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MFN 08-076

Docket No. 52-010

March 7, 2008

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

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 117 Related to ESBWR Design Certification Application - Site Characteristics - RAI Numbers 2.3-4 S03 and 2.3-12**

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

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

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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References:

1. 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 6, 2007.
2. 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.
3. 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.
4. E-mail from NRC to GE, April 2, 2007.
5. 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 2.3-4S01,* May 8, 2007.
6. 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.
7. 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. 117 Related to ESBWR Design Certification Application – Site Characteristics - RAI Numbers 2.3-4 S03 and 2.3-12.

cc:	AE Cubbage	USNRC (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	DH Hinds	GEH/Wilmington (with enclosure)
	GB Stramback	GEH/San Jose (with enclosure)
	eDRF	0000-0078-5526 (RAI 2.3-4 S03)
		0000-0078-6963 (RAI 2.3-12)

Enclosure 1

MFN 08-076

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[1] and 2.3-12

[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:

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

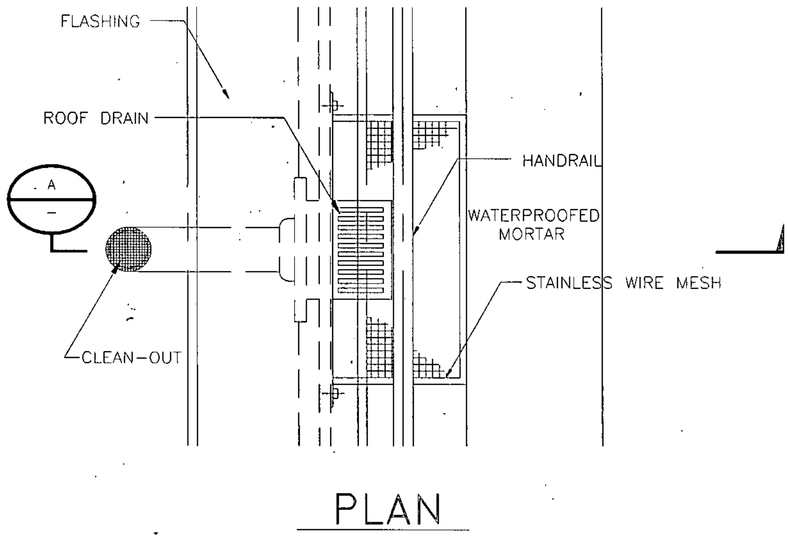
In the ESBWR Standard Plant, roofs are provided with two independent drainage systems. The roof drains form the primary drainage system and the scuppers form the secondary drainage system. As required by the International Plumbing Code (invoked by IBC-2003) and ASCE 7-02, only the blockage of the primary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



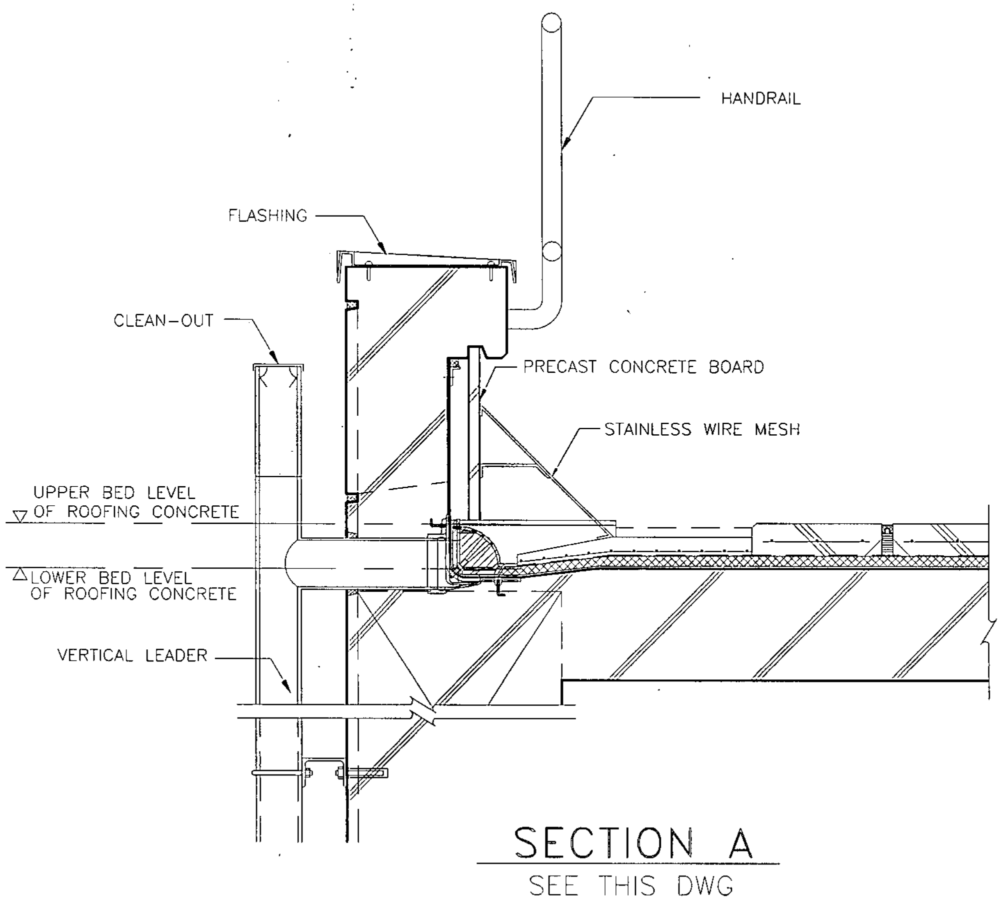


Figure 2.3-4(1) Typical Sketch of Roof Drain

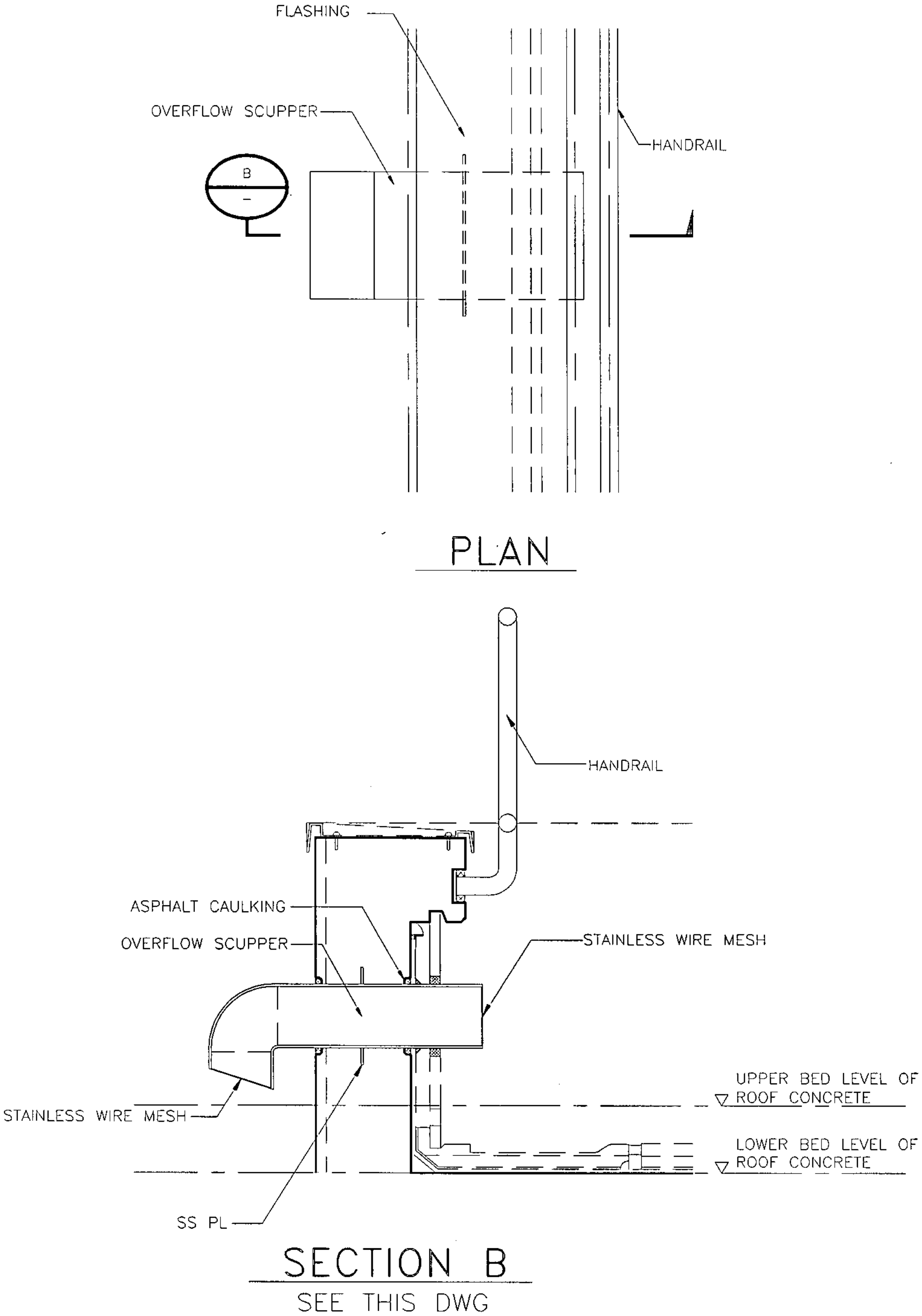


Figure 2.3-4(2) Typical Sketch of Overflow Scupper

NRC RAI 2.3-12

The last sentence in the fourth paragraph of Revision 4 to DCD Tier 2 Section 2.0 states that site parameters specified in Tier 1 are the same as those specified in Tier 2. However, the long term dispersion estimates listed as site parameters in Revision 4 to DCD Tier 2 Table 2.0-1 are not listed as site parameters in Revision 4 to DCD Tier 1 Table 5.1-1. Therefore, please clarify the statement in Tier 2 Section 2.0 regarding whether the site parameters specified in Tier 1 are the same as those specified in Tier 2.

GEH Response

With the exception of long-term dispersion estimates, the information provided in Tier 1 includes all site parameters that SRP 14.3.1 recommends (but does not require) be included in Tier 1. The GEH response to RAI 2.3-11 discusses the basis for not including long-term dispersion estimates in DCD Tier 1 Table 5.1-1. The GEH responses to RAIs 2.0-1 and 3.8-116 discuss the basis for excluding certain notes and building settlement information, respectively, from DCD Tier 1 Table 5.1-1.

The statement in DCD Tier 2 Section 2.0 will be revised to indicate that all site parameter values shown in DCD Tier 1 (Table 5.1-1) are consistent with those in Tier 2.

DCD Impact

DCD Tier 2, Section 2.0 will be revised as noted in the attached markup.

2. SITE CHARACTERISTICS

2.0 INTRODUCTION

This chapter defines the envelope of site-related parameters that the ESBWR Standard Plant is designed to accommodate. These parameters envelope most potential sites in the U.S. A list of the site envelope design parameters is given in Table 2.0-1.

Table 2.0-2 references the guidance in NUREG-0800 Standard Review Plan (SRP). Table 2.0-2 defines the limits imposed on the acceptance criteria in Section II of the various SRPs by (1) the envelope of site-related parameters that the ESBWR plant is designed to accommodate, and (2) the assumptions, both implicit and explicit, related to site parameters that were employed in the evaluation of the ESBWR design.

The requirements for site parameters for a standard design are contained in 10 CFR 52.47(a)(1)(iii). A design certification applicant provides postulated site parameters for the design, and an analysis and evaluation of the design in terms of such parameters. The following demonstrate that the standard design meets the above criteria.

~~The site parameters used in the ESBWR Standard Plant design are specified in both DCD Tier 1 and this chapter.~~ The specified site parameters are the top-level bounding site parameters useful in the selection of a suitable site for a facility referencing the ESBWR certified design. Because they were used in bounding evaluations of the certified design, they define the envelope of site parameters used for the design that must be considered for a site. When the site characteristics fall within the site parameter values, a facility built on the site is in conformance with the design certification. Appropriate values for site parameters have been selected that make the design suitable for many sites. ~~The~~ All site parameters specified in Tier 1 have ~~are~~ the same values as those presented in this chapter.

The analyses and evaluations of the design, considering the site parameters of Table 2.0-1, are contained in the various sections of this document~~the DCD Tier 2~~. For example, the safe shutdown earthquake parameters are used in structural and piping analyses in various sections of Chapter 3, atmospheric dispersion parameters are used in radiological analyses throughout Chapter 15, and the elevation parameter is used in the flooding analyses in Section 3.4.

Site parameters are specified for the following parameters:

- Maximum Ground Water Level
- Maximum Flood (or Tsunami) Level
- Precipitation (for roof design)
- Ambient Design Temperature
- Extreme Wind
- Tornado (maximum speed, pressure drop, missile spectrum, etc.)
- Maximum Settlement Values for Seismic Category I Buildings
- Soil Properties (minimum static bearing capacity, minimum dynamic bearing capacity, minimum shear wave velocity, liquefaction potential, angle of internal friction)

Notes for Table 2.0-1:

(1) 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.

(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.

(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 also Table 3G.1-2.

(6) Zero percent exceedance values are based on conservative estimates of historical high and low values for potential sites. 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. Maximum coincident wet bulb temperatures are considered to be the maximum wet bulb temperature that is expected to occur at the maximum dry bulb temperature. Maximum non-coincident wet bulb temperatures are considered to be the maximum value that occurs at any lower dry bulb temperature.

(7) At foundation level of Seismic Category I structures. For minimum dynamic bearing capacity site-specific 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.

(8) This is the equivalent uniform shear wave velocity (V_{cq}) over the entire soil column at seismic strain, which is a lower bound value after taking into account uncertainties. V_{cq} is calculated to achieve the same wave traveling time over the depth equal to the embedment depth plus 2 times the largest foundation plan dimension below the foundation as follows:

$$V_{eq} = \frac{\sum d_i}{\sum \frac{d_i}{V_i}}$$

where d_i and V_i are the depth and shear wave velocity, respectively, of the ith layer. The ratio of the largest to the smallest shear wave velocity over the mat foundation width at the foundation level does not exceed 1.7.

Table 3G.1-2

Site Design Parameters

Parameter	Value(s)
Soil:	
Minimum Shear Wave Velocity, m/s (ft/s)	300 (1000)
Maximum Ground Water Level, m (ft)	0.61 (2.0) below plant grade
Maximum Flood (or Tsunami) Level, m (ft)	0.30 (1.0) below plant grade
Maximum Ground Snow Load (100-year recurrence interval), kPa (lbf/ft^2)**	2.394 (50)
Design Exterior Temperatures	
Summer, °C (°F)***	46.1 (115)
Winter, °C (°F)	-40.0 (-40)
Seismology: For seismic design parameters, refer to Subsection 3.7.1.	
Extreme Wind	
Basic Wind Speed (100-year recurrence interval (3-sec gust)), m/s (mph)*	67.1 (150)
Exposure Category	Exposure D
Tornado	
Maximum Tornado Wind Speed, m/s (mph)	147.5 (330)
Maximum Rotational Speed, m/s (mph)	116.2 (260)
Translational Speed, m/s (mph)	31.3 (70)
Radius, m (ft)	45.7 (150)
Pressure Drop, kPa (psi)	16.6 (2.4)
Rate of Pressure Drop, kPa/s (psi/s)	11.7 (1.7)
Missile Spectra	Spectra I of SRP 3.5.1.4, Rev. 2 applied to full building.
Maximum Rainfall**	
Design Rainfall, cm/hr (in/hr)	49.3 (19.4)
48-hour Winter Rainfall, cm (in)	91.4 (36)

Note * 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 2873 Pa (60 psf) as live load category on all Seismic Category I structures and accommodates design roof snow load and 48-hour PMWP. ASCE 7-02 requirements for snow are used to analyze the various roof geometries and heights.

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