NuScale Power

RAIO-1217-57720

December 15, 2017

Docket No. 52-048

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

**SUBJECT:** NuScale Power, LLC Response to NRC Request for Additional Information No. 264 (eRAI No. 9179) on the NuScale Design Certification Application

**REFERENCE:** U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 264 (eRAI No. 9179)," dated October 16, 2017

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) response to the referenced NRC Request for Additional Information (RAI).

The Enclosure to this letter contains NuScale's response to the following RAI Questions from NRC eRAI No. 9179:

- 02.03.01-1
- 02.03.01-2
- 02.03.01-3
- 02.03.01-4
- 02.03.01-5

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Marty Bryan at 541-452-7172 or at mbryan@nuscalepower.com.

Sincerely,

Jennie Wike
Manager, Licensing
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Prosanta Chowdhury NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9179

**Enclosure 1:**

NuScale Response to NRC Request for Additional Information eRAI No. 9179

# Response to Request for Additional Information
# Docket No. 52-048

**eRAI No.:** 9179
**Date of RAI Issue:** 10/16/2017

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**NRC Question No.:** 02.03.01-1

Regulatory Background

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, “Design bases for protection against natural phenomena”, states, in part, that “[s]tructures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena….without loss of capability to perform their safety functions” and that “[t]he design bases for these structures, systems, and components shall reflect….[a]ppropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.”

In addition, 10 CFR Part 50, Appendix A, GDC 4, “Environmental and dynamic effects design bases,” as it relates to information on tornadoes and, where applicable, hurricane winds that generate missiles states, in part, that “structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles….from events and conditions outside the nuclear power unit.” Further, 10 CFR 52.47(a)(1) requires a design certification applicant to provide site parameters postulated for its design and an analysis and evaluation of the design in terms of those site parameters.

Information needed

The NuScale Small Modular Reactor (SMR) plant design has a smaller areal extent and likely smaller size of the overall plant site compared to that typical of larger light-water-reactor plant sites. Consequently, the NuScale SMR plant design might be able to be deployed in other-than-typical nuclear plant site locations.

FSAR Tier 2, Section 2.3, "Meteorology," of the NuScale design certification application (DCA) states that “[t]he NuScale Power Plant is designed using meteorological parameters selected to envelope conditions at most potential plant site locations in the United States.”, FSAR Tier 2, Section 2.3, of the NuScale DCD states that “[t]he NuScale Power Plant is designed using meteorological parameters selected to envelope conditions at most potential plant site locations in the United States.” Climatological and meteorological conditions vary significantly depending on the range of locations where they might be applied as site parameters. Therefore, to provide better context for the climate-related site parameters postulated for the NuScale SMR plant

design, please clarify the phrase “at most potential plant site locations in the United States”, in FSAR Tier 2, Section 2.3 and elsewhere, as to whether this statement is intended to include the contiguous (lower 48) states, the continental U.S. (which includes the State of Alaska), or U.S. Territories as well.

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**NuScale Response:**

The phrase “at most potential plant site locations in the United States” in the NuScale FSAR is intended to include the continental U.S. plus Hawaii. It is understood that some potential plant site locations in the United States may have more severe site-specific characteristics.

Per COL Item 2.0-1, “A COL applicant that references the NuScale Power Plant design certification will demonstrate that site-specific characteristics are bounded by the design parameters specified in Table 2.0-1. If site-specific values are not bounded by the values in Table 2.0-1, the COL applicant will demonstrate the acceptability of the site-specific values in the appropriate sections of its combined license application.”

**Impact on DCA:**

There are no impacts to the DCA as a result of this response.

# Response to Request for Additional Information
# Docket No. 52-048

**eRAI No.:** 9179
**Date of RAI Issue:** 10/16/2017

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**NRC Question No.:** 02.03.01-2

Regulatory Background

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, “Design bases for protection against natural phenomena,” states, in part, that “[s]tructures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena….without loss of capability to perform their safety functions” and that “[t]he design bases for these structures, systems, and components shall reflect….[a]ppropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.”

In addition, 10 CFR 52.47(a)(1) requires a design certification applicant to provide site parameters postulated for its design and an analysis and evaluation of the design in terms of those site parameters.

Further, NUREG-0800, Standard Review Plan (SRP), Section 2.3.1, “Regional Climatology,” establishes criteria that the NRC staff uses to evaluate whether an applicant meets the NRC’s regulations. Among them, Subsection I (Areas of Review), Item (6), last paragraph, states, with respect to meteorological conditions identified as site parameters for design certification (DC) applications, that “[a]ll references to FSAR (Final Safety Analysis Report) sections in which these conditions are used should be identified by the applicant.”

Information needed

SRP Section 2.3.1, Subsection I (Areas of Review), Item (6), addresses, in part, “[m]eteorological conditions identified as….site parameters for DC applications.” FSAR Tier 1, Table 5.0-1, "Site Design Parameters," and Tier 2, Table 2.0-1, "Site Design Parameters," provide a list of site parameters postulated for the NuScale SMR plant design comparable to those conditions identified in Item (6).

The last paragraph of Item (6) calls for “[a]ll references to FSAR sections in which these conditions are used should be identified by the applicant.” In order for COL applicants referencing the NuScale SMR plant design certification to properly associate their climate-related site characteristics with the corresponding site parameter values listed in FSAR Tier 1,

Table 5.0-1 and Tier 2, Table 2.0-1, the applicant should update FSAR Tier 2, Section 2.3.1 with the appropriate cross-references to those sections "in which these conditions are used" (i.e., linked to the design or operation of specific structures, systems, and components).

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**NuScale Response:**

FSAR Tier 2, Table 2.0-1 is revised, as shown in the attached markup, to include cross references to FSAR sections that reference the site parameters. Corresponding revisions to FSAR Tier 1, Table 5.0-1 are also shown in the attached markup. The attached markup also shows additional discussion that has been added in various FSAR sections for some site parameters.

Some parameters were not referenced elsewhere in the FSAR and these parameters have been removed from FSAR Tier 2, Table 2.0-1 and FSAR Tier 1, Table 5.0-1. Other parameters are relocated from FSAR Tier 2, Table 2.0-1 to other tables in the FSAR (FSAR Tier 2, Tables 11.3-12 and 15.0-20) because they are not site parameters.

**Impact on DCA:**

FSAR Sections 2.1, 2.3.4, 3.3.2, 3.8.4, and 3.8.5, FSAR Table 2.0-1, and Tier 1 Table 5.0-1 have been revised as described in the response above and as shown in the markup provided in this response.

RAI 02.03.01-2, RAI 03.07.02-24S1, RAI 03.08.05-1, RAI 03.08.05-8

## Table 5.0-1: Site Design Parameters

| Site Characteristic/Parameter | NuScale Design Parameter |
|---|---|
| **Nearby Industrial, Transportation, and Military Facilities** | |
| External hazards on plant structures, systems, and components (SSC) (e.g., explosions, fires, release of toxic chemicals and flammable clouds, pressure effects) on plant SSC | No external hazards |
| Aircraft hazards on plant SSC | No aircraft hazards |
| **Meteorology** | |
| Maximum precipitation rate | 19.4 in. per hour<br>6.3 in. for a 5-minute period |
| Normal roof snow load | 50 psf |
| Extreme roof snow load | 75 psf |
| 100-year return period 3-second wind gust speed | 145 mph (Exposure Category C) with an importance factor of 1.15 for Reactor Building, Control Building, and Radioactive Waste Building |
| Design Basis Tornado<br>• maximum horizontal wind speed<br>• maximum translational speed<br>• maximum rotational speed<br>• maximum radius of rotational speed<br>• maximum pressure differential<br>• maximum rate of pressure drop | <br>230 mph<br>46 mph<br>184 mph<br>150 ft<br>1.2 psi<br>0.5 psi/sec |
| Tornado missile spectra | Table 2 of Regulatory Guide 1.76, Revision 1, Region 1. |
| Maximum wind speed design basis hurricane | 290 mph |
| Hurricane missile spectra | Tables 1 and 2 of Regulatory Guide1.221, Revision 0. |
| Summer outdoor design dry bulb temperature | 115°F |
| Winter outdoor design dry-bulb temperature | -40°F |
| Summer outdoor wet bulb temperature<br>coincident<br>non-coincident | <br>80°F<br>81°F |
| Accident release χ/Q values at security owner controlled area fence<br>0-2 hr<br>2-8 hr<br>8-24 hr<br>24-96 hr<br>96-720 hr | <br><br>~~5.72~~6.22E-04 s/m$^3$<br>~~4.85~~5.27E-04 s/m$^3$<br>~~2.14~~2.41E-04 s/m$^3$<br>~~2.15~~2.51E-04 s/m$^3$<br>~~1.95~~2.46E-04 s/m$^3$ |
| Accident release χ/Q values at main control room/ technical support center door and heating ventilation and air conditioning intake<br>(approximately 112 feet from source)<br>0-2 hr<br>2-8 hr<br>8-24 hr<br>1-4 day<br>4-30 day | Door / Heating Ventilation and Air Conditioning Intake<br><br>6.50E-03 s/m$^3$ / 6.50E-03 s/m$^3$<br>5.34E-03 s/m$^3$ / 5.34E-03 s/m$^3$<br>2.32E-03 s/m$^3$ / 2.32E-03 s/m$^3$<br>2.37E-03 s/m$^3$ / 2.37E-03 s/m$^3$<br>2.14E-03 s/m$^3$ / 2.14E-03 s/m$^3$ |
| **Hydrologic Engineering** | |
| Maximum flood elevation<br>Probable maximum flood and coincident wind wave and other effects on maximum flood level | 1 foot below the baseline plant elevation |
| Maximum elevation of groundwater | 2 feet below the baseline plant elevation |

## Table 5.0-1: Site Design Parameters (Continued)

| Site Characteristic/Parameter | NuScale Design Parameter |
|---|---|
| **Geology, Seismology, and Geotechnical Engineering** | |
| Ground motion response spectra/safe shutdown earthquake | See Figure 5.0-1 and Figure 5.0-2 for horizontal and vertical certified seismic design response spectra (CSDRS) for all Seismic Category I SSC.<br><br>and<br><br>See Figure 5.0-3 and Figure 5.0-4 for horizontal and vertical high frequency certified seismic design response spectra (CSDRS-HF) for Reactor Building and Control Building. |
| Fault displacement potential | No fault displacement potential |
| Minimum soil bearing capacity ($Q_{ult}$) beneath safety-related structures | 75 ksf |
| Lateral soil variability | Uniform site (±≤ 20 degree dip) |
| SoilMinimum soil angle of internal friction | 30 degrees |
| Minimum coefficient of static friction (all interfaces between basemat and soil) | 0.58 |
| Minimum shear wave velocity | ≥ 1000 fps at bottom of foundation |
| Maximum settlement for the Reactor Building, Control Building, and Radioactive Waste Building:<br><br>• total settlement<br>• tilt settlement<br><br>• differential settlement (between Reactor Building and Control Building, and Reactor Building and Radioactive Waste Building) | <br><br><br>No limit4 inches<br>1 inch per 50 feet in any directionMaximum of 0.5 inch per 50 feet of building length or 1 inch total in any direction at any point in these structures<br>No limit0.5 inch |
| Slope failure potential | No slope failure potential |

RAI 02.03.01-2, RAI 03.07.02-24S1, RAI 03.08.05-1, RAI 03.08.05-8

## Table 2.0-1: Site Design Parameters

| Site Characteristic / Parameter | NuScale Design Parameter | References to Parameter |
|---|---|---|
| **Geography and Demography (Section 2.1)** | | |
| Minimum exclusion area boundary | ~~Security owner controlled area fence~~400 feet from the closest release point | Sections 2.1 and 2.3.4 |
| Minimum outer boundary of low population zone | ~~Security owner controlled area fence~~400 feet from the closest release point | Sections 2.1 and 2.3.4 |
| **Nearby Industrial, Transportation, and Military Facilities (Section 2.2)** | | |
| External hazards on plant systems, structures, and components (SSC) (e.g., explosions, fires, release of toxic chemicals and flammable clouds, pressure effects) on plant SSC | No external hazards | Section 2.2 |
| Aircraft hazards on plant SSC | No design basis aircraft hazards | Sections 2.2 and 3.5.1.6 |
| **Meteorology (Section 2.3)** | | |
| Maximum precipitation rate | 19.4 inches per hour<br>6.3 inches for a 5 minute period | Section 3.4.2.2 |
| Normal roof snow load | 50 psf | Sections 3.4.2.2, 3.8.4.3.11, and 3.8.4.8 |
| Extreme roof snow load | 75 psf | Sections 3.4.2.2, 3.8.4.3.12, and 3.8.4.8 |
| 100-year return period 3-second wind gust speed | 145 mph (exposure Category C) with an importance factor of 1.15 for Reactor Building, Control Building and Radioactive Waste Building | Sections 3.3.1.1, 3.8.4.3.13, and 3.8.4.8 |
| Design basis tornado<br>maximum ~~horizontal~~ wind speed<br>~~maximum~~ translational speed<br>maximum rotational speed<br>~~maximum~~ radius of maximum rotational speed<br>~~maximum~~ pressure ~~differential~~drop<br>~~maximum~~ rate of pressure drop | <br>230 mph<br>46 mph<br>184 mph<br>150 ft<br>1.2 psi<br>0.5 psi/sec | Sections 3.1.1.2, 3.3.2.1, 3.8.4.3.14, and 3.8.4.8 |
| Tornado missile spectra | Table 2 of Regulatory Guide 1.76, Revision 1, Region 1 | Section 3.5.1.4 |
| Maximum wind speed design basis hurricane | 290 mph | Sections 3.3.2.1, 3.8.4.3.14, and 3.8.4.8 |
| Hurricane missile spectra | Tables 1 and 2 of Regulatory Guide 1.221, Revision 0 | Section 3.5.1.4 |
| Summer outdoor design dry bulb temperature | 115°F | Sections 3.8.4.3.8, 3.8.4.8, and 20.1.1.5 and Table 9.4.1-1 |
| Winter outdoor design dry-bulb temperature | -40°F | Sections 3.8.4.3.8, 3.8.4.8, and 20.1.1.4 and Table 9.4.1-1 |
| Summer outdoor wet bulb temperature<br>coincident<br>non-coincident | <br>80°F<br>81°F | Table 9.4.1-1 |

**Table 2.0-1: Site Design Parameters (Continued)**

| Site Characteristic / Parameter | NuScale Design Parameter | References to Parameter |
|---|---|---|
| ~~Accident airborne effluent release point characteristics for offsite receptors~~<br>~~release height~~<br>~~adjacent building height~~<br>~~adjacent building cross-sectional area~~ | <br><br>~~ground level (0 meters)~~<br>~~negligible~~<br>~~negligible (0.1 square meters)~~ | |
| Accident release χ/Q values at security owner controlled area fence<br>0-2 hr<br>2-8 hr<br>8-24 hr<br>24-96 hr<br>96-720 hr | <br><br>~~5.72~~6.22E-04 s/m³<br>~~4.85~~5.27E-04 s/m³<br>~~2.14~~2.41E-04 s/m³<br>~~2.15~~2.51E-04 s/m³<br>~~1.95~~2.46E-04 s/m³ | Sections 15.0.3.2 and 15.0.3.3.12 and Table 15.0-13 |
| Accident release χ/Q values at main control room/technical support center door and HVAC intake (approximately 112 feet from source)<br>0-2 hr<br>2-8 hr<br>8-24 hr<br>1-4 day<br>4-30 day | Door / HVAC Intake<br><br>6.50E-03 s/m³ / 6.50E-03 s/m³<br>5.34E-03 s/m³ / 5.34E-03 s/m³<br>2.32E-03 s/m³ / 2.32E-03 s/m³<br>2.37E-03 s/m³ / 2.37E-03 s/m³<br>2.14E-03 s/m³ / 2.14E-03 s/m³ | Section 15.0.3.3.12 and Table 15.0-13 |
| ~~Routine airborne effluent release point characteristics for offsite receptors~~<br>~~release location~~<br>~~release height~~<br>~~vent/stack exit velocity~~<br>~~vent/stack inside diameter~~<br>~~vent/stack exhaust orientation (vertical, horizontal, or other)~~<br>~~restrictions to exhaust Air flow (e.g., rain caps)~~<br>~~adjacent building height~~<br>~~adjacent building cross-sectional area~~ | <br><br>~~Any point on Reactor Building or Turbine Building wall~~<br>~~37.0 meters~~<br>~~0.0 meters/second~~<br>~~0.0 meters~~<br>~~not applicable~~<br>~~not applicable~~<br>~~0.0 meters~~<br>~~0.01 square meters~~ | |
| ~~Annual average routine release χ/Q values at the security owner controlled area fence~~ | ~~3.64E-04 s/m³~~ | |

**Table 2.0-1: Site Design Parameters (Continued)**

| Site Characteristic / Parameter | NuScale Design Parameter | References to Parameter |
|---|---|---|
| Routine release $\chi$/Q and D/Q values ~~at site boundary and locations of interest~~associated with the bounding offsite dose location<br>undepleted/no decay<br>undepleted/2.26-day decay<br>depleted/8.00-day decay<br>D/Q | <br><br>5.43E-05 ~~$m/s^3$~~$s/m^3$<br>5.43E-05 ~~$m/s^3$~~$s/m^3$<br>5.43E-05 ~~$m/s^3$~~$s/m^3$<br>5.43E-07 $1/m^2$ | Table 11.3-6 |
| **Hydrologic Engineering (Section 2.4)** | | |
| Maximum flood elevation<br>probable maximum flood and coincident wind wave and other effects on max flood level | 1 foot below the baseline plant elevation | Sections 2.4.2 and 3.4.2.1 and Table 3.8.5-9 |
| Maximum elevation of groundwater | 2 feet below the baseline plant elevation | Sections 2.4.12, 3.4.2.1, 3.8.4.3.22.1, and 3.8.4.8 and Table 3.8.5-9 |
| ~~Site grading~~ | ~~Site is properly graded and has adequate drainage to prevent localized flooding~~ | |
| **Geology, Seismology, and Geotechnical Engineering (Section 2.5)** | | |
| Ground motion response spectra /safe shutdown earthquake | See Figures 3.7.1-1 and 3.7.1-2 for horizontal and vertical certified seismic design response spectra (CSDRS) for all Seismic Category I SSC.<br>See Figures 3.7.1-3 and 3.7.1-4 for horizontal and vertical high frequency certified seismic design response spectra (CSDRS-HF) for Reactor Building and Control Building. | Sections 3.7.1.1, 3.8.4.3.16, and 3.8.4.8 |
| Fault displacement potential | No fault displacement potential | Section 2.5.3 |
| Minimum soil bearing capacity ($Q_{ult}$) beneath safety-related structures | 75 ksf | Sections 2.5.4, 3.8.5.6.3, and 3.8.5.6.7 |
| Lateral soil variability | Uniform site (~~+/-~~ ≤ 20 degree dip) | Section 2.5.4 |
| Minimum ~~S~~soil angle of internal friction | 30 degrees | Sections 2.5.4 and 3.8.5.3.1 and Table 3.8.5-1 |
| ~~Minimum coefficient of static friction (all interfaces between basemat and soil)~~ | ~~0.58~~ | |
| Minimum shear wave velocity | ≥ 1000 fps at bottom of foundation | Section 2.5.4 |
| Liquefaction potential | No liquefaction potential | Section 2.5.4 |

**Table 2.0-1: Site Design Parameters (Continued)**

| Site Characteristic / Parameter | NuScale Design Parameter | References to Parameter |
|---|---|---|
| Maximum settlement for the Reactor Building, Control Building, and Radioactive Waste Building | | |
| total settlement | ~~no limit~~4 inches | Sections 3.8.5.6.1 and 3.8.5.6.2 |
| tilt settlement | ~~1 inch per 50 feet in any direction~~Maximum of 0.5 inch per 50 feet of building length or 1 inch total in any direction at any point in these structures | Sections 2.5.4, 3.8.5.6.1, 3.8.5.6.2, and 3.8.5.6.4 |
| differential settlement (between Reactor Building and Control Building, and between Reactor Building and Radioactive Waste Building) | ~~no limit~~0.5 inch | Section 3.8.5.6.4 |
| Slope failure potential | No slope failure potential | Section 2.5.5 |
| ~~**Source Terms**~~ | | |
| ~~Design basis accident source term~~ | ~~Accident source term is addressed in Section 15.0.3~~ | |
| ~~Inventory of radionuclides that could potentially seep into the groundwater~~ | ~~Potential inventory of radionuclides and compliance with Branch Technical Position 11-06 are described in Sections 11.2.3.2 and 12.2~~ | |

## 2.1 Geography and Demography

RAI 02.03.01-2

The certified design assumes that the Exclusion Area Boundary and Low Population Zone outer boundary are ~~at the Security owner controlled area fence. This fence is shown on Figure 1.2-4. This is the smallest footprint that can be used for these boundaries~~as close as 400 feet from the nearest release point. This is a key design parameter and included in Table 2.0-1.

COL Item 2.1-1: A COL applicant that references the NuScale Power Plant design certification will describe the site geographic and demographic characteristics.

## 2.3.4 Short-Term Atmospheric Dispersion Estimates for Accident Releases

### Accidental Radioactive Releases

Topical Report TR-0915-17565, Revision 0, (Reference 2.3-3) describes the methodology used for establishing source terms and calculating the atmospheric dispersion factors used to determine accident radiological consequences at the technical support center (TSC), main control room (MCR) and offsite locations for the NuScale Power Plant certified design.

RAI 02.03.01-2

Atmospheric dispersion factors (χ/Q values) are determined at the site owner controlled area boundary. This fence is as close as 400 feet from the closest release point and may be used as both the exclusion area boundary (EAB) and as the low population zone (LPZ) outer boundary. These χ/Q values as well as the χ/Q values for the MCR were determined for various sites in the United States using a meteorological database that included multiple years of data across all regions of the United States. This approach determined that the meteorological dataset for Sacramento, California, between 1984-1986, is representative of the bounding 80th to 90th percentile of potential NuScale Power Plant construction sites in the United States. This meteorological data set was used to calculate the χ/Q values for the certified design.

The χ/Q values at the site owner controlled area fence are listed in Table 2.0-1. These χ/Q values are based on the source location and path shown in Figure 2.3-1.

RAI 02.03.04-1

The χ/Q values used for evaluation of doses in the MCR and TSC are determined at the Control Building doors and HVAC inlet and are listed in Table 2.0-1. Figure 2.3-2 and Figure 2.3-3 show the path and distances from the Reactor Building release point to MCR door and HVAC inlet. The two source locations shown in Figure 2.3-2 and Figure 2.3-3 are the limiting source locations because they are the closest source locations to the main control room personnel doors and main control room HVAC intake. Assumptions for release point characteristics used for the χ/Q calculations are ~~also~~ listed in ~~Table 2.0-1.~~Table 15.0-20.

The χ/Q values for the TSC are the same as the MCR because the TSC is located directly above the MCR and shares the same HVAC inlet and outside doors.

The COL applicant will determine site specific χ/Q values for the EAB, LPZ outer boundary, MCR and present that information as part of the response to COL item 2.3-1.

### Hazardous Material Releases

As stated in Section 2.2, the NuScale Power Plant certified design does not postulate any hazards from on-site sources or nearby industrial, transportation, or military facilities.

The COL applicant will provide discussion of site specific hazardous material releases as part of the response to COL item 2.3-1.

## 3.3.2 Extreme Wind Loads (Tornado and Hurricane Loads)

### 3.3.2.1 Design Parameters for Extreme Winds

Tornado wind loads include loads caused by the tornado wind pressure, tornado atmospheric pressure change effect, and tornado-generated missile impact. Hurricane wind loads include loads due to the hurricane wind pressure and hurricane-generated missiles.

The parameters for the design basis tornado are the most severe tornado parameters postulated for the continental United States as identified in RG 1.76, Rev. 1.

RAI 02.03.01-2

- Maximum wind speed .................... 230 mph
- ~~Maximum t~~Translational speed............ 46 mph
- Maximum rotational speed ............... 184 mph
- Radius of maximum rotational speed...... 150 ft
- ~~Maximum p~~Pressure drop................. 1.2 psi
- Rate of pressure drop ..................... 0.5 psi/s

RAI 02.03.01-5

The wind speed for the design basis hurricane is the highest wind speed postulated ~~for the continental United States as identified~~ in ~~Figures 1 - 3 of~~ Regulatory Position 1 of RG 1.221, Rev. 0, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants,~~:~~" which occurs in Figure 2 of RG 1.221, Rev. 0.

- Maximum wind speed .................... 290 mph

Refer to Section 3.5 for a description of hurricane and tornado wind-generated missiles.

### 3.3.2.2 Determination of Tornado and Hurricane Forces

Tornado and hurricane wind velocities are converted into effective pressure loads in accordance with ASCE/SEI 7-05 (Reference 3.3-1), Equation 6-15, as follows:

$q_z = 0.00256\ K_z\ K_{zt}\ K_d\ V_w^2\ I\ (lb/ft^2)$

where,

RAI 03.03.01-1

$K_z$ = velocity pressure exposure coefficient evaluated at height "z", as defined in with ASCE/SEI 7-05, Table 6-3, but not less than 0.87~~5~~. (For tornados, wind speed is not assumed to vary with height.) For simplicity and conservatism, z is assumed to be the building height.

$K_{zt}$ = topographic factor equal to 1.0,

#### 3.8.4.3.9 Accident Thermal Loads ($T_a$)

The maximum post accident temperature in the RXB is assumed to be 212°F. This temperature is used in conjunction with the external temperature to determine the stresses and displacements.

The CRB does not have any high energy or high temperature piping. $T_a$ is not a load for the CRB.

#### 3.8.4.3.10 Rain Load (R)

RAI 02.03.01-3

The flat portion of the roof of the RXB does not have a parapet or any means to retain water. The CRB roof is sloped and the parapet has scuppers to disperse rainwater. An additional drainage pipe limits the average water depth on the CRB roof to a maximum of 4 inches. Therefore a rain load is assumed bounded by the snow load and extreme snow load.

#### 3.8.4.3.11 Snow Loads (S)

RAI 02.03.01-2, RAI 02.03.01-3

~~A~~As shown in Table 2.0-1, a roof snow load of 50 psf is assumed for normal load combinations. Equation 3.8-1 (taken from Equation 7-1 of Reference 3.8.4-8) is used to convert from ground-level snow loads to roof snow loads. An exposure factor of 1.0 is used. A thermal factor of 1.0 is used. An importance factor of 1.2 is used for buildings listed as Seismic Category I in Table 3.2-1 and an importance factor of 1.0 is used for all other buildings.

$$p_f = 0.7C_eC_tIp_g \quad \text{Equation 3.8-1}$$

where

$p_f$ is the roof snow load

$C_e$ is the exposure factor

$C_t$ is the thermal factor

I is the Importance Factor

$p_g$ is the ground snow load

#### 3.8.4.3.12 Extreme Snow Loads ($S_e$)

RAI 02.03.01-3

A wet roof snow load of 75 psf is assumed for extreme environmental load combinations. Extreme ground-level snow loads are converted to extreme roof snow loads using Equation 3.8-1 in the same manner described in Section 3.8.4.3.11.

### 3.8.4.3.13 Wind Loads (W)

RAI 02.03.01-2

The design wind load pressure on the RXB is 80 psf. This load is 76 psf for the CRB. Wind loads are developed as described in Section 3.3 based on the site parameters in Table 2.0-1.

### 3.8.4.3.14 Tornado Wind Loads ($W_t$) and Hurricane Wind Loads ($W_h$)

RAI 02.03.01-2

These loads are also developed as described in Section 3.3 based on the site parameters in Table 2.0-1. The RXB combined tornado wind and differential air pressure load is 250 psf and the hurricane wind load pressure is 260 psf. Therefore 260 psf is used as the design extreme wind load pressure for the RXB.

The CRB combined tornado wind and differential air pressure load is 225 psf, while the hurricane wind load pressure is 220 psf. For the CRB the extreme wind load pressure is 225 psf.

### 3.8.4.3.15 OBE Seismic Loads ($E_o$)

The operating basis earthquake (OBE) is defined as 1/3 of the safe shutdown earthquake (SSE). Earthquake loads from the operating basis earthquake ($E_o$) are not evaluated.

### 3.8.4.3.16 SSE Seismic Loads ($E_{ss}$)

RAI 02.03.01-2

The SSE for the site independent evaluation of the RXB and CRB is the CSDRS and the CSDRS-HF from Table 2.0-1. SSE Seismic Loads ($E_{ss}$) are derived from evaluation of the structures using ground motion accelerations from the CSDRS and the CSDRS-HF as described in Section 3.7.

Seismic dynamic analyses of the buildings considered 100 percent of the dead load and, 25 percent of the floor live load during normal operation and 75 percent of the roof snow load as the accelerated mass.

### 3.8.4.3.17 Crane Load ($C_{cr}$)

This load comes from the RBC. The RBC is a bridge crane located at EL. 145'-6" and provide lifting and handling for the NPMs. The RBC is described in more detail in

There are no safety-related reinforced masonry walls in Seismic Category I structures.

Steel-Concrete Modules

The NuScale Power Plant primary safety-related structure design does not use steel-concrete modules.

#### 3.8.4.6.2 Quality Control

Chapter 17 details the quality assurance program.

#### 3.8.4.6.3 Special Construction Techniques

Modular construction, where wall or slab elements (or the rebar reinforcement) is pre-fabricated and then incorporated into the building, will be used when possible. This process is expected to leave sacrificial (non-structural) steel within the buildings. Typically this will be reinforcing beams underneath slabs. The uniform distributed dead load applied in the structural and seismic analyses encompasses the weight of this steel.

### 3.8.4.7 Testing and Inservice Inspection Requirements

There is no testing or in-service surveillance beyond the quality control tests performed during construction, which is in accordance with ACI 349, and AISC N690 (Reference 3.8.4-6).

COL Item 3.8-1: A COL applicant that references the NuScale Power Plant design certification will describe the site-specific program for monitoring and maintenance of the Seismic Category I structures in accordance with the requirements of 10 CFR 50.65 as discussed in RG 1.160. Monitoring is to include below grade walls, groundwater chemistry if needed, base settlements and differential displacements.

### 3.8.4.8 Evaluation of Design for Site Specific Acceptability

RAI 02.03.01-2

The RXB and CRB are designed to remain operable and to transmit ~~acceptable~~ forces, moments, and accelerations so that contained safety-related SSC remain operable during and following an earthquake with a spectra equal to the CSDRS or the CSDRS-HF. This is accomplished by confirming the buildings meet code acceptance criteria if situated on a soft soil site, a hard soil/soft rock site, a rock site, and a hard rock site. However, each actual site will have unique soil conditions and a site-specific SSE. The entire analysis described in Section 3.8.4 does not need to be re-performed if it can be shown that non-seismic loads are less than those produced by the ~~design~~site parameters provided in Table 2.0-1 and that the forces experienced within the building from the site-specific earthquake are less than those produced from the CSDRS and CSDRS-HF.

RAI 02.03.01-2, RAI 03.08.05-15

Bearing pressure is used to establish a design parameter for bearing capacity for site selection. The bearing capacity of the soil should provide a factor of safety of 3.0 for the static bearing pressure and a factor of safety of 2.0 for dynamic bearing pressure. The maximum allowable differentialtilt settlement for the Reactor Building and the Control Building is 1" total or ½" per 50 feet in any direction at any point in theeither structure. The maximum allowable total settlement at any foundation node is 4 inches.

#### 3.8.5.6.1.1 RXB Uplift

RAI 03.08.05-3

As shown in Section 3.8.5.4.1.4Section 3.8.5.5.1

$$FOS = \frac{F_{resisting}}{F_{driving}} \qquad FOS_{flotation} = \frac{D}{B} \qquad FOS_{uplift} = \frac{D+F}{B+Rz}$$

The FOS for flotation is shown in Table 3.8.5-5 for each of the 16 cases considered, including cracked and uncracked conditions, Soil Types 7, 8, 9 and 11, and for RXB model and the triple building model. For each of the cases, an acceptable FOS for overturning was met.

##### 3.8.5.6.1.1.1 Dynamic RXB Uplift Ratio

The effect of foundation uplift has been evaluated for the RXB. The linear SSI analysis methods are acceptable if the ground contact ratio is equal to or greater than 80 percent. The ground contact ratio can be calculated from the linear SSI analysis using the minimum basemat area that remains in compression with the soil. The seismic total vertical base reactions are calculated by the time step-by-time step algebraic summation of all nodal vertical reactions of the nodes of the RXB basemat. The maximum seismic vertical reactions for the cracked and uncracked concrete conditions for the two models are summarized in Table 3.8.5-4. The base vertical reaction results for the uncracked condition are similar to those for the cracked concrete condition.

As shown in Table 3.8.5-4, the seismic reactions are much less than the total dead weight reaction over the rectangle basemat area of 471,487 kips. Thus, the net reactions are always in compression.

RAI 03.08.05-16

The typical total basemat vertical reaction time histories are shown in Figure 3.8.5-42 through Figure 3.8.5-47. Figure 3.8.5-42 and Figure 3.8.5-43 show the reactions for comparison between the cracked and uncracked concrete conditions. Each of the CSDRS and CSDRS-HF compatible seismic inputs contain three acceleration components, X (EW), Y (NS), and Z (vertical).

$$FOS_{overturning} = \frac{M_{restoring}}{M_{overturning}}$$

The FOS for overturning is shown in Table 3.8.5-5 for each of the 16 cases considered, including cracked and uncracked conditions, Soil Types 7, 8, 9, and 11, and for RXB model and the triple building model. For each of the cases, an acceptable FOS for overturning was met.

### 3.8.5.6.2 CRB Stability

The minimum acceptable factor of safety for flotation, uplift, sliding, and overturning is 1.1. This was not achieved for the CRB uplift.

Linear analyses were overly conservative and showed unsatisfactory results for the CRB Stability Analyses, so nonlinear evaluation was used. The uplift, sliding, and overturning stability analysis of the Control Building is performed using a nonlinear sliding and uplift analysis. A nonlinear sliding, overturning, and uplift analysis was performed for the CRB to show that sliding, overturning, and uplift are insignificant.

Figure 3.8.5-48 shows the designations used (A through I) for the locations on the CRB basemat where the relative vertical displacements (uplift) and lateral displacements (sliding) were assessed between the two end nodes of the CONTA178 elements.

RAI 02.03.01-2

Bearing pressure is used to establish a design parameter for bearing capacity for site selection. The bearing capacity of the soil should provide a factor of safety of 3.0 for the static bearing pressure and a factor of safety of 2.0 for dynamic bearing pressure. The maximum allowable tilt settlement for the Control Building is 1" total or 1/2" per 50 feet in any direction at any point in the structure. The maximum allowable total settlement at any foundation node is 4 inches.

#### 3.8.5.6.2.1 CRB Uplift

The key results are:

The relative displacements between the nodes at the basemat of the CRB are considered as actual uplift between CRB and surrounding soil. (Negative displacement values are considered as penetrations; a negligible amount of penetration is expected for penalty stiffness based contact algorithms.)

The elements transfer loads only when the contact is made. Therefore, the reactions drop to zero when there is a contact gap or uplift. This can be clearly seen from the force versus uplift comparison at location A in Figure 3.8.5-49 and Figure 3.8.5-50. The CRB is in an uplifted state at this corner location A for an infinitesimal duration of time just before the 10 seconds mark, resulting in zero reaction forces. The maximum uplift at location A is less than 1/64". The

A summary of the results is provided in Table 3.8.5-15Table 3.8.5-13. The results show that the deeply embedded Control Building experiences less than 1/10" of sliding and overturning horizontal displacement and less than 1/64" of total vertical uplift displacement. The magnitudes of these displacements are insignificant. Thus, the potential for sliding is insignificant.

#### 3.8.5.6.2.3 Control Building Overturning

RAI 03.08.05-21

The results provided in Table 3.8.5-13 results show that the deeply embedded Control Building experiences less than 1/10" of overturning horizontalsliding displacement and less than 1/64" of total vertical uplift displacement. The magnitudes of these displacements are insignificant. Thus, the potential for overturning is insignificant.

RAI 03.08.05-22

### 3.8.5.6.3 Average Bearing Pressure

RAI 03.08.05-22

Static bearing pressure is the dead load of the building divided by the footprint.As stated in Section 3.8.5.5.4, the average static bearing pressure is the dead load of the building divided by the footprint.

RAI 02.03.01-2

The weight of the RXB is 587,147 kips and the calculated footprint is 58,175 $ft^2$. This results in an average pressure of 10.1 ksf. This results in a factor of safety of 6.9 to the minimum soil bearing capacity of 75 ksf specified in Table 2.0-1. The weight of the CRB (based on static vertical gravity reaction (1GZ) and soil weight) is 75,779 kips with a base area of 11,800 $ft^2$. This results in a static bearing pressure of 6.42 ksf. This value for the CRB static bearing pressure provides a factor of safety of 10.9 to the minimum soil bearing pressurecapacity of 75 ksf in Table 2.0-1.

RAI 03.08.05-22

The dynamic bearing pressure is the maximum pressure experienced underneath the RXB basemat. To show the pressure distribution, the seismic bearing pressure contours are shown in Figure 3.8.5-3. As seen in the figures, the high bearing pressures are along the East and West edges of the RXB basemat and under the NPMs. The RXB foundation dynamic pressure is 4.6 ksf. The CRB foundation dynamic pressure is 5.32 ksf.The average dynamic bearing pressure is obtained as described in Section 3.8.5.5.4, with the vertical reaction for the entire basemat computed at each time step. The RXB foundation average dynamic pressure is 4.6 ksf. The CRB average foundation dynamic pressure is 2.3 ksf.

### 3.8.5.6.4 Settlement

RAI 02.03.01-2

Displacement values are provided for selected nodes in the foundation in Table 3.8.5-8. The location of these nodes is shown in Figure 3.8.5-10. As can be seen from the values in Table 3.8.5-8, total settlement at any foundation node, tilt settlement, and differential displacementsettlement isare minimal. The maximum allowable differential settlement between the RXB and CRB, and between the RXB and RWB is 0.5 inch.

RAI 02.03.01-2

The RXB settles approximately 1¾ inch on the west end and approximately 2 inches on the east end. The differentialtilt settlement of 0.25" is less than 1" as cited in Section 3.8.5.6.1. There is negligible tilt north to south. The east end of the building contains the pool and the NPMs.

RAI 02.03.01-2

The CRB settles approximately 1¾ inch on the west end and approximately 1 inch on the east end. The differentialtilt settlement of 0.75" is less than the 1" limit cited in Section 3.8.5.6Section 3.8.5.6.2. North- to south tilt is negligible. The CRB tilts toward the RXB. Differential settlement between the two buildings is on the order of ¼ inch.

The Seismic Category II Radioactive Waste Building settles approximately ½ inch on the west end and approximately 1½ inch on the east end. The RWB tilts toward the RXB. The RWB tilts approximately 1/5 inch in the north-south direction. Differential settlement between the RWB and the RXB is also on the order of ¼ inch.

### 3.8.5.6.5 Thermal Loads

During normal operation, a linear temperature gradient across the RXB foundation may develop.

An explicit analysis considering these loads has not been performed, as thermal loads are a minor consideration. Thermal loads are, by nature, self-relieving by means of concrete cracking and moment distribution. This is especially true of the NuScale RXB, as it is not a traditional pre-stressed/post-tensioned, cylindrical containment vessel, but, rather, a rectangular reinforced concrete building with several members framing into the roof, external walls, and basemat.

### 3.8.5.6.6 Construction Loads

The entire RXB basemat is poured in a very short time. The building is essentially constructed from the bottom up. The main loads (the reactor pool and the NPMs) are not added until the building is complete. Therefore, there are no construction-induced settlement concerns. The CRB basemat is much smaller and will be poured later than the RXB basemat in the construction sequence.

# Response to Request for Additional Information
# Docket No. 52-048

**eRAI No.:** 9179
**Date of RAI Issue:** 10/16/2017

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**NRC Question No.:** 02.03.01-3

Regulatory Background

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, “Design bases for protection against natural phenomena”, states, in part, that “[s]tructures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena….without loss of capability to perform their safety functions” and that “[t]he design bases for these structures, systems, and components shall reflect….[a]ppropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.”

In addition, 10 CFR 52.47(a)(1) requires a design certification applicant to provide site parameters postulated for its design and an analysis and evaluation of the design in terms of those site parameters.

Further, NUREG-0800, Standard Review Plan (SRP), Section 2.3.1, “Regional Climatology,” establishes criteria that the NRC staff uses to evaluate whether an applicant meets the NRC’s regulations. With respect to the assessment of normal and extreme winter precipitation events, the NRC staff issued Interim Staff Guidance (ISG) document DC/COL-ISG-007 on June 23, 2009 (see Agencywide Documents Access and Management System (ADAMS) Accession No. ML091490565), to clarify the staff’s position under SRP Acceptance Criterion (6) in Subsection II (Acceptance Criteria) of SRP Section 2.3.1 on identifying winter precipitation events as site characteristics and site parameters for determining normal and extreme winter precipitation loads on the roofs of Seismic Category I Structures.

Information needed

The applicant should address the following issues related to the normal and extreme roof snow load site parameters postulated for the NuScale SMR plant design in FSAR Tier 1, Table 5.0-1 and Tier 2, Table 2.0-1:

a. FSAR Tier 2, Table 1.9-4, "Conformance with Interim Staff Guidance (ISG)," indicates, with respect to the assessment of normal and extreme winter precipitation loads on the roofs of Seismic Category I structures, conformance with ISG document DC/COL-ISG-7. Under the

column heading “Comments”, the applicant states, in part, that “[t]he COL applicant needs to determine site-specific information to compare to the design parameters.That determination is performed in Section 2.4.”

Consistent with the scope of SRP Section 2.3.1, the applicant should correct the current section cross-reference to indicate Section “2.3” (i.e., of the FSAR) instead of Section “2.4” under the column headings “Comments” and “Section”.

b. FSAR Tier 2, Table 1.9-4 also includes two row entries (AC items) related to DC/COL-ISG-7, the primary distinction being under the column heading “AC Title / Description”. AC Item (1) refers to “Normal and Extreme Winter Precipitation Events”; AC Item (2) refers to “Resulting Normal and Extreme Winter Precipitation Live Roof Loads.” The NRC staff notes that DC/COL-ISG-007 first discusses site characteristics or site parameters associated with normal and extreme winter precipitation events in terms of ground snow loads (consistent with the basic snow load data in American Society of Civil Engineers / Structural Engineering Institute (ASCE / SEI) Standard 7-10 (“Minimum Design Loads for Buildings and Other Structures”) and later as resulting live roof snow loads. The staff further notes that the snow load-related site parameters in FSAR Tier 1, Table 5.0- 1 and Tier 2, Table 2.0-1 are specified only as roof snow loads.

   Consequently, the applicant should further clarify the intended distinction between the entries for AC Items (1) and (2) in FSAR Tier 2, Table 1.9-4 ,which otherwise appear to be redundant given the first two sentences in the AC Item (1) entry under the column heading “Comment.”

c. The site parameters listed in FSAR Tier 1, Table 5.0-1 and Tier 2, Table 2.0-1 and discussed in FSAR Tier 2, Subsection 3.4.2.2, “Probable Maximum Precipitation,” are specified only as roof snow loads. The FSAR does not address the determination of or identify the ground snow loads for normal and extreme winter precipitation events leading to the estimation of corresponding live roof snow loads consistent with ISG document DC/COL-ISG-007. Rather, FSAR Tier 2, Section 2.3.1 only states that “[t]he design normal roof snow load is 50 psf (pounds per square foot). For the extreme roof snow load, a value of 150 percent of the normal roof snow load, or 75 psf was selected.”

   The NRC staff also notes that the value 50 psf corresponds to the maximum snow load for roof design for precipitation as designated in Table 1.2-6 (Envelope of ALWR Plant Site Design Parameters) of the “Advanced Light Water Reactor Utility Requirements Document [URD]”, Volume II – ALWR Evolutionary Plant, Chapter 1 (Overall Requirements), Revision 8, published by the Electric Power Research Institute (EPRI), March 1999.

   Consistent with the guidance provided in DC/COL-ISG-007, snow load-related site parameters presented in FSAR Tier 1, Table 5.0-1 and Tier 2, Table 2.0-1 should be expressed as the appropriate ground snow load values associated with the normal and extreme winter precipitation events. Therefore, the applicant should revise FSAR Tier 2,

Section 3.8, "Design of Category I Structures," to discuss how the ground-level snow loads for normal and extreme winter precipitation events are to be converted to the corresponding normal and extreme roof snow loads for each of the buildings to which they are to be applied.

d. FSAR Tier 2, Subsection 3.8.4.3.10, “Rain Load,” states that “[t]he CRB (Control Building) roof is sloped and the parapet has scuppers to disperse rainwater. Therefore a rain load is assumed bounded by the snow load and extreme snow load.” As indicated above, the FSAR does not appear to provide any information regarding how (or if) the ground snow load for extreme winter precipitation events was accounted for. DC/COL-ISG-007 calls for the extreme winter precipitation event to be based on the normal winter precipitation event (i.e., the ground snow load associated with the highest of four values - either the 100-year return or historical maximum snowpack (snow depth) or the 100-year return or historical maximum two-day snowfall events) plus the higher of two values - either the extreme frozen winter precipitation event (i.e., the 100- year return or historical maximum two-day snowfall events) or the extreme liquid winter precipitation event (i.e., 48-hour probable maximum winter precipitation).

   More importantly to the statement in Tier 2, Subsection 3.8.4.3.10, DC/COL-ISG-007 also calls for potential blockage of primary and other roof drainage due to the antecedent snowpack on the roof to be accounted for, thus making all or some portion of the extreme liquid winter precipitation event relevant to determining the controlling CRB roof snow load.

   Therefore, assuming the antecedent normal winter precipitation event results in blockage or clogging of the roof scuppers and/or other liquid precipitation drainage systems on the CRB, the applicant should confirm whether the weight (load) due to that depth of liquid precipitation on top of the antecedent snowpack still supports the statement in Tier 2, Subsection 3.8.4.3.10 that “a rain load is assumed bounded by the….extreme snow load”. If so, please clarify the discussion in Tier 2, Subsection 3.8.4.3.10 in the context of the DC/COL-ISG-007 process (which FSAR Tier 2, Table 1.9-4 indicates conformance to) for evaluating extreme winter precipitation events. These clarifications should include identifying the maximum depth of standing water on the CRB roof to be assumed if the scuppers and/or other drainage provisions are clogged or otherwise blocked by the antecedent snowpack or ice. If the referenced statement in Tier 2, Subsection 3.8.4.3.10 is no longer supported, the applicant should revise any related text and/or table entries accordingly.

e. As indicated previously, the snow load-related site parameters in FSAR Tier 1, Table 5.0-1 and Tier 2, Table 2.0-1 are specified only as roof snow loads. The NuScale SMR plant design has a smaller areal extent and likely smaller size of the overall plant site compared to that typical of larger light- water-reactor plant sites. Consequently, the NuScale SMR plant design might be deployed in closer proximity to areas with differing surface roughness factors (e.g. terrain, trees, other building obstructions) that might affect the Exposure Factor to be considered in estimating roof snow loads from the ground snow

loads associated with normal and extreme winter precipitation events.

So that the roof snow load site characteristics developed for these events can be properly evaluated against the corresponding normal and extreme site parameter values at the COL application stage, the applicant should specify the Exposure Factor(s) to be assumed in developing the normal and extreme roof snow load values in FSAR Tier 1, Table 5.0-1 and Tier 2, Table 2.0-1 for each of the buildings to which they are to be applied (if different).

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**NuScale Response:**

a) FSAR Tier 2, Table 1.9-4 is revised, as shown in the attached markup, to change "2.4" to "2.3" under the column headings “Comments” and “Section”.

b) FSAR Tier 2, Table 1.9-4 is revised, as shown in the attached markup, to merge the two AC items (1) and (2) into one.

c) FSAR Tier 2, Section 3.8.4.3 is revised, as shown in the attached markup, to describe how ground-level snow loads are converted to roof snow loads.

d) The extreme winter precipitation event is based on DC/COL-ISG-007 and is considered the sum of the normal ground level winter precipitation event and the higher of either the extreme liquid winter precipitation event or the extreme frozen winter precipitation event. The normal ground snow load is equivalent to a roof snow load of 50 psf roof snow load identified in FSAR Tier 2 Section 3.8.4.3.11 if calculated based on ASCE 7-05 Equation 7-1. The extreme liquid winter precipitation event is not expected to exceed 4 inches of accumulated water or the equivalent of 21 psf. The extreme frozen winter precipitation event is assumed to be bound by 25 psf. The maximum roof snow load plus additional surcharge due to extreme liquid or frozen winter precipitation event is thus less than that of the extreme winter precipitation event of 75 psf.

e) An Exposure Factor of 1.0 is to be assumed in developing the normal and extreme roof snow loads, as described in the attached markup of FSAR Tier 2, Section 3.8.4.3.11.

**Impact on DCA:**

FSAR Sections 1.9, 3.4.2, and 3.8.4 have been revised as described in the response above and as shown in the markup provided in this response.

RAI 02.03.01-3

**Table 1.9-4: Conformance with Interim Staff Guidance (ISG)**

| ISG Section/ Title | AC | AC Title / Description | Conformance Status | COL Applicability | Comments | Section |
|---|---|---|---|---|---|---|
| DC/COL-ISG-1: Seismic Issues of High Frequency Ground Motion | 1 | Seismic Issues addressed in this Interim Staff Guidance | - | - | This section roadmaps out to the guidance provided in Sections 2, 3, 4, and 5. There are no specific requirements. | 3.7 |
| DC/COL-ISG-1 | 2 | Ground Motion Definitions | Conforms | Applicable | The definitions provided in Section 3.7 are consistent. | 3.7 |
| DC/COL-ISG-1 | 3 | Staff Guidance/Position on the Definitions of Safe-Shutdown and Operating-Basis Earthquakes, Use of Various Ground Motions, Seismic Instrumentation and Operating-Basis Earthquake Exceedance | Conforms | Applicable | The CSDRS (and CSDRs-HF) is effectively the SSE for the DCA. The OBE is specified as 1/3 of the CSDRS thus does not require any analysis in the DCA. There are COL items for the applicant to ensure the GMRS is enveloped and to have a seismic monitoring program with responses following an OBE exceedance. | 3.7 |
| DC/COL-ISG-1 | 4 | Staff Guidance/Position on Addressing HF Ground Motion Evaluations | Conforms | Applicable | The NuScale Certified Design includes a High Frequency CSDRS. | 3.7 |
| DC/COL-ISG-1 | 5 | Staff Comments on the Industry Draft White Paper on Testing of Dynamic Soil Properties for Nuclear Power Plant Combined License Applications and Guidance on Information for Review | Partially Conforms | Applicable | This discusses laboratory analysis of the site-specific soil column. The FSAR includes COL items for the Applicant to develop site-specific information. | 2.5 |
| DC/COL-ISG-2: Financial Qualifications of Applicants For Combined License Applications | All | Various | Not Applicable | Not Applicable | This ISG is applicable to COL applicants. | Not Applicable |
| DC/COL-ISG-3: Probabilistic Risk Assessment Information to Support Design Certification and Combined License Applications | All | Various | Not Applicable | Not Applicable | Guidance concerning the review of PRA information and severe accident assessments submitted to support DC and COL applications has been incorporated into SRP 19.0, Rev 3. | Not Applicable |

**Table 1.9-4: Conformance with Interim Staff Guidance (ISG) (Continued)**

| ISG Section/ Title | AC | AC Title / Description | Conformance Status | COL Applicability | Comments | Section |
|---|---|---|---|---|---|---|
| DC/COL-ISG-4: Definition of Construction and on Limited Work Authorizations | All | Various | Not Applicable | Not Applicable | This ISG is applicable to all ESP and COL applicants requesting authorization to perform limited work activities or considering preconstruction activities. | Not Applicable |
| DC/COL-ISG-5: GALE86 Code for Calculation of Routine Radioactive Releases in Gaseous and Liquid Effluents to Support Design Certification and Combined License Applications | All | Five paragraphs under heading Final Interim Staff Guidance on Page 3 - Acceptability of GALE86 | Not Applicable | Not Applicable | The NuScale design is similar to large PWRs in the existing fleet with regards to effluent release calculations. However, the development of an alternate methodology is necessary because the existing PWRGALE code was developed in the 1980s for evaluation of the large PWR reactors of that time and does not appropriately address the NuScale plant design. | Not Applicable |
| DC/COL-ISG-6: Evaluation and Acceptance Criteria for 10 CFR 20.1406 to Support Design Certification and Combined License Applications | Bullets 1 thru 6 (p 3 & 4) | Acceptance Criteria - Compliance with RG 4.21 | Partially Conforms | Applicable | This guidance refers to Attachment C. The correct reference is Attachment B. This guidance is applicable, except for the portions that relate to site-specific, operational aspects that are the responsibility of the COL applicant referencing the NuScale design. Consistent with SRP Section 1.0, Appendix A; RG 1.206, Position C.III.4; and ESP/DC/COL-ISG-015, the DCA contains COL information items that describe the site-specific, operational information deferred to the COL applicant referencing the certified design. The aspects of this guidance that pertain to design features, facilities, functions, and equipment that are technically relevant to the NuScale standard plant design are applicable to the DCA. | 12.3.6 |
| DC/COL-ISG-7: Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures | ~~1~~All | Normal and Extreme Winter Precipitation Events and their Resulting Live Roof Loads | Conforms | Applicable | Section 3.4 identifies parameter specified for the Extreme and Normal winter precipitation events. These values are used in the structural analysis in 3.8. The COL applicant needs to determine site-specific information to compare to the design parameters. That determination is performed in Section ~~2.4~~2.3. | ~~2.4~~2.3<br>3.4<br>3.8 |
| ~~DC/COL-ISG-7~~ | ~~2~~ | ~~Resulting Normal and Extreme Winter Precipitation Live Roof Loads~~ | ~~Conforms~~ | ~~Applicable~~ | ~~The design parameters are used in the analysis in section 3.8.~~ | ~~3.8~~ |

#### 3.8.4.3.9 Accident Thermal Loads ($T_a$)

The maximum post accident temperature in the RXB is assumed to be 212°F. This temperature is used in conjunction with the external temperature to determine the stresses and displacements.

The CRB does not have any high energy or high temperature piping. $T_a$ is not a load for the CRB.

#### 3.8.4.3.10 Rain Load (R)

The flat portion of the roof of the RXB does not have a parapet or any means to retain water. The CRB roof is sloped and the parapet has scuppers to disperse rainwater. Therefore a rain load is assumed bounded by the snow load and extreme snow load.

#### 3.8.4.3.11 Snow Loads (S)

RAI 02.03.01-3

A roof snow load of 50 psf is assumed for normal load combinations. Equation 3.8-1 (taken from Equation 7-1 of Reference 3.8.4-8) is used to convert from ground-level snow loads to roof snow loads. An exposure factor of 1.0 is used. A thermal factor of 1.0 is used. An importance factor of 1.2 is used for buildings listed as Seismic Category I in Table 3.2-1 and an importance factor of 1.0 is used for all other buildings.

$$p_f = 0.7C_eC_tIp_g$$ Equation 3.8-1

where

$p_f$ is the roof snow load

$C_e$ is the exposure factor

$C_t$ is the thermal factor

I is the Importance Factor

$p_g$ is the ground snow load

#### 3.8.4.3.12 Extreme Snow Loads ($S_e$)

RAI 02.03.01-3

A wet roof snow load of 75 psf is assumed for extreme environmental load combinations. Extreme ground-level snow loads are converted to extreme roof

snow loads using Equation 3.8-1 in the same manner described in Section 3.8.4.3.11.

#### 3.8.4.3.13 Wind Loads (W)

The design wind load pressure on the RXB is 80 psf. This load is 76 psf for the CRB. Wind loads are developed as described in Section 3.3.

#### 3.8.4.3.14 Tornado Wind Loads ($W_t$) and Hurricane Wind Loads ($W_h$)

These loads are also developed as described in Section 3.3. The RXB combined tornado wind and differential air pressure load is 250 psf and the hurricane wind load pressure is 260 psf. Therefore 260 psf is used as the design extreme wind load pressure for the RXB.

The CRB combined tornado wind and differential air pressure load is 225 psf, while the hurricane wind load pressure is 220 psf. For the CRB the extreme wind load pressure is 225 psf.

#### 3.8.4.3.15 OBE Seismic Loads ($E_o$)

The operating basis earthquake (OBE) is defined as 1/3 of the safe shutdown earthquake (SSE). Earthquake loads from the operating basis earthquake ($E_o$) are not evaluated.

#### 3.8.4.3.16 SSE Seismic Loads ($E_{ss}$)

The SSE for the site independent evaluation of the RXB and CRB is the CSDRS and the CSDRS-HF. SSE Seismic Loads ($E_{ss}$) are derived from evaluation of the structures using ground motion accelerations from the CSDRS and the CSDRS-HF as described in Section 3.7.

Seismic dynamic analyses of the buildings considered 100 percent of the dead load and, 25 percent of the floor live load during normal operation and 75 percent of the roof snow load as the accelerated mass.

#### 3.8.4.3.17 Crane Load ($C_{cr}$)

This load comes from the RBC. The RBC is a bridge crane located at EL. 145'-6" and provide lifting and handling for the NPMs. The RBC is described in more detail in Section 9.1 and Section 3.7.3. The RBC has a total weight of approximately 1,000 tons and a lifting capacity of 850 tons.

The crane live loads are used for the design of the runways beams, connections and crane supports. These crane live loads are due to the moving crane and include the maximum wheel load, vertical impact, lateral impact and longitudinal impact loads.

The maximum wheel load for the RBC is produced by the weight of the bridge, plus the sum of the maximum lift capacity and the weight of the trolley positioned on its

3.8.4-7 ACI 349.1R, "Reinforced Concrete Design for Thermal Effects on Nuclear Power Plant Structures, American Concrete Institute, 2007.

RAI 02.03.01-3

3.8.4-8 American Society of Civil Engineers/Structural Engineering Institute, "Minimum Design Loads for Buildings and Other Structures," ASCE/SEI 7-05, Reston, VA, 2005.

COL Item 3.4-7: A COL applicant that references the NuScale Power Plant design certification will determine the extent of waterproofing and dampproofing needed to prevent groundwater and foreign material intrusion into the expansion gap between the end of the tunnel between the RXB and the CRB, and the corresponding RXB connecting walls.

RAI 03.04.02-1, RAI 03.04.02-3

The NuScale Power Plant design establishes a design basis flood level (including wave action) of one foot below the baseline top of concrete elevation at the ground level floor. Therefore, there are no dynamic flood loads on the RXB and CRB. The lateral hydrostatic pressures on the structures due to the design flood level, as well as ground water and soil pressure, are factored into the structural design as discussed in Sections 3.7.1 and 3.8.4.

### 3.4.2.2 Probable Maximum Precipitation

The design utilizes bounding parameters for both rain and snow. The rainfall rate for roof design is 19.4 inches per hour and 6.3 inches for a 5 minute period and the design static roof load because of snow is 50 pounds per square foot. The extreme snow load is 75 pounds per square foot.

The roofs of the RXB and CRB prevent the undesirable buildup of standing water in conformance with Regulatory Guide 1.102 as described below:

- The RXB has a gabled roof, with the sloping portions to the north and south. There are no parapets on the top, flat section.

RAI 02.03.01-3

- The CRB roof is a sloped steel structure with scuppers in the parapet designed to allow rainfall to drain off the roof. An additional drainage pipe limits the average water depth on the CRB roof to a maximum of 4 inches.

The bounding rain and snow loads are used in the structural analysis described in Section 3.8.4.

### 3.4.2.3 Interaction of Non-Seismic Category I Structures with Seismic Category I Structures

Nearby structures are assessed, or analyzed if necessary, to ensure that there is no credible potential for interactions that could adversely affect the Seismic Category I RXB and CRB. Figure 1.2-2 provides a site plan showing the plant layout. The non-Seismic Category I structures that are adjacent to the Seismic Category I RXB and CRB are:

- RWB (Seismic Category II) adjacent to RXB
- CRB above elevation 120' (Seismic Category II), above Seismic Category I CRB and adjacent to RXB
- [[North and south Turbine Generator Buildings (Seismic Category III), adjacent to RXB]]
- [[Central Utilities Building (Seismic Category III), adjacent to CRB]]

thermal load, seismic load, thrust load, and transient unbalanced internal pressure loads under abnormal and/or extreme environmental conditions.

The CRB does not have any high energy or high temperature piping. $R_a$ is not a load for the CRB.

#### 3.8.4.3.8 Operating Thermal Loads ($T_o$)

Thermal loads are caused by a temperature variation through the concrete wall between the interior temperature and the external environmental temperature. In addition, in the RXB, a thermal gradient could occur in the five foot thick walls surrounding the reactor pool. Section 1.3 of ACI 349.1R (Reference 3.8.4-7) states that thermal gradients should be considered in the design of reinforcement for normal conditions to control concrete cracking. However, a thermal gradient less than approximately 100° F need not be analyzed because such gradients will not cause significant stress in the reinforcement or strength deterioration.

As shown in Table 2.0-1, the external temperature design parameters for the NuScale standard structures are -40°F and +115°F. The external soil temperature is assumed to be 21°F in the winter and 40°F in the summer.

The RXB has a design internal air temperature range of 70°F to 130°F, and a design pool temperature range of 40°F to 120°F. These temperatures are used to determine the stresses and displacements.

The CRB has a maximum temperature differential of 110°F, based on an external temperature of -40°F and an internal temperature of 70°F. This gradient has been determined not to affect the design stresses in the building. $T_0$ is not a load for the CRB.

#### 3.8.4.3.9 Accident Thermal Loads ($T_a$)

The maximum post accident temperature in the RXB is assumed to be 212°F. This temperature is used in conjunction with the external temperature to determine the stresses and displacements.

The CRB does not have any high energy or high temperature piping. $T_a$ is not a load for the CRB.

#### 3.8.4.3.10 Rain Load (R)

RAI 02.03.01-3

The flat portion of the roof of the RXB does not have a parapet or any means to retain water. The CRB roof is sloped and the parapet has scuppers to disperse rainwater. An additional drainage pipe limits the average water depth on the CRB roof to a maximum of 4 inches. Therefore a rain load is assumed bounded by the snow load and extreme snow load.

# Response to Request for Additional Information
# Docket No. 52-048

**eRAI No.:** 9179
**Date of RAI Issue:** 10/16/2017

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**NRC Question No.:** 02.03.01-4

Regulatory Background

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, "Design bases for protection against natural phenomena", states, in part, that "[s]tructures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as….tornadoes, hurricanes….without loss of capability to perform their safety functions" and that "[t]he design bases for these structures, systems, and components shall reflect….[a]ppropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated."

In addition, 10 CFR Part 50, Appendix A, GDC 4, "Environmental and dynamic effects design bases," as it relates to information on tornadoes and, where applicable, hurricane winds that generate missiles states, in part, that "structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles….from events and conditions outside the nuclear power unit." Further, 10 CFR 52.47(a)(1) requires a design certification applicant to provide site parameters postulated for its design and an analysis and evaluation of the design in terms of those site parameters.

Information needed

FSAR Tier 2, Table 1.9-8, "Conformance with SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs"," indicates, with respect to Issue II.F under SECY-93-087 ("Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs"), that this provision is applicable to COL applicants of such designs and that the tornado design basis discussed in Section 3.3 of the NuScale DC application conforms to Issue II.F in that "[t]he FSAR uses the maximum tornado wind speed" for a design basis tornado (DBT).

The DBT wind speed in Issue II.F under SECY-93-087 (ADAMS Accession No. ML003708021) is 300 mph which was based on the original version of NUREG/CR-4461 (PNNL-9697), "Tornado Climatology of the Contiguous United States", dated 1986. However, the current revision of Regulatory Guide (RG) 1.76 is based on Revision 2 to NUREG/CR-4461 (PNNL-15112, Revision 1), dated February 2007, which lists a DBT maximum wind speed of

230 mph. Both postulated DBT maximum tornado wind speeds are consistent with a recurrence interval of 1E-07 per year and the statement of conformance status in FSAR Tier 2, Table 1.9-8 is consistent with ACRS' agreement with the NRC staff's position in SECY- 93-087 "that the best available data should be used to establish the tornado design basis". The applicant should clarify this entry in FSAR Tier 2, Table 1.9-8 to explain the difference between the tornado wind speed in Issue II.F under SECY-93-087 and the tornado wind speed from the current guidance in RG 1.76 postulated as a site parameter.

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**NuScale Response:**

FSAR Tier 2, Table 1.9-8 is revised, as shown in the attached markup, to clarify that the 230 mph value stated in the more recent guidance of RG 1.76 Revision 1 is used rather than the older 300 mph value stated in SECY-93-087.

**Impact on DCA:**

FSAR Section 1.9 has been revised as described in the response above and as shown in the markup provided in this response.

RAI 02.03.01-4

**Table 1.9-8: Conformance with SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs"**

| Issue | Description | Conformance Status | COL Applicability | Comments | Section |
|---|---|---|---|---|---|
| I.A | Use of a Physically-Based Source Term: Incorporation of engineering judgment and a more realistic source term in design that deviates from the siting requirements in 10 CFR 100. | Conforms | Applicable | None. | 15.0.3 |
| I.B | Anticipated Transient without SCRAM (ATWS): Position on the current practices and design features to achieve a high degree of protection against an ATWS. | Partially Conforms | Applicable | NuScale submitted a white paper that describes the underlying purpose of the rule which is to reduce the risk from ATWS events (NuScale Power Plant Design for ATWS and 10 CFR 50.62 Regulatory Compliance, NP-ER-0000-2196, September 18, 2013). The proposed treatment of the rule was described in a presentation to the NRC, Design for ATWS and 10 CFR 50.62 Regulatory Compliance, PM-0114-5922-P, February 26, 2014. The NuScale design relies on diversity within the module protection system (MPS) to reduce the risk associated with ATWS events. | 15.8 |
| I.C | Mid-Loop Operation: Position on design features necessary to ensure a high degree of reliability of RHR systems in PWR. | Not Applicable | Not Applicable | Design does not use external loops and no drain down condition for refueling. | 19.2 |
| I.D | Station Blackout (SBO): Position on methods to mitigate the effects of a loss of all AC power. | Not Applicable | Not Applicable | The relevance of the SECY-90-016 SBO issue to passive ALWR designs was deferred to and addressed in Section F of SECY-94-084 and SECY-95-132. The NuScale design conforms to the passive plant guidance these documents. | 8.4 |

**Table 1.9-8: Conformance with SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor Designs" (Continued)**

| Issue | Description | Conformance Status | COL Applicability | Comments | Section |
|---|---|---|---|---|---|
| II.C | Seismic Hazard Curves and Design Parameters: Position on use of proposed generic bounding seismic hazard curves and performance of seismic PRA. | Conforms | Applicable | None. | 19.1 |
| II.D | Leak-Before-Break: Position on use of leak-before-break concept. | Conforms | Applicable | LBB is applied to the MS and FW lines inside containment. | 3.6.3 |
| II.E | Classification of Main Steam Lines in BWRs: Position on the staffs defined approach for seismic classification of the main steam line in both evolutionary and passive BWRs. | Not Applicable | Not Applicable | Applicable to BWRs. | Not Applicable |
| II.F | Tornado Design Basis: Position on the maximum tornado wind speed to be used for a design basis tornado. | Conforms | Applicable | The FSAR uses the maximum tornado wind speed of 230 mph found in RG 1.76 Revision 1 rather than the outdated 300 mph guidance found in SECY-93-087. | 3.3 |
| II.G | Containment Bypass: Position on ALWR design against containment bypass. Specifically, failure of the containment system to channel fission product releases through the suppression pool, or the failure of passive containment cooling heat exchanger tubes in large pools of water outside containment. | Conforms | Applicable | None. | 15.0.3<br>19.1<br>19.2 |
| II.H | Containment Leak Rate Testing: Position on testing duration for Type C leak rate testing (prior to rule change). | Partially Conforms | Applicable | None. | 6.2.6 |
| II.I | Post-Accident Sampling System: Position on the required capability to analyze dissolved hydrogen, oxygen, and chloride in accordance with applicable regulations. | Conforms | Applicable | As described by SRP 9.3.2, I.6, and RG 1.206, C.I.9.3.2, a post-accident sampling system is not required provided that the guidance provided in SRP 9.3.2 for utilizing the normal process sampling system (post-accident) has been satisfied. | 9.3.2 |
| II.J | Level of Detail: Position on a design certification submittal with depth of detail similar to that in an FSAR. | Conforms | Applicable | None. | All FSAR Sections |
| II.K | Prototyping: No guidance provided; information only | Conforms | Applicable | None. | 1.5 |
| II.L | ITAAC: Position on providing ITAAC to demonstrate that a nuclear power plant referencing a certified design is built and operates consistent with the design certification. | Conforms | Applicable | None. | Tier 1<br>14.3 |

# Response to Request for Additional Information
# Docket No. 52-048

**eRAI No.:** 9179
**Date of RAI Issue:** 10/16/2017

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**NRC Question No.:** 02.03.01-5

Regulatory Background

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, "Design bases for protection against natural phenomena", states, in part, that "[s]tructures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as….tornadoes, hurricanes….without loss of capability to perform their safety functions" and that "[t]he design bases for these structures, systems, and components shall reflect….[a]ppropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated."

In addition, 10 CFR Part 50, Appendix A, GDC 4, "Environmental and dynamic effects design bases," as it relates to information on tornadoes and, where applicable, hurricane winds that generate missiles states, in part, that "structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles….from events and conditions outside the nuclear power unit." Further, 10 CFR 52.47(a)(1) requires a design certification applicant to provide site parameters postulated for its design and an analysis and evaluation of the design in terms of those site parameters.

Information needed

FSAR Tier 2, Table 1.9-2 indicates, with respect to design-basis hurricane and hurricane missiles, conformance with RG 1.221 and comments that "NuScale uses Region I (bounding) characteristics as design parameters." The NRC staff notes that this is the same comment appearing in Tier 2, Table 1.9-2 with respect to the design-basis tornado characteristics in RG 1.76.

However, there are no designated regions, per se, in RG 1.221 except as shown in Figures 1, 2, and 3 of RG 1.221, adapted from Figures 3-2b, 3-2c, and 3-2d in NUREG/CR-7005, "Technical Basis for Regulatory Guidance on Design-Basis Hurricane Wind Speeds for Nuclear Power Plants," which cover the U.S. coastline along the western Gulf of Mexico, the eastern Gulf of Mexico and southeastern Atlantic coastline, and the mid- and northern Atlantic coastline, respectively. The highest hurricane wind speed listed in the FSAR Tier 1, Table 5.0-1 and Tier

2, Table 2.0-1 appears on Figure 2 of RG 1.221. The applicant should clarify the corresponding comment entry in FSAR Tier 2, Table 1.9-2 and Tier 2, Subsection 3.3.2.1 accordingly.

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**NuScale Response:**

FSAR Tier 2, Table 1.9-2 and Section 3.3.2.1 are revised, as shown in the attached markup, to clarify that the wind speed for the design basis hurricane occurs in Figure 2 of RG 1.221.

**Impact on DCA:**

FSAR Sections 1.9 and 3.3.2.1 have been revised as described in the response above and as shown in the markup provided in this response.

RAI 02.03.01-5, RAI 05.02.03-13, RAI 08.01-1, RAI 08.01-1S1, RAI 08.02-4, RAI 08.02-6, RAI 08.03.02-1, RAI 09.02.06-1

## Table 1.9-2: Conformance with Regulatory Guides

| RG | Division Title | Rev. | Conformance Status | COL Applicability | Comments | Section |
|---|---|---|---|---|---|---|
| 1.3 | Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors | 2 | Not Applicable | Not Applicable | This guidance is only applicable to BWRs. | Not Applicable |
| 1.4 | Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors | 2 | Not Applicable | Not Applicable | This RG pertains to existing reactors; RG 1.183 is specified in SRP Section 15.0.3 to be used for new reactors. | Not Applicable |
| 1.5 | Safety Guide 5 - Assumptions Used for Evaluating the Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors | - | Not Applicable | Not Applicable | This guidance is only applicable to BWRs. | Not Applicable |
| 1.6 | Safety Guide 6 - Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems | - | Partially Conforms | Applicable | The onsite electrical AC power systems do not contain any Class 1E distribution systems. The EDSS design conforms to the guidance for independence of standby power sources and their distribution systems. | 8.3 |
| 1.7 | Control of Combustible Gas Concentrations in Containment | 3 | Not Applicable | Not Applicable | The containment vessel design is such that its integrity does not rely on combustible gas control systems. | 6.2 |
| 1.8 | Qualification and Training of Personnel for Nuclear Power Plants | 3 | Not Applicable | Applicable | Site-specific programmatic and operational activities are the responsibility of the COL applicant. | Not Applicable |
| 1.9 | Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants | 4 | Not Applicable | Not Applicable | Based on reduced reliance on AC power, the design does not require or include safety-related emergency diesel generators. | 8.3 |
| 1.11 | Instrument Lines Penetrating the Primary Reactor Containment | 1 | Not Applicable | Not Applicable | No lines penetrate the NPM containment. | 6.2 |

**Table 1.9-2: Conformance with Regulatory Guides (Continued)**

| RG | Division Title | Rev. | Conformance Status | COL Applicability | Comments | Section |
|---|---|---|---|---|---|---|
| 1.218 | Condition-Monitoring Techniques for Electric Cables Used in Nuclear Power Plants | - | Not Applicable | Applicable | ~~This guidance governs electric cable monitoring program activities that are not within the scope of design certification. Rather, these activities are the responsibility of and applicable to operating reactor licensees, including COL holders.~~The COL holder determines whether a cable is subject to condition monitoring during the development of the maintenance rule (10 CFR 50.65) program. This includes identification of SSC that require assessment per 10 CFR 50.65(a)(4). Cables that meet the criteria for inclusion in the maintenance rule program are subject to the guidance of RG 1.218. | ~~Not Applicable~~8.1<br>8.2<br>8.3 |
| 1.219 | Guidance on Making Changes to Emergency Plans for Nuclear Power Reactors | - | Not Applicable | Applicable | These requirements are applicable to operating reactor licensees, including COL holders. | Not Applicable |
| 1.221 | Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants | - | Conforms | Applicable | NuScale uses ~~Region 1 (bounding) characteristics~~the highest wind speed postulated in Regulatory Position 1 (which occurs in Figure 2 of RG 1.221 Rev. 0) as the wind speed for the design basis hurricane~~design parameters~~. | 3.3<br>3.5<br>3.8 |
| 1.226 | Flexible Mitigation Strategies for Beyond-Design-Basis Events (Draft DG-1301) | - | Partially Conforms | Applicable | The RG, presently in draft, endorses, with clarifications, NEI 12-06 Rev 1A, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide. NuScale is writing Chapter 20 meeting the applicable portions of the draft guidance. There is guidance in NEI 12-06 that is not applicable the NuScale design. These items are addressed in Chapter 20. | Ch 20 |

- Radius of maximum rotational speed . . . . . . 150 ft
- Maximum pressure drop . . . . . . . . . . . . . . . . . . 1.2 psi
- Rate of pressure drop . . . . . . . . . . . . . . . . . . . . . 0.5 psi/s

RAI 02.03.01-5

The wind speed for the design basis hurricane is the highest wind speed postulated for the continental United States as identified in Figures 1 - 3 of Regulatory Position 1 of RG 1.221, Rev. 0, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants,." which occurs in Figure 2 of RG 1.221, Rev. 0.

- Maximum wind speed . . . . . . . . . . . . . . . . . . . . 290 mph

Refer to Section 3.5 for a description of hurricane and tornado wind-generated missiles.

### 3.3.2.2 Determination of Tornado and Hurricane Forces

Tornado and hurricane wind velocities are converted into effective pressure loads in accordance with ASCE/SEI 7-05 (Reference 3.3-1), Equation 6-15, as follows:

$q_z = 0.00256\, K_z\, K_{zt}\, K_d\, V_w^2\, I$ (lb/ft$^2$)

where,

RAI 03.03.01-1

$K_z$ = velocity pressure exposure coefficient evaluated at height "z", as defined in with ASCE/SEI 7-05, Table 6-3, but not less than 0.875. (For tornados, wind speed is not assumed to vary with height.) For simplicity and conservatism, z is assumed to be the building height.

$K_{zt}$ = topographic factor equal to 1.0,

$K_d$ = wind directionality factor equal to 1.0,

$V_w$ = maximum wind speed (mph) (For tornadoes, $V_w$ is the resultant of the maximum rotational speed and the translational speed), and

I = importance factor equal to 1.15 for the RXB, CRB, and RWB.

Extreme wind loads on the RXB, CRB, and RWB are determined in conformance with ASCE/SEI 7-05, Equation 6-17:

$p = qGC_p - q_i\,(GC_{pi})$ (lb/ft$^2$)

where,

G = gust factor equal to 0.85 or greater,