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MFN 09-387 Docket No. 52-010

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U.S. Nuclear Regulatory Commission
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Rockville, MD 20852

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 345 Related to ESBWR Design Certification Application – Site Characteristics - RAI Number 2.3-4 S06**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) responses to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC letter No. 345, dated May 28, 2009 (Reference 1).

GEH response to RAI 2.3-4 S06 is provided in Enclosure 1. Enclosure 2 provides any affected DCD Sections.

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

Reference:

1. MFN 09-367 - Letter from U.S. Nuclear Regulatory Commission to Mr. Jerald G. Head, GEH, *Request For Additional Information Letter No. 345 Related To ESBWR Design Certification Application*, dated May 28, 2009

Enclosure:

1. MFN 09-387 -Response to NRC Request for Additional Information Letter No. 345 Related to ESBWR Design Certification Application – DCD Tier 2 Chapter 2 - Site Characteristics - RAI Number 2.3-4 S06

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2. MFN 09-387 -Response to NRC Request for Additional Information Letter No. 345 Related to ESBWR Design Certification Application – DCD Tier 2 Chapter 2 – Site Characteristics - RAI Number 2.3-4 S06 DCD Markups.

cc:

AE Cubbage	USNRC (with enclosure)
JG Head	GEH/Wilmington (with enclosure)
DH Hinds	GEH/Wilmington (with enclosure)
eDRF Section	0000- 0103-2900 (RAI 2.3-4 S06)

ENCLOSURE 1

MFN 09-387

Response to NRC RAI Letter No. 345
Related to ESBWR Design Certification Application[1]

DCD Tier 2 Chapter 2 – Site Characteristics

RAI Number 2.3-4 S06

[1] Original Response, Supplement 1, Supplement 2, Supplement 3, Supplement 4 and Supplement 5 previously submitted under MFNs 06-206, 06-206 S01, 07-628, 08-076, 08-919 and 09-307 without DCD updates are included to provide historical continuity during review.

NRC RAI 2.3-4

What is the basis for the maximum rainfall rate and maximum snow load for the roof design given in DCD tier 2, Table 2.0-1? Is the maximum rainfall rate assumed to be over a period of five minutes?

GE Response

The maximum rainfall rate and maximum snow loads were taken from the Advanced Light Water Reactor Utility Requirements Document (URD), Volume III, Table 1.2-6. These values are also the same as those that were applied during design certification of the Advanced Boiling Water Reactor (ABWR).

As Indicated in the text of Table 2.0-1 for Subsection 2.3.1, the maximum rainfall rate in the URD was obtained from National Weather Service Publication HMR No. 52 using the probable maximum precipitation (PMP) for 1 hour over a 2.6×10^6 m^2 (1 sq. mile) area with a PMP ratio of 5 minutes to 1 hour of 0.32.

DCD Impact

A markup of DCD Table 2.0-1 to clarify that the URD is the source of these values was provided in MFN 06-206.

NRC RAI 2.3-4 S01

E-mail from Andrea Johnson.

Comments on response to RAI 2.3-4:

This RAI addresses the design values and bases for winter precipitation loads to be included in the combination of (1) normal live loads and (2) extreme live loads.

Tier 1 Table 5.1-1 and Tier 2 Table 2.0-1 of DCD Revision 3 state that the maximum design roof load of 2873 Pa (60 lbf/ft2) accommodates snow load and probable maximum winter precipitation as specified in ASCE 7-02 and HMR-52. The March 24, 1975 Site Analysis Branch Position on Winter Precipitation Loads (ML050470024) states that (1) winter precipitation loads to be included in the combination of normal live loads should be based on the weight of the 100-year snowpack or snowfall, whichever is greater, recorded at ground level, and (2) winter precipitation loads to be included in the combination of extreme live loads should be based on the addition of the weight of the 100-year snowpack at ground level plus the weight of the 48-hour Probable Maximum Winter Precipitation (PMWP) at ground level for the month corresponding to the selected snowpack. Modifications to this procedure are allowed for certain areas where it can be satisfactorily demonstrated that the PMWP could neither fall nor remain entirely on top of the antecedent snowpack and/or roofs.

Consequently, please update the DCD to provide the design values and bases for winter precipitation loads to be included in the combination of (1) normal live loads and (2) extreme live loads. Note that the 48-hour PMWP should be based on data presented in HMR-53.

GE Response

The roof load design bases for concrete structures is 2873 Pa (60 psf) which is multiplied by the Load Factors indicated depending on the particular combination and is combined with other loads as shown on DCD Table 3.8-15.

The rain and snow loads are described in Section 3G.1.5.2.1.2.

The live load represents a 100-year return ground snow load of 2394 Pa (50 psf) that on the roof is 60% of that based on exposure and thermal conditions (ASCE 7 Commentary). Therefore, the basic roof snow load is 1436 Pa (30 psf). The lower lip of roof scuppers is 100 mm (4 in) above the roof and assuming all primary roof drains are clogged, this added load is 996 Pa (21 psf).

The PMWP is based on the 48-hour PMWP in HMR 53 Section 6 example calculation for December, January, February and the drainage system (roof drains and scuppers independently) will be sized accordingly. Therefore, the total maximum conservative loading (rain + snowpack) would be 2442 Pa (51 psf), which is less than the design live load of 2873 Pa (60 psf).

DCD Impact

A markup of DCD Tier 2 Table 3G.1-2 to clarify that the ground snow load represents a 100-year recurrence interval was provided in MFN 06-206, Supplement 1.

NRC RAI 2.3-4 S02

In its response to supplemental RAI 2.3-4 dated May 8, 2007, the applicant stated that the roof design maximum 48-hr. winter rainfall standard plant site design parameter of 91.4 cm (36 in.) would result in an additional weight of 10 cm (4 in.) of water on the roof because the lower lip of the roof scuppers is 10 cm (4 in.) above the roof. Assuming all primary roof drains are clogged, the additional weight of water on the roof would be 996 Pa (21 psf). However, the applicant should also provide an additional roof design 48-hour probable maximum winter precipitation (PMWP) standard plant design parameter to account for the additional weight if at least part of the 48-hour PMWP falls as frozen precipitation (e.g., snow and/or ice) and therefore remains on the roof.

GEH Response

As stated in our response to NRC RAI 2.3-4 S01, total conservative loading for rain plus snowpack for the ESBWR Standard Plant is 2442 Pa (51 psf), which is less than the design live load of 2873 Pa (60 psf) at the roof. This design live load is specified in DCD Tier 2, Revision 4, Table 2.0-1 as the ESBWR Standard Plant Site Parameter of Maximum Roof Load. Thus, a margin of 431 Pa (9 psf) is provided for any additional increase in snow load as rain percolates through the snowpack and potential increase due to frozen precipitation.

Per Section 7.10 of ASCE 7-02, the rain-on-snow surcharge associated with rain percolating through a snowpack is 239 Pa (5 psf). Hence, a margin of 192 Pa (4 psf) remains to account for any frozen precipitation for the ESBWR Standard Plant.

The values for rain-on-snow surcharge and frozen precipitation are not shown individually in DCD Tier 2, Revision 4, Table 2.0-1 as ESBWR Standard Plant Site Parameters because the Maximum Roof Load of 2873 Pa (60 psf) is already specified in DCD Tier 2 Tables 2.0-1 and 3G.1-2. As required in DCD Tier 2, Revision 4, Subsection 2.0.1, Item 2.0.1-A, each COL applicant will demonstrate in their COL application how the site characteristics of 100-year snowpack plus 48-hour PMWP (including frozen precipitation) are combined to fall within the ESBWR DCD site parameter value for Maximum Roof Load.

DCD Impact

No DCD change was made in response to this RAI Supplement.

NRC RAI 2.3-4 S03

Footnote 5 to DCD Tier 2 Table 2.0-1 states that the roof scuppers and drains are designed independently to limit water accumulation on the roof to no more than 100 mm (4 in) during PMWP conditions. Please provide details of the design of the roof scuppers and drains demonstrating that an antecedent 100-year recurrence interval ground level snow pack of 2394 Pa (50 lbf/ft^2) will not clog both the roof scuppers and drains and prevent no more than 100 mm (4 in) of water accumulating on the roof.

GEH Response

In the ESBWR Standard Plant, roofs are provided with two independent drainage systems. The roof drains form the primary drainage system and the scuppers form the secondary drainage system. As required by the International Plumbing Code (invoked by IBC-2003) and ASCE 7-02, only the blockage of the primary system is postulated when designing the secondary system and for calculating the rain load on the roof.

Figures 2.3-4(1) and (2) show typical sketches of the roof drain and overflow scupper. The design of the roof scuppers and drains follows ASCE 7-02. The elevation of the overflow scupper is set such that the average water depth does not exceed 100 mm (4 in.) in case the roof drains are clogged by snow, ice, or other obstructions.

DCD Tier 2 Table 2.0-1, Note 5 and Table 3G.1-2, Note** will be clarified to state that the depth of water considered on the roof is an average depth.

DCD Impact

Markups of DCD Tier 2 Table 2.0-1, Note 5 and Table 3G.1-2, Note** were provided in MFN 08-076.

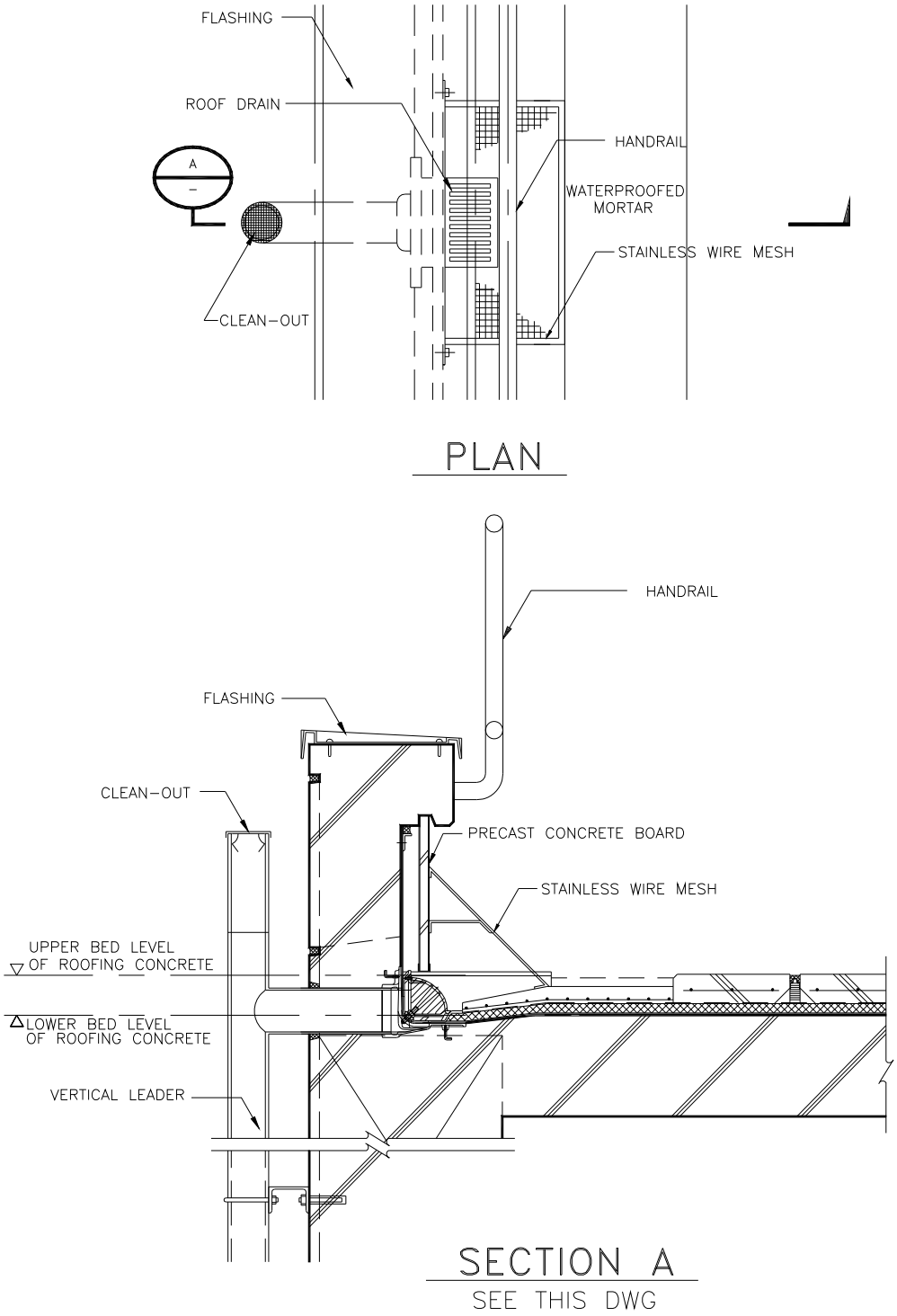

Figure 2.3-4(1) Typical Sketch of Roof Drain

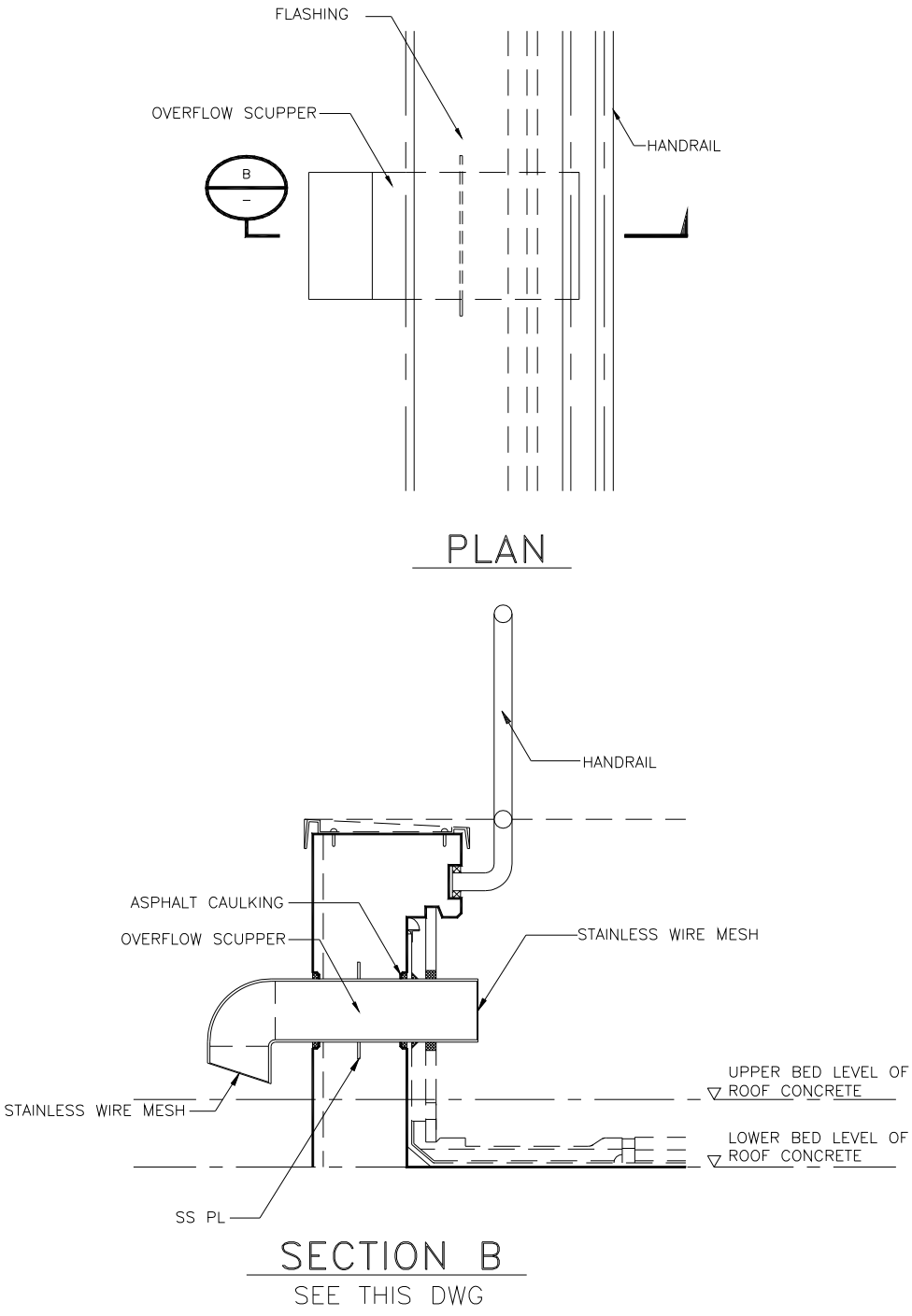

Figure 2.3-4(2) Typical Sketch of Overflow Scupper

NRC RAI 2.3-4 S04

Specify and identify the normal and extreme liquid and frozen precipitation events used in the design of the roofs of safety related structures in accordance with the Proposed Interim Staff Guidance (ISG) DC/COL-ISG-07, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures." These events should be identified as site parameters in DCD Tier 1 Table 5.1-1 and Tier 2 Table 2.0-1. Provide a basis for the chosen site parameter values, including ensuring the postulated site parameter values are representative of a reasonable number of sites that have been or may be considered for a COL application. Also describe the design and analysis method used to accommodate the resulting loads.

GEH Response

This NRC RAI addresses the normal and extreme liquid and frozen precipitation events used in the design of the roofs of safety related structures in accordance with the Proposed Interim Staff Guidance (ISG) DC/COL-ISG-07, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures."

As indicated in DCD Tier 2 Table 2.0-1, the maximum rainfall rate is based on probable maximum precipitation (PMP) for one hour over 2.6 km^2 (one square mile) with a ratio of 5 minutes to one hour PMP of 0.32 as found in National Weather Service Publication Hydrometeorology Report No. 52 (HMR-52). The maximum rainfall rate selected for design is 49.3 cm/hr (19.4 in/hr). The maximum short term rate selected is 15.7 cm (6.2 in) in 5 minutes. The roof scuppers and drains are designed independently to handle the PMP or 48-hour probable maximum winter precipitation (PMWP) with no more than an average depth of 100 mm (4 in) of water accumulation on the roof.

Normal winter precipitation event is equal to highest ground-level weight among (1) the 100-year return period snowpack, (2) the historical maximum snowpack, (3) the 100-year return period snowfall event, or (4) the historical maximum snowfall event in the site region. The normal ground snow load of 2394 Pa (50 psf) for a 100-year return period conidered in the DCD Tier 2 Table 2.0-1 envelopes all sites currently being considered for ESBWR COL applications. The corresponding roof load, p_f, is calculated to be 38.5 psf in accordance with ASCE 7-02, Equation 7-1.

$$p_f = 0.7 C_e C_t I p_g$$

where

C_e = exposure factor = 1.1 for sheltered roof in Terrain Category C

C_t = thermal factor = 1.0

I = importance factor = 1.0 for 100-year return peiord

P_g = 100-year ground snow load = 50 psf

This is the roof live load associated with normal winter precipitation event. It is less than the design live load of 2873Pa (60 psf) at the roof considered in all loading combinations for Seismic Category I structures as shown in DCD Tier 2 Tables 3.8-15 and 3.8-16.

The extreme winter precipitation roof load as defined in DC/COL-ISG-07 is the roof load due to the normal winter precipitation event plus the roof load due to the extreme winter precipitation event which is the higher roof load resulting from either the extreme frozen winter precipitation event or the extreme liquid winter precipitation event. The industry comments on this ISG (Reference 1) recommend that the bullet "An additional site characteristic for evaluating extreme load winter precipitation events should be provided to account for additional weight if at least part of the 48-hour PMWP falls as frozen precipitation" on page 4 under "Issues" be deleted. The extreme liquid winter precipitation is associated with the maximum 48-hour winter rainfall as defined in DCD Tier 2 Table 2.0-1. Its effect on the roof is accounted for in a form of an average depth of 4" of water. The resulting liquid weight is 21 psf. The extreme winter precipitation roof load is thus 59.5 psf which is the sum of 38.5 psf for normal winter precipitation and 21 psf for extreme liquid winter precipitation. It is still less than the 60 psf roof design live load. In accordance with the ISG, the extreme winter precipitation roof load is considered as an extreme live load and treated similarly to other extreme environmental loads such as SSE or tornado in loading combinations. In other words the extreme winter precipitation roof load, treated as live load, is combined with other applicable loads excluding SSE or tornado as an additional load combination case for the extreme environmental category in DCD Tier 2 Tables 3-8-15 and 3.8-16. The roof of ESBWR Seismic Category I buildings are designed to a much more severe loading due to SSE or tornado in the extreme environmental load combination category. Take the tornado load for example, the roof is designed to a pressure drop equal to 2.4 psi or 345.6 psf. For the extreme winter precipitation roof load to reach 345.6 psf will require the extreme frozen winter precipitation roof load equal to 307.1 psf (i.e., 345.6-38.5 for normal winter precipitation). This is much higher than any conceivable frozen winter precipitation anywhere. Therfore, the extreme frozen winter precipitation event is not controlling in the ESBWR design.

Reference

1. NEI Letter to NRC, Industry Comments on Interim Staff Guidance on Winter Precipitation Loads for Seismic Category 1 Structures (ISG-7), dated October 15, 2008.

DCD Impact

No DCD change was made in response to this RAI Supplement.

NRC RAI 2.3-4 S05

In its response to RAI 2.3-4 S04 (MFN 08-919 dated December 8, 2008), GEH assumed weight of 4 inches of water in addition to snow load on roof due to normal winter precipitation for computing extreme winter precipitation roof load. Based on the pictorial layout of the roof drain and the scuppers, the staff could not conclude if the roof scuppers would be available for draining water from roof in case of rain after an antecedent snow fall. In that case, the combined snowpack and water on roof may be as high as the height of the solid parapet, and may be more critical.

Also, while justifying possible roof load due to frozen precipitation during an extreme winter precipitation event, GEH compared the roof design having been done for 345.6 psf load due to tornado pressure drop, and concluded that "the extreme frozen winter precipitation event is not controlling in the ESBWR design." Since load due to pressure drop acts in a direction opposite to the roof live load, and since dead load of roof is available to offset load due to tornado pressure drop, a direct comparison of these two loads without considering effect due to dead load was not understood. GEH needs to calculate the value of extreme frozen winter precipitation and demonstrate how it is enveloped by other loading combinations.

Accordingly, the staff requests GEH to address the following in the DCD:

1. Identify the normal roof load considering normal winter precipitation event which should be treated as live load in all loading combinations.

2. Identify the extreme roof load considering extreme winter precipitation event.

3. Include in the DCD a loading combination for consideration of the extreme roof load for design, or provide justification why it is not necessary.

GEH Response

1. The roof load considering a normal winter precipitation event, which should be treated as a normal live load in all loading combinations, is 38.5 lb/ft^2, which corresponds to the maximum 50 lb/ft^2 ground snow load (100-year recurrence interval) in Revision 5 of DCD Tier 1 Table 5.1-1 and DCD Tier 2 Table 2.0-1. For clarification, the parameter heading "Maximum Ground Snow Load (100-year recurrence interval)" will be changed to "Maximum Ground Snow Load (100-year recurrence interval) for normal winter precipitation event" in Revision 6 of DCD Tier 1 Table 5.1-1 and DCD Tier 2 Table 2.0-1. The maximum roof snow load for the normal winter precipitation event of 38.5 lb/ft^2 will be replacing the corresponding maximum ground snow load of 50 lb/ft^2 in Revision 6 of DCD Tier 2 Table 3G.1-2.
2. The roof load considering an extreme winter precipitation event, which should be treated as an extreme live load in the extreme environmental and abnormal/extreme environmental loading combinations without concurrent seismic and tornado loads, is 125 lb/ft^2, and its corresponding ground snow load will be added as a standard plant site parameter in Revision 6 of DCD Tier 1 Table 5.1-1 and DCD Tier 2 Table 2.0-1. The maximum roof

snow load for the extreme winter precipitation event of 125 lb/ft^2 will be added in Revision 6 of DCD Tier 2 Table 3G.1-2.

Derivation of this roof live load and corresponding maximum ground snow load for an extreme winter precipitation event is presented herein.

The design limit for the roof live load associated with the extreme winter precipitation event is established so that it is less than the roof SSE vertical load and, therefore, will not be a controlling load for design.

Among the Seismic Category I structures (RB, FB, CB and FWSC), the Fire Pump Enclosure (FPE) of the FWSC has the lowest seismic capacity for the roof. The FPE roof is a 1.97 ft thick reinforced concrete slab designed to 1.12g SSE vertical acceleration. The corresponding area load is,

p_s = 1.12 x 1.97 ft x 150 lb/ft^3 (specific weight of concrete) = 330 lb/ft^2

The extreme winter precipitation roof load, which is not considered as occurring at the same time as seismic or tornado loads, in accordance with NRC DC/COL-ISG-07 is,

$p = p_n$ + larger (p_f, p_l)

where,

p_n = normal winter precipitation

p_f = extreme frozen winter precipitation

p_l = extreme liquid winter precipitation

For the extreme winter precipitation event to control the roof design, the load intensity "p" has to be larger than 330 lb/ft^2 considered in the seismic design, which is an inconceivable load intensity attributable to either frozen or liquid precipitation at locations suitable for nuclear plants.

If it is assumed that water can accumulate up to the top of the parapet during the extreme liquid winter precipitation event, and the height of the parapet is typically 2 ft, the resulting liquid load is 124.8 lb/ft^2 (i.e., 2 ft x 62.4 lb/ft^3 specific weight of water). This is more severe than the 48-hour probable maximum winter precipitation (PMWP) but smaller than the 330 lb/ft^2 seismic design capacity for Seismic Category I structures.

To ensure that the extreme winter precipitation event does not control the design of Seismic Category II structures as well, the extreme live load for roofs is selected to be 125 lb/ft^2, which includes the contribution of 38.5 lb/ft^2 normal winter precipitation corresponding to 50 lb/ft^2 maximum ground snow load (100-year recurrence interval), as the bounding value for extreme frozen and extreme liquid loads. This translates into 0.56g vertical seismic load for a 1.5 ft thick concrete roof. Since Seismic Category II structures are designed to the same SSE with a 0.5g peak ground acceleration, the actual vertical acceleration at the roof is expected to be higher than 0.56g.

To facilitate a direct comparison with site specific parameters, the 125 lb/ft^2 roof load for the extreme winter precipitation is converted to the ground snow load using ASCE 7-02, Equation 7-1 as presented below.

$p_g = p_f/(0.7C_eC_tI) = 125/(0.7 \times 1.1 \times 1.0 \times 1.0) = 162$ lb/ft^2

where,

C_e = exposure factor = 1.1 for sheltered roof in Terrain Category C

C_t = thermal factor = 1.0

I = importance factor = 1.0

3. DCD Tier 2 Sections 3.8 and 3G will be updated in Revision 6 to document the roof live loads for both normal and extreme winter precipitation events and associated load combinations. Table 2.3-4(1) is a summary of the roof live loads and ground snow loads. Since roof loads are more of a structural design parameter, they will be deleted from the standard plant site parameters in DCD Tier 1 Table 5.1-1 and DCD Tier 2 Table 2.0-1. Since roof scupper and drain design information is more of a structural design issue and is addressed in DCD Tier 2 Table 3G.1-2, Note **, it will be deleted from DCD Tier 2 Table 2.0-1, Notes 4 and 5.

Table 2.3-4(1) Summary of Roof Live Loads and Ground Snow Loads

Event	Roof Live Load		Ground Snow Load	
	lb/ft^2	Pa	lb/ft^2	Pa
Normal winter precipitation	38.5	1843	50	2394
Extreme winter precipitation	125	5985	162	7757

DCD Impact

Markups of DCD Tier 1 Table 5.1-1 and DCD Tier 2 Table 2.0-1, Table 3.8-15, Table 3.8-16, Table 3G.1-2 and DCD Tier 2 Subsections 2.0.2, 3G.1.5.2.1.2, 3G.2.5.2.1.2, 3G.3.5.2.1.2 and 3G.4.5.2.1.2 were provided to the NRC in MFN 09-307, dated 5/11/09.

NRC RAI 2.3-4 S06

Consider implementing the following changes to the DCD revisions proposed in the response to RAI 2.3-4 S5:

1. *In DCD Tier 1 Table 5.1-1 and Tier 2 Table 2.0-1, delete the phrase "(100-year recurrence interval)" under the definition of the Precipitation (for Roof Design) Maximum Ground Snow Load for normal precipitation event site parameter. Per DC/COL-ISG-07, normal winter precipitation events include historic maximum events as well as 100-year events, whichever are bounding.*
2. *In DCD Tier 1 Table 5.1-1 and Tier 2 Table 2.0-1, delete the listing Precipitation (for Roof Design) Maximum 48-hr Winter Rainfall as a site parameter. The response to RAI 2.3-4 S05 states that water can only accumulate up to the height of the parapet (which is typically only 2 feet), limiting the maximum extreme winter precipitation roof live load to 125 lbf/ft^2. Consequently, this site parameter is no longer needed.*
3. *Delete the following sentence in Footnote 4 to DCD Tier 2 Table 2.0-1:*

   > *"The 48-hour probable maximum winter precipitation (PMWP) is based on Reference 2.0-6."*

   The 48-hour PMWP will no longer be listed in Table 2.0-1 as a site parameter.
4. *Add the following sentence to Footnote 5 to DCD Tier 2 Table 2.0-1 as a point of clarification:*

   > *"The maximum ground snow load for extreme winter precipitation event includes the contribution from the normal winter precipitation event."*
5. *Delete the following phrase from the end of the fourth sentence to Footnote ** to DCD Tier 2 Table 3G.1-2:*

   > *"or 48-hour probable maximum winter precipitation (PMWP) with no more than an average depth of 100 mm (4 in) of water accumulation on the roof"*

   This statement concerning the PMWP is no longer valid.
6. *Delete the following phrase from the middle of the fifth sentence to Footnote ** to DCD Tier 2 Table 3G.1-2:*

   > *"corresponding to 100-year ground snow load"*

   Per DC/COL-ISG-07, normal winter precipitation events include historic maximum events as well as 100-year events, wherever is bounding.
7. *Add the following sentence after the fifth sentence to Footnote ** to DCD Tier 2 Table 3G.1-2:*

   > *The roof snow load of 5986 kPa (125 lbf/ft^2) for the extreme winter precipitation event is based on the 0.61- meter (2-foot) height of the parapet and the specific weight of water. Water will not accumulate above the height of the parapet during*

the extreme winter precipitation event when the roof scuppers and drains are assumed to be clogged."

This change is needed to document the basis for the 125 lbf/ft^2 extreme winter precipitation event roof load.

GEH Response

1. The phrase, "(100-year recurrence interval)," under the definition of the Precipitation (for Roof Design) Maximum Ground Snow Load for normal winter precipitation event site parameter will be deleted from DCD Tier 1 Table 5.1-1 and DCD Tier 2 Table 2.0-1 in Revision 6.
2. The site parameter, Precipitation (for Roof Design) Maximum 48-hr Winter Rainfall will be deleted from DCD Tier 1 Table 5.1-1, DCD Tier 2 Table 2.0-1 and DCD Tier 2 Table 3G.1-2 in Revision 6.
3. The sentence, "The 48-hour probable maximum winter precipitation (PMWP) is based on Reference 2.0-6," will be deleted from Footnote 4 to DCD Tier 2 Table 2.0-1 in Revision 6. DCD Tier 2 Subsection 2.0.2, Reference 2.0-6 will be deleted in Revision 6.
4. The sentence, "The maximum ground snow load for extreme winter precipitation event includes the contribution from the normal winter precipitation event," will be added to Footnote 5 to DCD Tier 2 Table 2.0-1 in Revision 6.
5. The phrase, "or 48-hour probable maximum winter precipitation (PMWP) with no more than an average depth of 100 mm (4 in) of water accumulation on the roof," will be deleted from the end of the fourth sentence to Footnote ** to DCD Tier 2 Table 3G.1-2 in Revision 6.
6. The phrase, "corresponding to 100-year ground snow load," will be deleted from the middle of the fifth sentence to Footnote ** to DCD Tier 2 Table 3G.1-2 in Revision 6.
7. The sentences, "The roof snow load of 5985 kPa (125 lbf/ft^2) for the extreme winter precipitation event is based on the 0.61 m (2.0 ft) height of the parapet and the specific weight of water. Water will not accumulate above the height of the parapet during the extreme winter precipitation event when the roof scuppers and drains are assumed to be clogged," will be added after the fifth sentence to Footnote ** to DCD Tier 2 Table 3G.1-2 in Revision 6.

DCD Impact

DCD Tier 1 Table 5.1-1, DCD Tier 2 Subsection 2.0.2, DCD Tier 2 Table 2.0-1 and DCD Tier 2 Table 3G.1-2 will be revised in Revision 6 as noted in the attached markups.

ENCLOSURE 2

MFN-09-387

Response to NRC RAI Letter No. 345
Related to ESBWR Design Certification Application

DCD Tier 2 Chapter 2 – Site Characteristics

RAI Number 2.3-4 S06

DCD Markups

Table 5.1-1

Envelope of ESBWR Standard Plant Site Parameters (1)

Maximum Ground Water Level:	0.61 m (2 ft) below plant grade
Extreme Wind:	**Seismic Category I, ~~and~~ II and Radwaste Building Structures** - 100-year Wind Speed (3-sec gust): 67.1 m/s (150 mph) - Exposure Category: D **~~Non~~Other - Seismic Category NS Standard Plant Structures** - 50-year Wind Speed (3-sec gust): 58.1 m/s (130 mph)
Maximum Flood (or Tsunami) Level:	0.3 m (1 ft) below plant grade
Tornado:	- Maximum Tornado Wind Speed: 147.5 m/s (330 mph) - Maximum Rotational Speed: 116.2 m/s (260 mph) - Translational Speed: 31.3 m/s (70 mph) - Radius: 45.7 m (150 ft) - Pressure Drop: 16.6 kPa (2.4 psi) - Rate of Pressure Drop: 11.7 kPa/s (1.7 psi/s) - Missile Spectrum(7): Spectrum I of SRP 3.5.1.4, Rev 2 applied to full building height.
Precipitation (for Roof Design):	- Maximum Rainfall Rate: 49.3 cm/hr (19.4 in/hr) - Maximum Short Term Rate: 15.7 cm (6.2 in) in 5 minutes - Maximum Ground Snow Load ~~(100-year recurrence interval)~~ for normal winter precipitation event: 2394 Pa (50 lb/ft^2) - Maximum Ground Snow Load for extreme winter precipitation event: 7757 Pa (162 lb/ft^2) ~~- Maximum 48-hr Winter Rainfall: 91.4 cm (36 in)~~
Ambient Design Temperature:	**2% Annual Exceedance Values** - Maximum: 35.6°C (96°F) dry bulb 26.1°C (79°F) wet bulb (mean coincident) 27.2°C (81°F) wet bulb (non-coincident) - Minimum: -23.3°C (-10°F) **1% Annual Exceedance Values** - Maximum: 37.8°C (100°F) dry bulb 26.1°C (79°F) wet bulb (mean coincident) 27.8°C (82°F) wet bulb (non-coincident) - Minimum: -23.3°C (-10°F) **0% Exceedance Values** - Maximum: 47.2°C (117°F) dry bulb 26.7°C (80°F) wet bulb (mean coincident) 31.1°C (88°F) wet bulb (non-coincident) - Minimum: -40°C (-40°F)

2.0.2 References

2.0-1 GE Hitachi Nuclear Energy, "ESBWR Certification Probabilistic Risk Assessment," NEDO-33201, Class I (Non-proprietary), Revision 3, May 2008.

2.0-2 ~~American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures, ASCE 7-02, 2002.~~(Deleted)

2.0-3 National Weather Service Publication Hydrometeorology Report No. 52 (HMR-52)

2.0-4 Electric Power Research Institute, "Advanced Light Water Reactor Utility Requirements Document," Revision 6, May 1997.

2.0-5 U. S. Nuclear Regulatory Commission, "A Risk-Informed Approach to Defining the Design Basis Tornado for New Reactor Licensing," SECY 04-0200, October 26, 2004.

2.0-6 ~~National Weather Service Publication Hydrometeorology Report No. 53 (HMR-53)~~(Deleted)

2.0-7 U. S. Nuclear Regulatory Commission, "Interim Staff Guidance on Seismic Issues Associated with High Frequency Ground Motion in Design Certification and Combined License Applications," COL/DC-ISG-1, May 2008.

2.0-8 Nuclear Energy Institute, "Consistent Site-Response/ Soil-Structure Interaction Analysis and Evaluation," Draft White Paper, October 10, 2008.

2.0-9 U. S. Nuclear Regulatory Commission, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures," COL/DC-ISG-7.

Table 2.0-1

Envelope of ESBWR Standard Plant Site Parameters[1]

Maximum Ground Water Level:	0.61 m (2 ft) below plant grade
Extreme Wind:	**Seismic Category I, ~~and~~ II and Radwaste Building Structures** - 100-year Wind Speed (3-sec gust): [13] 67.1 m/s (150 mph) - Exposure Category: D **Other ~~Non~~ Seismic Category NS Standard Plant Structures** - 50-year Wind Speed (3-sec gust): 58.1 m/s (130 mph)
Maximum Flood (or Tsunami) Level: [2]	0.3 m (1 ft) below plant grade
Tornado:	- Maximum Tornado Wind Speed: [3] 147.5 m/s (330 mph) - Maximum Rotational Speed: 116.2 m/s (260 mph) - Translational Speed: 31.3 m/s (70 mph) - Radius: 45.7 m (150 ft) - Pressure Drop: 16.6 kPa (2.4 psi) - Rate of Pressure Drop: 11.7 kPa/s (1.7 psi/s) - Missile Spectrum: [3] Spectrum I of SRP 3.5.1.4, Rev 2 applied to full building height.
Precipitation (for Roof Design):	- Maximum Rainfall Rate: [4] 49.3 cm/hr (19.4 in/hr) - Maximum Short Term Rate: 15.7 cm (6.2 in) in 5 minutes ~~- Maximum Roof Load: [5] 2873 Pa (60 lbf/ft^2)~~ - Maximum Ground Snow Load [5] 2394 Pa (50 lbf/ft^2) ~~(100-year recurrence interval)~~ for normal winter precipitation event: - Maximum Ground Snow Load[5] 7757 Pa (162 lb/ft^2) for extreme winter precipitation event: ~~- Maximum 48-hr Winter Rainfall: [5] 91.4 cm (36 in)~~
Ambient Design Temperature: [6]	**2% Annual Exceedance Values** - Maximum: 35.6°C (96°F) dry bulb 26.1°C (79°F) wet bulb (mean coincident) 27.2°C (81°F) wet bulb (non-coincident) - Minimum: -23.3°C (-10°F) **1% Annual Exceedance Values** - Maximum: 37.8°C (100°F) dry bulb 26.1°C (79°F) wet bulb (mean coincident) 27.8°C (82°F) wet bulb (non-coincident) - Minimum: -23.3°C (-10°F) **0% Exceedance Values** - Maximum: 47.2°C (117°F) dry bulb 26.7°C (80°F) wet bulb (mean coincident) 31.1°C (88°F) wet bulb (non-coincident) - Minimum: -40°C (-40°F)

Notes for Table 2.0-1:

(1) The site parameters defined in this table are applicable to Seismic Category I, II, and Radwaste Building structures, unless noted otherwise. ~~The design of the Radwaste Building uses a set of design parameters that are specified in Regulatory Guide 1.143, Table 2, Class RW-IIa instead of the corresponding values given in this table for all parameters except as follows: (1) Tornado: Winds Speeds, Radius, Pressure Drop, and Rate of Pressure Drop; (2) Seismology: Horizontal and Vertical Ground Spectra: See Figures 2.0-1 and 2.0-2.~~

(2) Probable maximum flood level (PMF), as defined in Table 1.2-6 of Volume III of Reference 2.0-4.

(3) Maximum speed selected is based on Attachment 1 of Reference 2.0-5, which summarizes the NRC Interim Position on Regulatory Guide 1.76. Concrete structures designed to resist Spectrum I missiles of SRP 3.5.1.4, Rev. 2, also resist missiles postulated in Regulatory Guide 1.76, Revision 1. Tornado missiles do not apply to Seismic Category II buildings. For the Radwaste building, the tornado missiles defined in Regulatory Guide 1.143, Table 2, Class RW-IIa apply.

(4) Based on probable maximum precipitation (PMP) for one hour over 2.6 km^2 (one square mile) with a ratio of 5 minutes to one hour PMP of 0.32 as found in Reference 2.0-3. ~~Roof scuppers and drains are designed independently to limit water accumulation on the roof to no more than 100 mm (4 in) during PMP conditions.~~ See also Table 3G.1-2.

(5) ~~Maximum design roof load accommodates snow load and 48-hour probable maximum winter precipitation (PMWP) in References 2.0-2 and 2.0-6. Roof scuppers and drains are designed independently to limit water accumulation on the roof to no more than an average depth of 100 mm (4 in) during PMWP conditions.~~ See Reference 2.0-9 for the definition of normal winter precipitation and extreme winter precipitation events. The maximum ground snow load for extreme winter precipitation event includes the contribution from the normal winter precipitation event. See also Table 3G.1-2.

(6) Zero percent exceedance values are based on conservative estimates of historical high and low values for potential sites. Consistent with Reference 2.0-4, they represent historical limits excluding peaks of less than two hours. One and two percent annual exceedance values were selected in order to bound the values presented in Reference 2.0-4 and available Early Site Permit applications.

(7) At the foundation level of Seismic Category I structures. The static bearing pressure is the average pressure. The dynamic bearing pressure is the toe pressure. To compare with the maximum bearing demand, the allowable bearing pressure is developed from the site-specific bearing capacity divided by a factor of safety appropriate for the design load combination. The~~For~~ maximum~~minimum~~ dynamic bearing demand~~capacity~~ to be compared with the site-specific allowable dynamic bearing pressure is~~application, use~~ the larger value or a linearly interpolated value of the applicable range of shear wave velocities at the foundation level. The shear wave velocities of soft, medium and hard soils are 300 m/sec (1000 ft/sec), 800 m/sec (2600 ft/sec) and greater than or equal to 1700 m/sec (5600 ft/sec), respectively.

Table 3G.1-2

Site Design Parameters

Parameter	Value(s)
Maximum Rainfall**	
Design Rainfall, cm/hr (in/hr)	49.3 (19.4)
~~48-hour Winter Rainfall, cm (in)~~(Deleted)	~~91.4 (36)~~

Notes * Equivalent to 62.6 m/s (140 mi/hr) 50-year recurrence interval wind speed (3-sec gust) with importance factor of 1.15 per ASCE 7-02.

** Based on probable maximum precipitation (PMP) for one hour over 2.6 km^2 (one square mile) with a ratio of 5 minutes to one hour PMP of 0.32 as found in National Weather Source Publication Hydrometeorology Report No. 52 (HMR-52). 49.3 cm/hr (19.4 in/hr) for maximum rainfall rate is selected for design. The maximum short term rate selected is 15.7 cm (6.2 in) in 5 minutes. The roof scuppers and drains are designed independently to handle the PMP~~ or 48-hour probable maximum winter precipitation (PMWP) with no more than an average depth of 100 mm (4 in) of water accumulation on the roof~~. The roof ~~is designed for~~snow load for the normal winter precipitation event is less than the design live load of 2873 Pa (60 lbf/ft^2~~psf~~) ~~as live load category on all Seismic Category I structures and accommodates design roof snow load and 48-hour PMWP~~ for all load combinations. The roof snow load of 5985 kPa (125 lbf/ft^2) for the extreme winter precipitation event is based on the 0.61 m (2.0 ft) height of the parapet and the specific weight of water. Water will not accumulate above the height of the parapet during the extreme winter precipitation event when the roof scuppers and drains are assumed to be clogged. The roof is also capable of withstanding extreme live load for the extreme winter precipitation event because it is less than the SSE vertical load considered in the roof design. ASCE 7-02 requirements for snow are used to analyze the various roof geometries and heights. The conversion between the ground snow load and roof snow load is based on ASCE 7-02 Equation 7-1 using 1.1 exposure factor for sheltered roof in Terrain Category C, 1.0 thermal factor and 1.0 importance factor.

*** Steady state; 47.2°C (117°F) allowed for short term.