

Therefore, the applicant is requested to describe the design and analysis procedures to explain how the elements described in SRP 3.8.5.II.4 E, J and K are incorporated in APR14000 design, and include this information in DCD Section 3.8.5.

Response – (Rev. 1)

According to SRP Section 3.8.5.II.4.E, the settlement was evaluated as follows:

(1) Effects of static and dynamic differential settlement

The detailed explanation of the analysis procedure is discussed in RAI 255-8285, Question 03.08.05-7.

(2) Short term and long term

Short term settlement is evaluated as a construction sequence analysis limited to the NI common basemat. The considered sequence was based on the concrete pouring sequence with the basemat. The analysis result is summarized in Technical Report "APR1400-ES-NR-14006-P, Rev 1", Table 5-3. In addition, the differential settlement under the loads (Dead + Live) in the as-built status were checked.
The detailed construction sequence analysis with superstructure is contained in RAI 255-8285, Question 03.08.05-7. A detailed explanation regarding long term settlement is contained in RAI 255-8285, Question 03.08.05-18.

For the case of a settlement monitoring program throughout construction, the COL applicant will be able to modify the construction sequences of adjacent buildings to conform to the site's settlement characteristics and minimize differential settlement. Accordingly, the COL item (COL 3.8(8)) will be changed as shown in the attachment to this response to incorporate differential settlement related to angular distortion and tilt. In the attachment, the criteria of angular distortion will be limited to 1/750 in accordance with EM-1110-1-1904, Engineering and Design Settlement Analysis, US Army Corps of Engineers. In the case of tilt induced by differential settlement, it is conservatively calculated as the criteria of differential settlement [0.5 in per 50ft (0.5/50=1/1200)].

(3) Effect of soil type

Three generic site soil profiles (S1: Soft, S4: Medium, S8: Hard) are used to consider the effects of soil conditions on settlement. The selected profiles have been chosen to be a representative sample.

(4) Effect of foundation type and size

In order to represent soil stiffness, the compression-only soil spring to each direction (X, Y, Z) on basemat nodes is considered. The subgrade modulus used in spring stiffness was calculated using the method described in Technical Report APR1400-E-S-NR-14006-P/NP, Rev.1, Subsection 2.3. To achieve the subgrade modulus used in the soil spring, the 3D FE foundation model was considered and applied to unit pressure. The size of these foundation media model with uniform soil stiffness in each layer throughout the soil is enough to capture the shape of deformed soil.

According to SRP Section 3.8.5.II.4.G, the evaluation of stiff and soft spots should be considered in basemat analysis. The stiff and soft spots are not predictable before the site survey or site excavation for a specific site. So, if these are found during excavation, the COL applicant shall perform basemat analysis considering stiff and soft spots (RAI 255-8285 Question 03.08.05-7, COL item,COL 3.8(12)).

According to SRP Section 3.8.5.II.4.J, the evaluation of settlement during the construction sequence of superstructures will be performed and reflected in the design as described in RAI 255-8285 Question 03.08.05-7. If the actual soil status and loss of cement from mud mat is expected after the site survey or site excavation, the site-specific evaluation is performed by COL applicant as shown RAI 255-8285 03.08.05-7, COL item (COL 3.8 (12)).

According to SRP Section 3.8.5.II.4.K, the two soil stiffness parameters are applied to the NI common basemat analysis corresponding to which loads are considered. In the stability evaluation (Settlement, Bearing Capacity) under static loading cases and load combination (LC01~07) for member forces, the soil springs that posses the subgrade moduli are used to represent soil. Each vertical subgrade modulus on the bottom of the NI common basemat considers the vertical variation of soil. For the load combination included in the seismic load for member forces, the foundation media are used to represent soil. The foundation media model's properties are applied to dynamic elastic modulus calculated from strain-compatible shear wave velocity used in the SASSI analysis in order to keep consistent with the magnitude of soil strains. A detailed explanation of applied soil stiffness is contained in the attachment to RAI 255-8285 Question 03.08.05-8.

Impact on DCD

DCD Tier 2, Table 1.8-2, Subsection 3.8.5.7 and 3.8.6 will be revised as indicated in the attachment associated with this response.

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.

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Table 1.8-2 (5 of 29)

Item No.	Description
COL 3.8(7)	The COL applicant is to confirm that uneven settlement due to construction sequence of the NI basemat falls within the values specified in Table 2.0-1.
COL 3.8(8)	~~The COL applicant is to provide the necessary measures for foundation settlement monitoring considering site-specific conditions.~~
COL 3.8(9)	The COL applicant is to provide testing and inservice inspection program to examine inaccessible areas of the concrete structure for degradation and to monitor groundwater chemistry.
COL 3.8(10)	The COL application is to provide the following soil information for APR1400 site: 1) Elastic shear modulus and Poisson's ratio of the subsurface soil layers, 2) Consolidation properties including data from one-dimensional consolidation tests (initial void ratio, Cc, Ccr, OCR, and complete e-log p curves) and time-versus-consolidation plots, 3) Moisture content, Atterberg limits, grain size analyses, and soil classification, 4) Construction sequence and loading history, and 5) Excavation and dewatering programs.
COL 3.9(1)	The COL applicant is to provide the inspection results for the APR1400 reactor internals classified as non-prototype Category I in accordance with RG 1.20.
COL 3.9(2)	The COL applicant is to provide a summary of the maximum total stress, deformation, and cumulative usage factor values for each of the component operating conditions for ASME Code Class 1 components except for ASME Code Class 1 nine major components. For those values that differ from the allowable limits by less than 10 percent, the contribution of each loading category (e.g., seismic, deadweight, pressure, and thermal) to the total stress is provided for each maximum stress value identified in this range. The COL applicant is to also provide a summary of the maximum total stress and deformation values for each of the component operating conditions for Class 2 and 3 components required to shut down the reactor or mitigate consequences of a postulated piping failure without offsite power (with identification of those values that differ from the allowable limits by less than 10 percent).
COL 3.9(3)	The COL applicant is to identify the site-specific active pumps.
COL 3.9(4)	The COL applicant is to confirm the type of testing and frequency of site-specific pumps subject to IST in accordance with the ASME Code.
COL 3.9(5)	The COL applicant is to confirm the type of testing and frequency of site-specific valves subject to IST in accordance with the ASME Code.
COL 3.9(6)	The COL applicant is to provide a table listing all safety-related components that use snubbers in their support systems.

Replace by the contents described in page 4 of Attachment.

~~COL 3.8 (11) The COL applicant is to perform a foundation evaluation including stiff and soft spots using the methodology described in DCD Tier 2, Section 3.8.5.4.~~

~~COL. 3.8 (12) The COL applicant is to evaluate the loss of subgrade contact due to loss of cement from the mud mat using site specific data and the methodology described in DCD Tier 2, Section 3.8.5.4.~~

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The sliding resistance is based on the friction force developed between the basemat and the foundation with a coefficient of friction of 0.7 calculated with an internal friction angle of 35 degrees in the soil below the basemat. Resistance force due to passive soil pressure is not included in F_s. Therefore, active and overburden soil pressures are also not considered.

3.8.5.5.3 Flotation Acceptance Criteria

The factor of safety against flotation is identified as the ratio of the total dead load of the structure including basemat (D_r) to the buoyant force (F_b). Therefore, $FS_f = D_r / F_b$, not less than the factor of safety determined from Table 3.8-10.

Where:

FS_f = structure factor of safety against flotation caused by the maximum design basis flood or groundwater table

D_r = total dead load of the structure including basemat

F_b = buoyant force caused by the design basis flood or high groundwater table, whichever is greater

3.8.5.6 Material, Quality Control, and Special Construction Techniques

The materials, quality control, and special construction techniques for foundations conform with those set forth for the superstructures as discussed in Subsections 3.8.1.6 and 3.8.4.6 and Appendix 3.8A.

The COL applicant is to confirm that uneven settlement due to construction sequence of the NI basemat falls in the values specified in Table 2.0-1 (COL 3.8(7)).

3.8.5.7 Testing and Inservice Inspection Requirements

Testing and inservice surveillance of the basemat are performed in accordance with the requirements described in Subsections 3.8.1.7 and 3.8.4.7.

~~The COL applicant is to provide the necessary measures for foundation settlement monitoring considering site specific conditions (COL 3.8(8))~~.

Replace by the contents described in page 4 of Attachment.

RAI 255-8285 - Question 03.08.05-9_Rev.1

COL 3.8(7) The COL applicant is to confirm that uneven settlement due to construction sequence of the NI basemat falls within the values specified in Table 2.0-1.

Replace by the contents described in page 4 of Attachment.

COL 3.8(8) ~~The COL applicant is to provide the necessary measures for foundation settlement monitoring considering site-specific conditions.~~

COL 3.8(9) The COL applicant is to provide testing and inservice inspection program to examine inaccessible areas of the concrete structure for degradation and to monitor groundwater chemistry.

COL 3.8.(10) The COL applicant is to provide the following soil information for the APR1400 site: 1) elastic shear modulus and Poisson's ratio of the subsurface soil layers, 2) consolidation properties including data from one-dimensional consolidation tests (initial void ratio, Cc, Ccr, OCR, and complete e-log p curves) and time-versus-consolidation plots, 3) moisture content, Atterberg limits, grain size analyses, and soil classification, 4) construction sequence and loading history, and 5) excavation and dewatering programs.

~~COL.3.8 (11) The COL applicant is to perform a foundation evaluation including stiff and soft spots using the methodology described in DCD Tier 2, Section 3.8.5.4.~~

~~COL. 3.8 (12) The COL applicant is to evaluate the loss of subgrade contact due to loss of cement from the mud mat using site specific data and the methodology described in DCD Tier 2, Section 3.8.5.4.~~

3.8.7 References

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission.

2. ASME Section III, Subsection NE, "Class MC Components," The American Society of Mechanical Engineers, the 2007 Edition with the 2008 Addenda.

3. ASME Section III, Division 2, "Code for Concrete Containments," Subsection CC, American Society of Mechanical Engineers, 2001 Edition with 2003 Addenda.

4. Regulatory Guide 1.35, "Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containment," Rev. 3, U.S. Nuclear Regulatory Commission, July 1990.

5. Regulatory Guide 1.35.1, "Determining Prestressing Forces for Inspection of Prestressed Concrete Containments," U.S. Nuclear Regulatory Commission, July 1990.

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The COL applicant is to provide a site-specific monitoring program and to monitor differential settlement, tilt, and angular distortion are bounded by following values during construction and plant operation.
Allowable differential settlement associated with tilt: 1/1200
Allowable differential settlement associated with angular distortion: 1/750

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Question No. 03.08.05-13

10 CFR 50.55a and Appendix A to 10 CFR Part 50, General Design Criteria 1, 2, 4, 16 and 50, provide the regulatory requirements for the design of the containment internal structures. Standard Review Plan (SRP) 3.8.5, Section II specifies analysis and design procedures applicable to the foundation of seismic Category I structures.

Technical Report (TR) APR1400-E-S-NR-14006-P, Rev 1, “Stability Check for NI Common Basemat,” Section 3.2.6, “Load Combinations,” states that, “The division of the basemat by code jurisdiction at the thickness transition is a logical choice, and the boundary of the code jurisdiction is conservatively designed using the greater forces from the analysis results of ASME and ACI codes.” It is not clear to the staff as to how the applicant consider the loads and load combinations for the basemat of the containment and the Auxiliary building (AB), and how the applicant design the transition region. For example, it is not clear whether the division of the basemat code jurisdiction at the thickness transition is in accordance with the ASME Code Interpretation: 111-2-83-01, which covers this design configuration and how do they define the transition region. Per 10 CFR 50.55a; Appendix A to 10 CFR Part 50, General Design Criteria 1, 2, 4, 16 and 50; and SRP 3.8.5, the applicant is requested to describe in more detail how the loads and load combinations for the basemat of the containment and the AB, were considered in the analysis and how the transition region is design.

Response – (Rev. 1)

Load combinations and load factors for the RCB and the AB basemats are selected based on their relevant design codes, ASME and ACI respectively. The boundary of code jurisdiction between the ASME code and the ACI code is shown in Figure 1. The details of the code jurisdiction boundary are presented in the response to RAI 199-8223, Question 03.08.01-11.

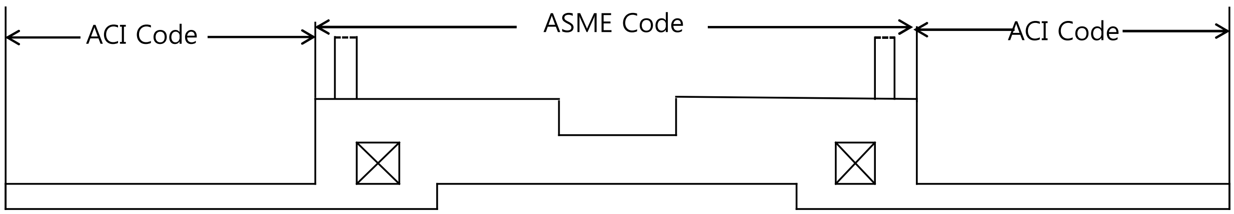

Figure 1 Jurisdictional Boundary for Design of Common Basemat

For the RCB basemat, the 5 loading combinations (test, normal, severe, abnormal, and abnormal/extreme environmental) are selected as the critical loading combinations in the analysis of the NI basemat. Table1 shows the selected load combinations and applicable load factors for anlaysis.

As shown in Table 1, the loads, except for loads G, To, Ta, W, Ro, Ra, Yj, Ym and Pv, are considered in the basemat analysis. The polar crane load includes the self-weight and lifted loads in the basemat analysis.

- Valve actuation load (G), due to POSRV discharge, is a short transient pressure in expansion and collapse of the air bubble. The load from the spargers is locally applied in the IRWST. The load does not effect on the global behavior of the basemat. Based on the explanation above, this load was not considered in the basemat analysis.

- According to ACI 349 thermal gradients less than approximately 100°F need not be analyzed because such gradients will not cause significant stress in the reinforcement or strength deterioration. The effects of the temperature load in the basemat are negligible and not considered in the basemat analysis because the temperature gradient is approximately 50°F.

- Wind (W) and tornado (Wt) loads are not considered. From the loading conditions, wind and tornado loads are not considered simultaneously with the seismic load. A comparison of the loads shows the seismic load is larger than the wind and tornado loads.

- The reactions of piping, cable trays (Ro, Ra), jet impingment load (Yj), and missile impact load (Ym) are considered in local analyses.

- The external pressure load (Pv) in the normal loading condition is negligible compared with the accident pressure (Pa) in the abnormal loading condition. So, it does not effect on global behavior of the basemat.

- In Table 1, as mentioned in the response to RAI 129-8085, Question 03.08.01-1 Rev.1, the terminology of “Severe Accident” was changed to “Combustible Gas Control inside Containment”. This combustible gas load associated with hydrogen generation caused by the reaction between the fuel cladding and the water coolant is not considered in the basemat analysis and design. Regulatory Guide 1.216 classifies the combustible gas load as the internal pressure loading above design-basis pressure and requires that the concrete containment should meet the Factored Load Category requirements of ASME Section III Div.2 CC-3720, which is related to allowable strain of the liner plate, for integrity of containment. Therefore, the combustible gas load due to hydrogen generation is only considered in the structural integrity assessment based on deterministic design basis analysis, and is not considered in the determination of structural member forces for design. In addition, the evaluation of the combustible gas load is executed under pressure boundary conditions in accordance with ASME CC Code. Note that in the case of auxiliary building design (which does not follow ASME CC), the evaluation of combustible gas load is not necessary for the auxiliary basemat. Therefore, the basemat, which is classified as a ACI Code boundary (see Figure 1), is not included in Table 2.

For the AB basemat, the 4 loading combinations (test, normal, abnormal, and abnormal/extreme environmental) are selected as the critical loading combinations in the analysis of the NI basemat. Table 2 shows the selected load combinations and applicable load factors for the anlaysis. For a detailed description related to the construction sequence load combination, refer to RAI 255-8285 Question 03.08.05-7.

As shown in Table 2, the loads, except for loads Ra, To, Po, Mo, Pa, Ta and Ma, are considered in the basemat analysis. Because these load are considered in local analysis. For the crane and trolley loads, the self-weight of the fuel handling overhead crane is considered in the basemat analysis. Additionally, Tables 1 and 2 (new additions), and the load combination Table used for NI common basemat analysis, will be revised in Technical Report APR1400-E-S-NR-14006-P/NP, as shown in the attachment.

For the design of the basemat, at the interface between the ASME and ACI codes, the lager amount of reinforcement required by either code was used.

Table 1 Selected Loading Conditions of Superstructures for Basmat Analysis (RCB)

Loading Condition	D	L	F	Pt	G	Pa	Tt	To	Ta	Es	W	Wt	Ro	Ra	Yr	Yj	Ym	Yf	H	Hs	Pv	Ha	Ps	Analysis
Test	1.0	1.0	1.0	1.0	-	-	(1.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	yes
Construction	1.0	1.0	1.0	-	-	-	-	1.0	-	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-	no(①)
Normal	1.0	1.0	1.0	-	(1.0)	-	-	(1.0)	-	-	-	-	(1.0)	-	-	-	-	-	-	-	(1.0)	-	-	yes
Severe Environmental	1.0	1.3	1.0	-	(1.0)	-	-	(1.0)	-	-	(1.5)	-	(1.0)	-	-	-	-	-	-	-	(1.0)	-	-	yes
	1.0	1.3	1.0	-	1.0	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	1.5	-	1.0	-	-	no(②)
Extreme Environmental	1.0	1.0	1.0	-	1.0	-	-	1.0	-	1.0	-	-	1.0	-	-	-	-	-	-	-	1.0	-	-	no(③)
	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	-	1.0	1.0	-	-	-	-	-	-	-	1.0	-	-	no(④)
	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	-	1.0	1.0	-	-	no(⑤)
Abnormal	1.0	1.0	1.0	-	(1.0)	1.5	-	-	(1.0)	-	-	-	-	(1.0)	-	-	-	-	-	-	-	-	-	yes
	1.0	1.0	1.0	-	1.0	1.0	-	-	1.0	-	-	-	-	1.25	-	-	-	-	-	-	-	-	-	no(⑥)
	1.0	1.0	1.0	-	1.25	1.25	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	no(⑦)
Abnormal/Severe Environmental	1.0	1.0	1.0	-	1.0	1.25	-	-	1.0	-	1.25	-	-	1.0	-	-	-	-	-	-	-	-	-	no(⑧)
	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-	no(⑨)
	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	1.0	-	-	-	-	-	-	-	-	-	-	1.0	-	no(⑩)
Abnormal/Extreme Environmental	1.0	1.0	1.0	-	(1.0)	1.0	-	-	(1.0)	1.0	-	-	-	(1.0)	1.0	(1.0)	(1.0)	-	-	-	-	-	-	yes
Combustible Gas Control inside Containment	1.0	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	no(⑪)

* ( ) : not considered in basemat analysis. * yellow column : considered load combination in basemat analysis.

① - Effect on the basemat due to wind is less than that of Pt, and To is negligible

② - H is not considered to be critical for the basemat (Containment building roof could not contain any rainwater.)

③, ④, ⑤ - Abnormal/ Extreme Environmental combination is more limiting than these combinations.

⑥ - 0.25 x Ra is less critical than 0.5 x Pa for the basemat

⑦, ⑧ - 0.25 x G and 1.25W are less critical than 0.25 x Pa for the basemat

⑨, ⑩ - 1.0 x W is less critical than 1.5 x Pa for the basemat

⑪ - Beyond design load combination : Combustible gas load due to hydrogen generation is classified as the internal pressure loading above design-basis pressure in accordance with RG 1.216 and is only considered in the structural integrity assessment based on the deterministic design basis analysis, not considered in the determination of structural member forces for design.

Table 2 Selected Loading Conditions of Superstructures for Basemat Analysis (AB)

Loading Condition	Normal									Severe		Abnormal					Extreme			Analysis
	D	D_d	L	L_h	T_o	R_o	C	P_o	M_o	W	H	P_a	T_a	R_a	Y	M_a	E_s	W_t	H_s	
Construction	1.1	-	1.3	1.1	-	1.1	1.3	-	1.3	1.6	-	-	-	-	-	-	-	-	-	no(①)
	-	0.9	-	1.1	-	-	1.3	-	1.3	1.6	-	-	-	-	-	-	-	-	-	no(②)
Test	1.1	-	1.3	1.1	(1.3)	(1.1)	1.3	(1.3)	(1.3)	-	-	-	-	-	-	-	-	-	-	yes
Normal	1.4	-	1.7	1.4	(1.3)	(1.4)	1.7	(1.7)	(1.7)	-	-	-	-	-	-	-	-	-	-	yes
Severe Environmental	1.4	-	1.7	1.4	1.3	1.4	1.7	1.7	1.7	1.7	-	-	-	-	-	-	-	-	-	no(③)
	1.2	-	-	1.4	1.3	1.2	1.7	1.7	1.7	1.7	-	-	-	-	-	-	-	-	-	no(④)
	1.4	-	1.7	1.4	1.3	1.4	1.7	1.7	1.7	-	1.7	-	-	-	-	-	-	-	-	no(⑤)
	1.2	-	-	1.4	1.3	1.2	1.7	1.7	1.7	-	1.7	-	-	-	-	-	-	-	-	no(⑥)
Abnormal	1.0	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-	-	1.0	-	-	-	no(⑦)
	1.0	-	1.0	1.0	-	-	1.0	-	(1.0)	-	-	(1.4)	(1.0)	(1.0)	-	-	-	-	-	yes
Extreme Environmental	1.0	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-	-	-	1.0	-	-	no(⑧)
	1.0	-	1.0	1.0	1.0	1.0	-	1.0	1.0	-	-	-	-	-	-	-	-	1.0	-	no(⑨)
	1.0	-	1.0	1.0	1.0	1.0	-	1.0	1.0	-	-	-	-	-	-	-	-	-	1.0	no(⑩)
Abnormal / Extreme Environmental	1.0	-	1.0	1.0	-	-	1.0	-	(1.0)	-	-	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	1.0	-	-	Yes

* ( ) : not considered in basemat analysis. * yellow column : considered load combination in basemat analysis.

①, ② - Governed by the severe environmental load combination

③ - It is the same as Normal loading condition except wind load which is not critical in basemat design.

④ - Governed by the severe environmental load combination

⑤, ⑥ - H is not considered critical for the basemat

⑦, ⑧, ⑨, ⑩ - Abnormal/Extreme Environmental combination is more critical than these combinations

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

Technical Report APR1400-E-S-NR-14006-P/NP, Rev.1 Tables 1 through 3 will be revised, as indicated in Attachment to this response.

RAI 255-8285 - Question 03.08.05-13_Rev.1

Table 1. Selected Loading Conditions of Superstructure for Basemat analysis (RCB)

Loading Condition	D	L	F	Pt	G	Pa	Tt	To	Ta	Es	W	Wt	Ro	Ra	Yr	Yj	Ym	Yf	H	Hs	Pv	Ha	Ps	Analysis
Test	1.0	1.0	1.0	1.0	-	-	(1.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	yes
Construction	1.0	1.0	1.0	-	-	-	-	1.0	-	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-	no(①)
Normal	1.0	1.0	1.0	-	(1.0)	-	-	(1.0)	-	-	-	-	(1.0)	-	-	-	-	-	-	-	(1.0)	-	-	yes
Severe Environmental	1.0	1.3	1.0	-	(1.0)	-	-	(1.0)	-	-	(1.5)	-	(1.0)	-	-	-	-	-	-	-	(1.0)	-	-	yes
	1.0	1.3	1.0	-	1.0	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	1.5	-	1.0	-	-	no(②)
Extreme Environmental	1.0	1.0	1.0	-	1.0	-	-	1.0	-	1.0	-	-	1.0	-	-	-	-	-	-	-	1.0	-	-	no(③)
	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	-	1.0	1.0	-	-	-	-	-	-	-	1.0	-	-	no(④)
	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	-	1.0	1.0	-	-	no(⑤)
Abnormal	1.0	1.0	1.0	-	(1.0)	1.5	-	-	(1.0)	-	-	-	-	(1.0)	-	-	-	-	-	-	-	-	-	yes
	1.0	1.0	1.0	-	1.0	1.0	-	-	1.0	-	-	-	-	1.25	-	-	-	-	-	-	-	-	-	no(⑥)
	1.0	1.0	1.0	-	1.25	1.25	-	-	1.0	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	no(⑦)
Abnormal/Severe Environmental	1.0	1.0	1.0	-	1.0	1.25	-	-	1.0	-	1.25	-	-	1.0	-	-	-	-	-	-	-	-	-	no(⑧)
	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-	no(⑨)
	1.0	1.0	1.0	-	1.0	-	-	1.0	-	-	1.0	-	-	-	-	-	-	-	-	-	-	1.0	-	no(⑩)
Abnormal/Extreme Environmental	1.0	1.0	1.0	-	(1.0)	1.0	-	-	(1.0)	1.0	-	-	-	(1.0)	1.0	(1.0)	(1.0)	-	-	-	-	-	-	yes
Combustible Gas Control inside Containment	1.0	-	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	no(⑪)

* ( ) : load not considered in basemat analysis. * yellow column : considered load combination in basemat analysis.

① - Effect on the basemat due to wind is less than that of Pt, and To is negligible

② - H is not considered to be critical for the basemat (Containment building roof could not contain any rainwater.)

③, ④, ⑤ - Abnormal/ Extreme Environmental combination is more limiting than these combinations.

⑥ - 0.25 x Ra is less critical than 0.5 x Pa for the basemat

⑦, ⑧ - 0.25 x G and 1.25W are less critical than 0.25 x Pa for the basemat

⑨, ⑩ - 1.0 x W is less critical than 1.5 x Pa for the basemat

⑪ - Beyond design load combination : Combustible gas load due to hydrogen generation is classified as the internal pressure loading above design-basis pressure in accordance with RG 1.216 and is only considered in the structural integrity assessment based on the deterministic design basis analysis, not considered in the determination of structural member forces for design.

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Table 2 Selected Loading Conditions of Superstructures for Basemat Analsysi (RCB)

Loading Condition	Normal									Severe		Abnormal					Extreme			Analysis
	D	D_d	L	L_h	T_o	R_o	C	P_o	M_o	W	H	P_a	T_a	R_a	Y	M_a	E_s	W_t	H_s	
Construction	1.1	-	1.3	1.1	-	1.1	1.3	-	1.3	1.6	-	-	-	-	-	-	-	-	-	no(①)
	-	0.9	-	1.1	-	-	1.3	-	1.3	1.6	-	-	-	-	-	-	-	-	-	no(②)
Test	1.1	-	1.3	1.1	(1.3)	(1.1)	1.3	(1.3)	(1.3)	-	-	-	-	-	-	-	-	-	-	yes
Normal	1.4	-	1.7	1.4	(1.3)	(1.4)	1.7	(1.7)	(1.7)	-	-	-	-	-	-	-	-	-	-	yes
Severe Environmental	1.4	-	1.7	1.4	1.3	1.4	1.7	1.7	1.7	1.7	-	-	-	-	-	-	-	-	-	no(③)
	1.2	-	-	1.4	1.3	1.2	1.7	1.7	1.7	1.7	-	-	-	-	-	-	-	-	-	no(④)
	1.4	-	1.7	1.4	1.3	1.4	1.7	1.7	1.7	-	1.7	-	-	-	-	-	-	-	-	no(⑤)
	1.2	-	-	1.4	1.3	1.2	1.7	1.7	1.7	-	1.7	-	-	-	-	-	-	-	-	no(⑥)
Abnormal	1.0	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-	-	1.0	-	-	-	no(⑦)
	1.0	-	1.0	1.0	-	-	1.0	-	(1.0)	-	-	(1.4)	(1.0)	(1.0)	-	-	-	-	-	yes
Extreme Environmental	1.0	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-	-	-	-	-	-	-	1.0	-	-	no(⑧)
	1.0	-	1.0	1.0	1.0	1.0	-	1.0	1.0	-	-	-	-	-	-	-	-	1.0	-	no(⑨)
	1.0	-	1.0	1.0	1.0	1.0	-	1.0	1.0	-	-	-	-	-	-	-	-	-	1.0	no(⑩)
Abnormal / Extreme Environmental	1.0	-	1.0	1.0	-	-	1.0	-	(1.0)	-	-	(1.0)	(1.0)	(1.0)	(1.0)	(1.0)	1.0	-	-	Yes

* ( ) : load not considered in basemat analysis. * yellow column : considered load combination in basemat analysis.

①, ② - Governed by the severe environmental load combination

③ - It is the same as Normal loading condition except wind load which is not critical in basemat design.

④ - Governed by the severe environmental load combination

⑤, ⑥ - H is not considered critical for the basemat

⑦, ⑧, ⑨, ⑩ - Abnormal/Extreme Environmental combination is more critical than these combinations

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Table 3 Load Combination for NI Common Basemat Analysis

Condition	Load Case	Load Combination	Remark	Reference
Test	LC01	$1.0D+1.0L+1.0L_1+1.0F+1.0P_t$	For RCB basemat design	DCD Table 3.8-2
Normal	LC02	$1.0D+1.0L+1.0L_1+1.0F$		
Severe	LC03	$1.0D+1.3L+1.3L_1+1.0F$		
Abnormal	LC04	1.0D+1.0L+1.0L1+1.0F+1.5Pa		
Test	LC05	$1.1D+1.3L+1.1L_1+1.0F+1.0P_t$	For AB basemat design	DCD Table 3.8-9A
Normal	LC06	$1.4D+1.7L+1.4L_1+1.0F$		
Abnormal	LC07	1.0D+1.0L+1.0L1+1.0F+1.4Pa		
Abnormal /Extreme	LC08	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es01+Lg_d	For RCB & AB Basemat design	DCD Table 3.8-2, 3.8-9A
	LC09	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es02+Lg_d		
	LC10	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es03+Lg_d		
	LC11	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es04+Lg_d		
	LC12	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es05+Lg_d		
	LC13	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es06+Lg_d		
	LC14	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es07+Lg_d		
	LC15	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es08+Lg_d		
	LC16	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es09+Lg_d		
	LC17	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es10+Lg_d		
	LC18	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es11+Lg_d		
	LC19	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es12+Lg_d		
	LC20	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es13+Lg_d		
	LC21	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es14+Lg_d		
	LC22	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es15+Lg_d		
	LC23	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es16+Lg_d		
	LC24	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es17+Lg_d		
	LC25	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es18+Lg_d		

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	LC26	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es19+Lg_d		
	LC27	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es20+Lg_d		
	LC28	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es21+Lg_d		
	LC29	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es22+Lg_d		
	LC30	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es23+Lg_d		
	LC31	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es24+Lg_d		
	LC32	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es25+Lg_d		
	LC33	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es26+Lg_d		
	LC34	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es27+Lg_d		
	LC35	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es28+Lg_d		
	LC36	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es29+Lg_d		
	LC37	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es30+Lg_d		
	LC38	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es31+Lg_d		
	LC39	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es32+Lg_d		
	LC40	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es33+Lg_d		
	LC41	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es34+Lg_d		
	LC42	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es35+Lg_d		
	LC43	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es36+Lg_d		
	LC44	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es37+Lg_d		
	LC45	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es38+Lg_d		
	LC46	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es39+Lg_d		
	LC47	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es40+Lg_d		
	LC48	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es41+Lg_d		
	LC49	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es42+Lg_d		
	LC50	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es43+Lg_d		
	LC51	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es44+Lg_d		
	LC52	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es45+Lg_d		

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	LC53	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es46+Lg_d		
	LC54	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es47+Lg_d		
	LC55	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es48+Lg_d		
	LC56	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es49+Lg_d		
	LC57	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es50+Lg_d		
	LC58	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es51+Lg_d		
	LC59	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es52+Lg_d		
	LC60	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es53+Lg_d		
	LC61	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es54+Lg_d		
	LC62	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es55+Lg_d		
	LC63	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es56+Lg_d		
	LC64	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es57+Lg_d		
	LC65	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es58+Lg_d		
	LC66	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es59+Lg_d		
	LC67	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es60+Lg_d		
	LC68	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es61+Lg_d		
	LC69	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es62+Lg_d		
	LC70	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es63+Lg_d		
	LC71	$1.0D+1.0L+1.0L_1+1.0F+1.0P_a+1.0Y_r$ +1.0Es64+Lg_d		

Where:

D = Dead load (Including Hydrostatic load) from RCB and AB
L = Live load (Including Static Earth Pressure) from RCB and AB
F = Post-tension load of tendon embedded RCB shell and dome
Pa = Design internal pressure of RCB shell and dome
Pt = Internal pressure of RCB shell and dome at testing phase
Yr = Pipe break load
E_s = Seismic load (Including 5% Torision) from RCB and AB
L_{g_d} = Dynamic Earth Pressure
L_1 = Buoyance load