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MFN 08-919

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U.S. Nuclear Regulatory Commission
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Washington, D.C. 20555-0001

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 250 Related to ESBWR Design Certification Application – Site Characteristics - RAI Number 2.3-4 S04**

Enclosure 1 contains GEH's response to the subject RAI transmitted via Reference 1. For RAI 2.3-4, Supplement 3 was transmitted via Reference 2 for which GEH provided response in Reference 3. Supplement 2 was transmitted via Reference 4 for which GEH provided response in Reference 5. Supplement 1 was transmitted via Reference 6 for which GE response was provided in Reference 7. The original RAI 2.3-4 was transmitted via Reference 8 for which GE response was provided to the NRC via Reference 9.

Should you have any questions about the information provided here, please contact me.

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 08-686, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 250 Related to the ESBWR Design Certification Application,* September 5, 2008.

2. MFN 07-656, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 117 Related to the ESBWR Design Certification Application,* December 5, 2007.

3. MFN 08-076, Letter from GEH to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 117 Related to ESBWR Design Certification Application – Site Characteristics – RAI Number 2.3-4 S03,* March 7, 2008.

4. MFN 07-555, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 109 Related to the ESBWR Design Certification Application,* October 12, 2007.

5. MFN 07-628. Letter from GEH to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 109 Related to ESBWR Design Certification Application – Site Characteristics – RAI Number 2.3-4 S02,* November 29, 2007.

6. NRC to GE, Request for Additional Information, RAI 2.3-4 S01, April 2, 2007 (ACN: ML070930067).

7. MFN 06-206 S01, Letter from GE to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 37 Related to ESBWR Design Certification Application – Siting Issues – RAI Numbers 2.3-2 S01, 2.3-3 S01 and 2.3-4 S01,* May 8, 2007.

8. MFN 06-201, Letter from U.S. Nuclear Regulatory Commission to David H. Hinds, *Request for Additional Information Letter No. 37 Related to the ESBWR Design Certification Application,* June 21, 2006.

9. MFN 06-206, Letter from GE to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 37 Related to ESBWR Design Certification Application – Siting Issues, Hydrological Engineering – RAI Numbers 2.1-1, 2.2-1 through 2.2-3, 2.3-1 through 2.3-6, 14.3-22, 15.3-1, 15.3-3, and 2.4-32,* July 31, 2006.

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 250 Related to ESBWR Design Certification Application – Site Characteristics - RAI Number 2.3-4 S04.

cc:

AE Cubbage	USNRC (with enclosure)
RE Brown	GEH/Wilmington (with enclosure)
DH Hinds	GEH/Wilmington (with enclosure)
eDRF	0000-0081-1706 R3

Enclosure 1

MFN 08-919

Response to Portion of NRC Request for Additional Information Letter No. 250 Related to ESBWR Design Certification Application

Site Characteristics

RAI Number 2.3-4 S04[1]

[1]Original Response and Supplements 1 and 2 previously submitted under MFNs 06-206 and 06-206 Supplement 1, and 07-628 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 dated April 2, 2007 - Comments on response to RAI 2.3-4 (ACN: ML 070930067):

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 changes will be made in response to this RAI.

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

DCD Tier 2 Table 2.0-1, Note 5 and Table 3G.1-2, Note** will be revised in the next update as noted in the attached markups.

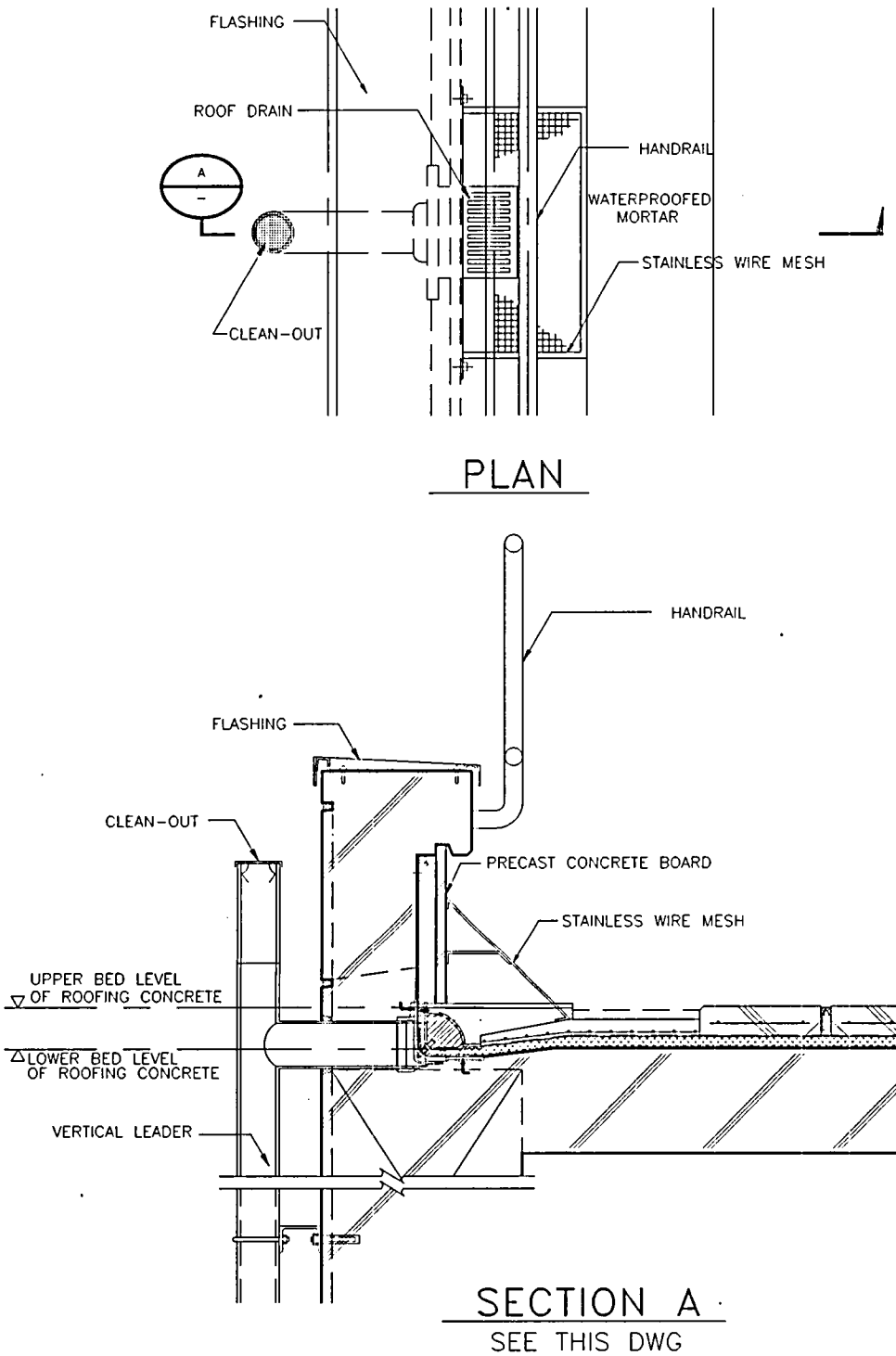

Figure 2.3-4(1) Typical Sketch of Roof Drain

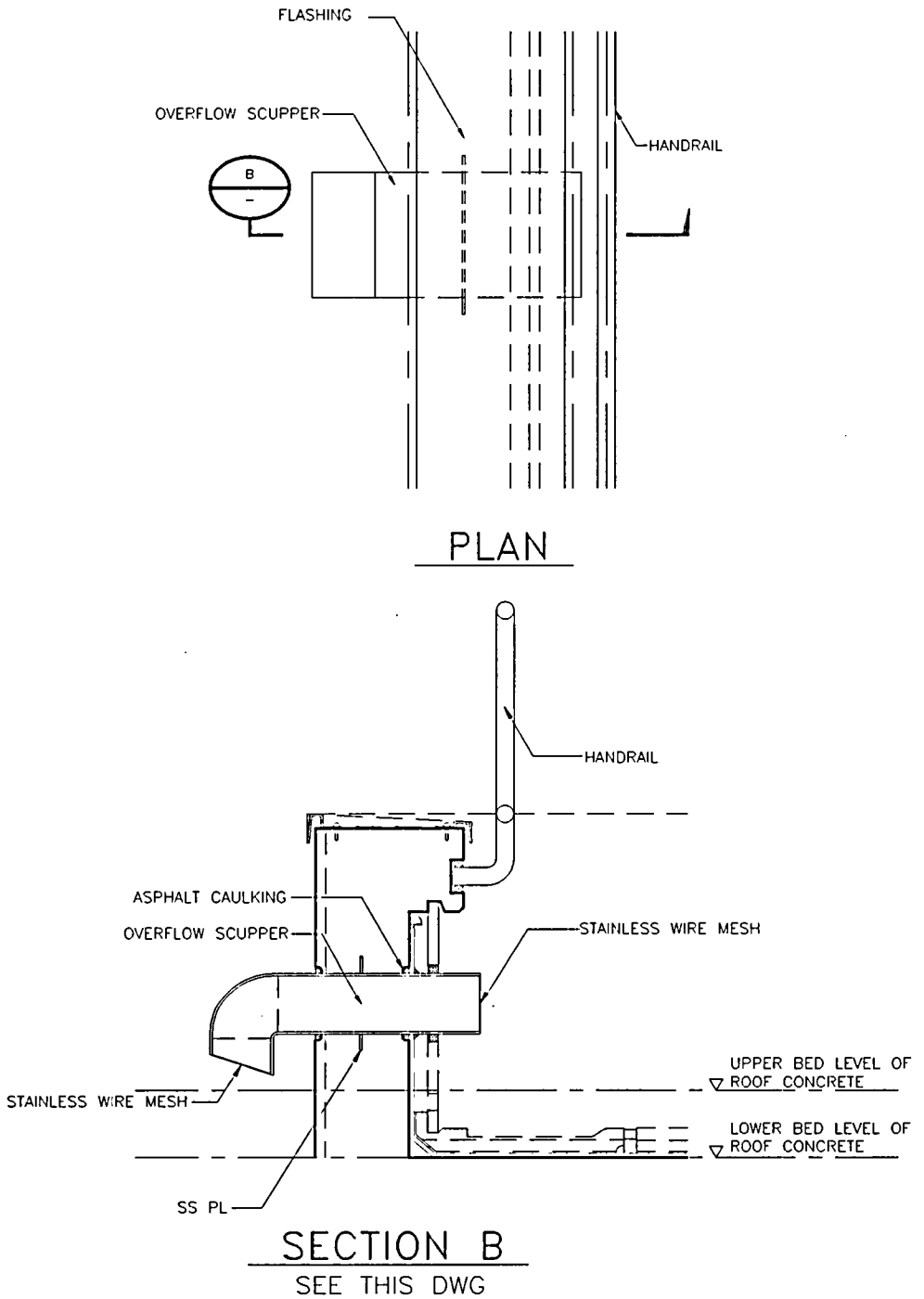

Figure 2.3-4(2) Typical Sketch of Overflow Scupper

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 considered 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 period
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. Therefore, 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 is required in response to this RAI Supplement.