APR1400
Feedback on Draft Response to RAI 255-8285, Question 03.08.05-13
Prepared August 3, 2016
Updated with NRC Feedback September 7, 2016

The response is acceptable except for addressing the items below.

Item (1)
The response correctly states that the severe accident load is not considered for the basemat analysis and design, and the severe accident was changed to combustible gas control inside containment. However, the last load combination in Table 1 still identifies a load combination named "Severe Accident" and added a new footnote 11 which states that this is "Beyond design load combination." Also, it identifies Ps as the load to include in this load combination; however, Ps was defined in the response to RAI Question 3.8.1-1 as the load developed from hydrogen generation due to fuel clad water interaction, not severe accident events. So this is an inconsistency that should be addressed. Also, as discussed in the past, normally severe accident evaluation is addressed as part of Section 19 of the DCD, not Section 3.8, and the hydrogen generation load combination needs to be included in Table 1 (RCB) and then combined with the appropriate load combination in Table 2 (AB) because the two structures are supported by the common basemat.

KHNP INPUT
In the table 1 of response, "Severe Accident" of loading condition column will be changed to "Combustible Gas Control inside Containment" in accordance with response to RAI Question 3.8.1-1.
The combustible gas load associated with hydrogen generation caused by the reaction between the fuel cladding and the water coolant is applied to the containment evaluation above design-basis pressure, not related to the design of containment structure.
With regard to load combination of AB structure, in accordance with RG 1.216 Position 2, for combustible gas control load, the concrete containment should meet the Factored Load Category requirements of ASME Code, Section III, Division 2, Subarticle CC-3720. This requirement is for pressure boundary structure not for other structures. Therefore, the combustible gas load is not necessary to add in the load combination of AB structure.

NRC Feedback
Regarding the above KHNP input which indicates that the hydrogen generated loads are "not related to the design of containment structure," that is not appropriate because SRP 3.8.1, which covers the design of the containment, includes hydrogen generation load combination and the containment must be designed for this load to demonstrate its structural integrity. So

this phrase should be revised. Also, see staff feedback on Footnote 11 on Item 2 below which relates to this subject.

Regarding the phrase "combustible gas load is not necessary to add in the load combination of AB structure," that is correct. However, for the containment, the basemat is part of the containment structure and for hydrogen generation load combination, the dead load needs to be considered from whatever source may affect the containment structure. Since the AB and containment structure are on the same basemat, any contribution to dead load from the AB on the containment structure should also be considered, unless otherwise justified.

Item (2)

The response states that "There is no impact on any Technical, Topical, or Environmental Report." However, the revised Tables 1 and 2 should be incorporated into the KHNP technical report APR1400-E-S-NR-14006-P, Rev. 1. Also, the load combinations in Tables 1 and 2 are not consistent with the load combinations presented in Table 3-5 of the technical report. Lastly, Table 3-5 of the technical report separates RCB load combinations from AB load combinations for Test, Normal, and Abnormal loading combinations, while providing RCB and AB (combined) load combinations for only Abnormal/Extreme. This needs to be explained or revised because all load combinations (not just Abnormal/Extreme) need to be considered for the combined RCB and AB basemat analysis, since the basemat is common and monolithic to both structures.

KHNP INPUT

The revised table 1 and 2 will be added to Technical report APR1400-E-S-NR-14006-P/NP. So, the load combination table 3-5 related with feedback item (2) is revised as shown attachment.

NRC Feedback

(a) Footnote 11 in Table 1 indicates that the combustible gas control inside containment is not considered as one of the load combinations that need to be analyzed because it is beyond design load combination. As explained in the NRC feedback under Item (1) above, this statement is not appropriate. Also, and more importantly, if this load combination is eliminated then there is no other load combination within design basis (i.e., Table 1) or beyond design basis (elsewhere in the DCD) which demonstrates the structural integrity of the containment under the hydrogen generated loads in accordance with RG 1.216. Therefore, the applicant is requested to address this item.

(b) For some of the load combinations, certain loads identified within a parenthesis are not considered for the basemat analysis; however, the basis is not provided. Some examples (but not necessarily a complete list) are – W (wind) is not included for the severe environmental load combination and Ta (temperature due to LOCA) is not included in the abnormal load combination.

(c) The revised Table 3 identifies three sets of load combinations under the remark column as (1) For RCB basemat design, (2) For AB basemat design, and (3) For RCB & AB Basemat design.

As discussed previously with the applicant, this is unclear because, for load combination sets (1) and (2) above, it suggests these load combinations are for the RCB basemat design and for the AB basemat design rather than “RCB load combinations for the RCB basemat design” and “AB load combinations for the RCB basemat design.” KHNP previously indicated that these were separated because the load factors are different between the RCB and AB, but the approach used analyzes each of the two sets separately and then combines the results. KHNP should consider revising the Remark column as indicated in the quotes above and should make it clear that the results from these two sets of load combinations are analyzed separately for the design of the RCB basemat and then the results are combined. This should be incorporated wherever these are discussed (i.e., RAI response, technical report, and DCD if applicable)

(d) Note that there are still some inconsistencies among the three tables (e.g., Table 2 does not include 1.4 X Pa, while Table 3 includes 1.4 X Pa for AB basemat design. Lastly, the revised Table 3 shows a total of 64 different load cases for abnormal/extreme load combination. This will be evaluated by the staff under RAI Question 3.8.5-12.

Attachment

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.

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

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

□, □, □ - Abnormal/ Extreme Environmental combination is more limiting than these combinations.

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

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

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

⑪ - Beyond design load combination

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

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		
	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
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