NuScale Power

RAIO-0218-58794

February 21, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 185 (eRAI No. 8963) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 185 (eRAI No. 8963)," dated August 18, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 185 (eRAI No.8963)," dated October 17, 2017

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

The Enclosure to this letter contains NuScale's supplemental response to the following RAI Questions from NRC eRAI No. 8963:

- 03.08.05-8
- 03.08.05-10
- 03.08.05-11
- 03.08.05-15
- 03.08.05-18

The response to question 03.08.05-6 will be provided by December 20, 2018.

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,

Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8963

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8963

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

eRAI No.: 8963
Date of RAI Issue: 08/18/2017

NRC Question No.: 03.08.05-8

10 CFR Part 50, Appendix A, GDC 1, 2, 4 and 5 provide the regulatory requirements for the design of the seismic Category I structures. DSRS Section 3.8.5 provides review guidance pertaining to the stability on foundations.

FSAR Tier 2, Tables 3.8.5-1,"RXB Stability Evaluation Input Parameters," tabulates the coefficient of friction (CoF) between walls and soil and between basemat bottom surface and soil. However, the applicant did not tabulate these CoF values in Table 3.8.5-9,"CRB Stability Evaluation Input Parameters." Provide the CRB CoF values between walls and soil and between basemat bottom surface and soil in Table 3.8.5-9.

NuScale Response:

As discussed, in a public meeting on January 30, 2018, a supplement to NuScale's original response to RAI 8963 Question 03.08.05-8 is provided to address the coefficient of friction values in the FSAR. The coefficient of friction values shown throughout Revision 1 of the FSAR correspond with the values given in Tier 2, Table 3.8.5-9. These values have been deleted from Tier 1, Table 5.0-1 and Tier 2, Table 2.0-1 to only include the soil angle of internal friction, which is used to calculate the coefficient of friction.

Impact on DCA:

There are no impacts to the DCA as a result of this response, however Revision 1 changes are included 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 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 • maximum horizontal wind speed • maximum translational speed • maximum rotational speed • maximum radius of rotational speed • maximum pressure differential • maximum rate of pressure drop	 230 mph 46 mph 184 mph 150 ft 1.2 psi 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 coincident non-coincident	 80°F 81°F
Accident release χ/Q values at security owner controlled area fence 0-2 hr 2-8 hr 8-24 hr 24-96 hr 96-720 hr	 ~~5.72~~6.22E-04 s/m^3 ~~4.85~~5.27E-04 s/m^3 ~~2.14~~2.41E-04 s/m^3 ~~2.15~~2.51E-04 s/m^3 ~~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 (approximately 112 feet from source) 0-2 hr 2-8 hr 8-24 hr 1-4 day 4-30 day	Door / Heating Ventilation and Air Conditioning Intake 6.50E-03 s/m^3 / 6.50E-03 s/m^3 5.34E-03 s/m^3 / 5.34E-03 s/m^3 2.32E-03 s/m^3 / 2.32E-03 s/m^3 2.37E-03 s/m^3 / 2.37E-03 s/m^3 2.14E-03 s/m^3 / 2.14E-03 s/m^3
Hydrologic Engineering	
Maximum flood elevation 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. and 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: • total settlement • tilt settlement • differential settlement (between Reactor Building and Control Building, and Reactor Building and Radioactive Waste Building)	 ~~No limit~~4 inches ~~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 ~~No limit~~0.5 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 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 maximum ~~horizontal~~ wind speed ~~maximum~~ translational speed maximum rotational speed ~~maximum~~ radius of maximum rotational speed ~~maximum~~ pressure ~~differential~~drop ~~maximum~~ rate of pressure drop	 230 mph 46 mph 184 mph 150 ft 1.2 psi 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 coincident non-coincident	 80°F 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~~		
~~release height~~	~~ground level (0 meters)~~	
~~adjacent building height~~	~~negligible~~	
~~adjacent building cross-sectional area~~	~~negligible (0.1 square meters)~~	
Accident release χ/Q values at security owner controlled area fence		
0-2 hr	~~5.72~~6.22E-04 s/m³	Sections 15.0.3.2 and 15.0.3.3.12 and Table 15.0-13
2-8 hr	~~4.85~~5.27E-04 s/m³	
8-24 hr	~~2.14~~2.41E-04 s/m³	
24-96 hr	~~2.15~~2.51E-04 s/m³	
96-720 hr	~~1.95~~2.46E-04 s/m³	
Accident release χ/Q values at main control room/technical support center door and HVAC intake (approximately 112 feet from source)	Door / HVAC Intake	
0-2 hr	6.50E-03 s/m³ / 6.50E-03 s/m³	Section 15.0.3.3.12 and Table 15.0-13
2-8 hr	5.34E-03 s/m³ / 5.34E-03 s/m³	
8-24 hr	2.32E-03 s/m³ / 2.32E-03 s/m³	
1-4 day	2.37E-03 s/m³ / 2.37E-03 s/m³	
4-30 day	2.14E-03 s/m³ / 2.14E-03 s/m³	
~~Routine airborne effluent release point characteristics for offsite receptors~~		
~~release location~~	~~Any point on Reactor Building or Turbine Building wall~~	
~~release height~~	~~37.0 meters~~	
~~vent/stack exit velocity~~	~~0.0 meters/second~~	
~~vent/stack inside diameter~~	~~0.0 meters~~	
~~vent/stack exhaust orientation (vertical, horizontal, or other)~~	~~not applicable~~	
~~restrictions to exhaust Air flow (e.g., rain caps)~~	~~not applicable~~	
~~adjacent building height~~	~~0.0 meters~~	
~~adjacent building cross-sectional area~~	~~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 χ/Q and D/Q values ~~at site boundary and locations of interest~~associated with the bounding offsite dose location		
undepleted/no decay	5.43E-05 ~~m/s^3~~s/m^3	Table 11.3-6
undepleted/2.26-day decay	5.43E-05 ~~m/s^3~~s/m^3	
depleted/8.00-day decay	5.43E-05 ~~m/s^3~~s/m^3	
D/Q	5.43E-07 $1/m^2$	
Hydrologic Engineering (Section 2.4)		
Maximum flood elevation 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. 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~~	

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.

Stability Load Combinations

The load combinations used for the assessment of stability (flotation, uplift, sliding, overturning) are discussed below.

Five load combinations are considered:

A. $D + H + E_{OBE}$

B. $D + H + W$

C. $D + H + E_{SSE}$

D. $D + H + W_t$

E. $D + B$

Load case A is not analyzed. The OBE is defined as one-third of the SSE and analysis is not required. In addition, the wind loads are bounded by the seismic loads as discussed in Section 3.8.4. Therefore load cases B and D are also not analyzed.

The loads are discussed in Section 3.8.4.3, but are summarized below:

D is the dead load. This is equal to 587,147 kips for the RXB (equipment and water weight) and 45,774 kips (includes equipment weight) for the CRB.

B is the buoyant force generated by the water table. This is equivalent to the embedded volume of the building times the weight of water. This load is +279,445 kips for the RXB and 40,500 kips for the CRB.

E_{SSE} is the seismic load generated by the CSDRS or CSDRS-HF.

H is the lateral static soil pressure.

W_t = Loads generated by the design basis tornado that cause tornado wind pressure, tornado-created differential pressures, and tornado generated missiles.

3.8.5.3.1 Lateral Soil ForcePressure and Seismic Loads

The RXB and CRB are embedded structures and, therefore, the surrounding soil contributes significantly to the stability of the structures. The surrounding soil imposes lateral soil pressures. The seismic inertia loads cause sliding and overturning forces. These pressures are calculated using the backfill soil which has a density of 130 pcf and an assumed angle of internal friction, f, of 30°. The coefficient of friction (COF) used for the calculation of friction resistance betweensoil and walls and soil and basemat is 0.580.57735. The friction is defined between concrete and clean gravel, gravel-sand mixture, or coarse sand with a friction angle of 30°. Thus, the COF = tan (30°) = 0.57735, which rounds to 0.58.

to the RXB and one belonging to the soil. The coincident nodes were used to define a nonlinear contact region as shown on Figure 3.8.5-9. A coefficient of friction of 0.5 was used so that the tangential force required for overcoming compressive normal force resistance to allow the building to slide and uplift relative to the soil is equal to half of the normal force between the RXB walls and soil.

The seismic analyses were performed in SASSI for Soil Type 11 backfill. The SASSI results yielded acceleration versus time in the global N-S, E-W, and vertical direction for each node on the external surface of the RXB and the backfill soil. The SSI seismic input acceleration histories in the three orthogonal directions obtained at representative skin node 946 were applied to 5,822 RXB and backfill soil nodes in contact with the in-situ soil. These nodes are shown on Figure 3.8.5-11 and Figure 3.8.5-12. There were a total of three time histories for each soil type considered.

Rather than directly applying the SASSI accelerations to the RXB and backfill soil, coincident nodes were created. Nonlinear node-to-node CONTA178 elements were defined between the coincident nodes as shown in Figure 3.8.5-13 and Figure 3.8.5-14. Figure 3.8.5-15 illustrates the CONTA178 definition wherein forces are transferred between the end node-I and node node-J only when the gap is closed, i.e., transmitting compression but not tension. The elements directly under the RXB have a coefficient of friction of ~~0.57~~0.58 defined to resist sliding.

A pressure of 36.92 psi was applied to the bottom of the basemat to account for buoyancy effects as shown on Figure 3.8.5-16. In addition, there are static surcharge effects from the backfill soil against the RXB outer wall.

Table 3.8.5-6 shows the number of elements in the ANSYS structural analysis model including joints, frame elements, shell elements, solid elements, and links/supports.

Figure 3.8.5-17 through Figure 3.8.5-19 show the applied acceleration time histories for each of the Soil Type 7 cases.

Figure 3.8.5-20 through Figure 3.8.5-22 show the applied acceleration time histories for each of the Soil Type 8 cases.

Figure 3.8.5-23 through Figure 3.8.5-25 show the applied acceleration time histories for each of the Soil Type 11 cases.

The final nonlinear time history analysis was performed with all acceleration time-histories scaled by a factor of 1.1 but without the presence of buoyancy loads.

3.8.5.4.1.3 Analysis of Control Building Basemat

Linear Analysis

Acceptance criteria for flotation/ uplift, sliding, and overturning is based on a factor of safety (FOS) determined from the ratio of the driving force to the resisting force. These analyses are performed statically using the maximum forces from the combinations of soil profiles, time histories, and cracked/ uncracked conditions discussed in Section 3.7. The FOS performed for the CRB yielded unacceptable results (less than 1.1 FOS) for uplift stability; therefore, the uplift, sliding and overturning of the CRB is determined by a nonlinear sliding and uplift analysis.

3.8.5.4.1.4 Control Building Basemat Nonlinear Analysis Model Description

For the nonlinear analysis, the ANSYS CRB model with fixed-base boundary sliding and uplift conditions was changed to:

1) Provide independence of the building and soil domain by establishing coincident joints/nodes for the building and soil in the finite element mesh.

2) Define a nonlinear frictional contact region with the coincident nodes as shown in Figure 3.8.5-26. A coefficient of friction of 0.5 (between the CRB walls and soil) was used so that the tangential force required to overcome the resistance from any compressive normal force is equal to half the normal force, allowing the building to slide and uplift relative to the soil.

3) Obtain, at a typical skin node near the CRB basemat, the seismic input acceleration time histories in the three orthogonal directions for the Soil Type 11 backfill in combination with the surrounding Soil Type 7 and Soil Type 11. Three time histories for each soil type were considered by uniformly applying the time histories from the typical skin node to the CRB and backfill soil nodes, as shown in Figure 3.8.5-27, which are in contact with the in-situ soil. The SASSI time histories for the Capitola input case were selected since that case produced the largest horizontal base reactions, as shown in Table 3.8.5-3. The three time histories are shown in

   - Acceleration time history for each of the Soil Type 11 cases (Figure 3.8.5-28 through Figure 3.8.5-30)
   - Acceleration time history for each of the Soil Type 7 cases. (Figure 3.8.5-31 through Figure 3.8.5-33)

4) Create coincident nodes and define nonlinear node-to-node CONTA178 elements as shown on Figure 3.8.5-34 and Figure 3.8.5-35 to accurately model the contact gap between CRB and soil. The typical definition of CONTA178 elements is shown in Figure 3.8.5-15, where forces are transferred between node-I and node-J only when the gap is closed. The elements directly under the CRB foundation have a coefficient of friction of ~~0.57~~0.58 defined to resist sliding, i.e., transmitting compression but not tension. The elements on the sides of the CRB have a coefficient of friction of 0.50 defined to resist sliding.

Acceptance criteria for flotation/ uplift, sliding, and overturning is based on a factor of safety (FOS) determined from the ratio of the driving force to the resisting force. These analyses are performed statically using the maximum forces from the combinations of soil profiles, time histories, and cracked/ uncracked conditions discussed in Section 3.7. The FOS performed for the CRB yielded unacceptable results (less than 1.1 FOS) for uplift stability; therefore, the uplift, sliding and overturning of the CRB is determined by a nonlinear sliding and uplift analysis.

3.8.5.4.1.4 Control Building Basemat Nonlinear Analysis Model Description

For the nonlinear analysis, the ANSYS CRB model with fixed-base boundary sliding and uplift conditions was changed to:

1) Provide independence of the building and soil domain by establishing coincident joints/nodes for the building and soil in the finite element mesh.

2) Define a nonlinear frictional contact region with the coincident nodes as shown in Figure 3.8.5-26. A coefficient of friction of 0.5 (between the CRB walls and soil) was used so that the tangential force required to overcome the resistance from any compressive normal force is equal to half the normal force, allowing the building to slide and uplift relative to the soil.

3) Obtain, at a typical skin node near the CRB basemat, the seismic input acceleration time histories in the three orthogonal directions for the Soil Type 11 backfill in combination with the surrounding Soil Type 7 and Soil Type 11. Three time histories for each soil type were considered by uniformly applying the time histories from the typical skin node to the CRB and backfill soil nodes, as shown in Figure 3.8.5-27, which are in contact with the in-situ soil. The SASSI time histories for the Capitola input case were selected since that case produced the largest horizontal base reactions, as shown in Table 3.8.5-3. The three time histories are shown in

   - Acceleration time history for each of the Soil Type 11 cases (Figure 3.8.5-28 through Figure 3.8.5-30)
   - Acceleration time history for each of the Soil Type 7 cases. (Figure 3.8.5-31 through Figure 3.8.5-33)

4) Create coincident nodes and define nonlinear node-to-node CONTA178 elements as shown on Figure 3.8.5-34 and Figure 3.8.5-35 to accurately model the contact gap between CRB and soil. The typical definition of CONTA178 elements is shown in Figure 3.8.5-15, where forces are transferred between node-I and node-J only when the gap is closed. The elements directly under the CRB foundation have a coefficient of friction of ~~0.57~~0.55 defined to resist sliding, i.e., transmitting compression but not tension. The elements on the sides of the CRB have a coefficient of friction of 0.50 defined to resist sliding.

For sliding stability evaluation, the effective dead weight, or buoyant weight, of the RXB is an important stabilizing force.

The RXB buoyant dead weight is calculated in Section 3.8.5.3.3 as:

$D_{effective}$ = 307,702 kips

The RXB friction resistance R_sliding between basemat and soil against N-S or E-W sliding is calculated by multiplying the buoyant weight and the friction coefficient as follows:

$R_{sliding} = D_{effective} \times \mu$ (Eq 3.8-6) = 307,702 × 0.5~~7~~8 = ~~175,404~~178,467 kips

Similarly, the CRB buoyant dead weight ~~from Table 3.8.5-9 is~~, calculated in Section 3.8.5.3.3, is ~~40,500~~5,274, kips. The frictional resistance $R_{sliding}$ between the basemat and soil against N-S or E-W sliding is:

$R_{sliding} = D_{effective} \times \mu$ = 5,274 x 0.58~~40,500 x 0.57~~ = ~~23,085~~3,059 kips

3.8.5.5.3 Overturning Stability Analysis Approach

The overturning stability evaluation is done with load combination C as described in Section 3.8.5.3. The factor of safety for overturning is calculated as follows:

$$FOS_{overturning} = \frac{M_{restoring}}{M_{overturning}} \qquad \text{Eq. 3.8-7}$$

The overturning evaluation is determined by comparing the total resisting overturning moment and the total driving overturning moments. An overturning evaluation is performed for both directions separately; one for the North-South movement (moment about Global X-direction) and one for the East-West movement (moment about Global Y-direction).

The RXB is a deeply embedded structure, therefore, the frictional resisting moments provided by the interaction between soil and structure on the exterior walls and basemat are considered. The restoring moment due to the effective vertical load is also included in the evaluation.

Three components result in resistance to overturning:

- Friction on Parallel Walls
- Friction on Perpendicular Walls
- Effective Dead Weight

The North-South overturning pivot for the RXB is the north edge of the foundation. The East-West overturning pivot is the west wall edge of the foundation.

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 ~~differential~~tilt settlement for the Reactor Building ~~and the Control Building~~ is 1" total or ½" per 50 feet in any direction at any point in the~~either~~ 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 3.8.5.4.1.4~~Section 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.

Table 3.8.5-1: RXB Stability Evaluation Input Parameters

Data Description	Value
RXB Dead Weight (kips)	**587,147**
RXB East-West Length (ft) (between exterior faces of walls)	**346**
RXB North-South Length (ft) (between exterior faces of walls)	**150.5**
RXB Height (ft)	**167**
RXB Embedment Depth (ft)	**86**
Foundation East-West Length (ft)	**358**
Foundation North-South Length (ft)	**162.5**
Foundation Area (ft^2)	**58,175**
Soil Density, γ_{soil} (pcf)	**130**
Coefficient of Friction between Wall and Soil	**0.5**
Coefficient of Friction between Basemat and Soil	**0.58~~0.57~~**
Effective Soil Density, $\gamma_{eff} = \gamma_{soil} - \gamma_{water}$ (pcf)	**67.6**
Angle of Internal Friction	**30°**
Soil Coefficient of Pressure at Rest, K_o	**0.5**
Surcharge (psf)	**250**

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

eRAI No.: 8963
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NRC Question No.: 03.08.05-10

10 CFR Part 50, Appendix A, GDC 1, 2, 4 and 5 provide the regulatory requirements for the design of the seismic Category I structures. DSRS Section 3.8.5 provides review guidance pertaining to the modeling of foundations.

FSAR Tier 2, 3.8.5.4.1.2, "RXB Basemat Analysis Model Description," page 3.8-60, the 4th paragraph, states that a pressure of 36.92 psi was used to account for buoyancy effects, while the 9th paragraph states that the analysis was done without the presence of buoyancy force. Therefore, address this inconsistency.

NuScale Response:

As discussed, in a public meeting on January 30, 2018, a supplement to NuScale's original response to RAI 8963 Question 03.08.05-10 is provided to further describe, in FSAR Section 3.8.5.4.1.2, the nonlinear sliding analysis cases performed in ANSYS.

Impact on DCA:

FSAR Tier 2, Section 3.8.5.4.1.2 has been revised as described in the response above and as shown in the markup provided in this response.

The seismic forces, moments and stresses in all structural elements such as walls, pilasters, and basemat were calculated using the standalone and combined SASSI2010 models. The enveloped base pressures were applied to the solid foundation model to evaluate the responses. To be consistent with the SASSI2010 analysis, absolute values of all responses obtained by applying base pressures from SASSI2010 were used together with the fixed end forces and moments from walls and pilasters to arrive at the seismic demands.

RAI 03.08.05-10S1

As shown in Table 3.8.5-5, the linear analysis for stability ~~for~~ gave factors of safety less than 1 for sliding. Therefore a nonlinear analysis was performed for RXB Sliding.

Nonlinear Analysis Approach for RXB Sliding where Linear Analysis is too conservative

RAI 03.08.05-10S1

Where the RXB linear sliding analyses did not yield acceptable factors of safety results for sliding, ~~a~~detailed nonlinear sliding analys~~i~~es ~~was~~were performed using ANSYS. The fixed base boundary conditions for this analysis were compared favorably with the SAP2000 linear analysis boundary conditions, and the model is shown in Figure 3.8.5-8. The nonlinear ANSYS analysis uncoupled the soil domain from the building to permit simulation of sliding under seismic conditions by creating two coincident joint/nodes in the finite element mesh, one belonging to the RXB and one belonging to the backfill soil. The coincident nodes were used to define a nonlinear contact region as shown on Figure 3.8.5-9. A coefficient of friction of 0.5 was used so that the tangential force required for overcoming compressive normal force resistance to allow the building to slide and uplift relative to the soil is equal to half of the normal force between the RXB walls and soil.

The seismic analyses were performed in SASSI for Soil Type 11 backfill. The SASSI results yielded acceleration versus time in the global N-S, E-W, and vertical direction for each node on the external surface of the RXB and the backfill soil. The SSI seismic input acceleration histories in the three orthogonal directions obtained at representative skin node 946 were applied to 5,822 RXB and backfill soil nodes in contact with the in-situ soil. These nodes are shown on Figure 3.8.5-11 and Figure 3.8.5-12. There were a total of three time histories for each soil type considered.

RAI 03.08.05-10S1

Rather than directly applying the SASSI accelerations to the RXB and backfill soil, coincident nodes were created. Nonlinear node-to-node CONTA178 elements were defined between the coincident nodes as shown in Figure 3.8.5-13 and Figure 3.8.5-14. Figure 3.8.5-15 illustrates the CONTA178 definition wherein forces are transferred between the end node-I and node node-J only when the gap is closed, i.e., transmitting compression but not tension. The elements directly under the RXB basemat have a coefficient of friction of ~~0.57~~0.58 defined to resist sliding.

RAI 03.08.05-10S1

A pressure of 36.92 psi was applied to the bottom of the basemat to account for buoyancy effects as shown on Figure 3.8.5-16. In addition, there areThe static surcharge effects from the backfill soil against the RXB outer wall are ignored.

Table 3.8.5-6 shows the number of elements in the ANSYS structural analysis model including joints, frame elements, shell elements, solid elements, and links/supports.

RAI 03.08.05-10S1

East-west and north-south unidirectional, horizontal time-history analyses were performed for each of the surrounding Soil Types 7, 8, and 11. For all cases, the respective acceleration time-history from the SASSI representative skin node 946 was applied uniformly to all the boundary nodes in the ANSYS model, while the displacements in the other two directions were constrained. Thus, for each soil type, the cases performed were acceleration time history in the east-west direction, with the displacements in the vertical and north-south directions fixed and acceleration time history in the north-south direction, with the displacements in the vertical and east-west directions fixed.

RAI 03.08.05-10S1

Figure 3.8.5-17 through Figure 3.8.5-19 show the appliedinput acceleration time histories for each of the Soil Type 7 cases.

RAI 03.08.05-10S1

Figure 3.8.5-20 through Figure 3.8.5-22 show the appliedinput acceleration time histories for each of the Soil Type 8 cases.

RAI 03.08.05-10S1

Figure 3.8.5-23 through Figure 3.8.5-25 show the appliedinput acceleration time histories for each of the Soil Type 11 cases.

RAI 03.08.05-10

The final nonlinear time history analysis was performed with all acceleration time-histories scaled by a factor of 1.1 but without the presence of buoyancy loads.

3.8.5.4.1.3 Analysis of Control Building Basemat

RAI 03.08.05-22

The static load results are obtained from the SAP2000 model of the CRB. Both the stand-alone and the combined CRB SAP2000 models are used to obtain the static forces and moments in the basemat, using the most critical static load combination for the calculation of structural responses.

RAI 03.08.05-10S1, RAI 03.08.05-22

The seismic forces, moments, and stresses in the structural elements, such as walls, beam elements, and basemat, are calculated using the stand-alone and combined SASSI2010 models. The enveloped seismic pressures contours on the CRB basemat are shown in Figure 3.8.5-3a. The enveloped seismic pressures are obtained as a result of the four-step, post-processing method described in Section 3.7.2.4.1. These maximum pressures are loaded into an SAP2000 model of the CRB basemat from where the seismic forces and moments for the basemat design are obtained. Absolute values of the responses obtained by applying base pressures from SASSI2010 are used to arrive at the total seismic demands.

RAI 03.08.05-22

~~Linear Analysis~~Control Building Basemat and Stability Linear Analysis

Acceptance criteria for flotation/ uplift, sliding, and overturning is based on a factor of safety (FOS) determined from the ratio of the driving force to the resisting force. These analyses are performed statically using the maximum forces from the combinations of soil profiles, time histories, and cracked/ uncracked conditions discussed in Section 3.7. The FOS performed for the CRB yielded unacceptable results (less than 1.1 FOS) for uplift stability; therefore, the uplift, sliding and overturning of the CRB is determined by a nonlinear sliding and uplift analysis.

3.8.5.4.1.4 Control Building Basemat Nonlinear Analysis Model Description

For the nonlinear analysis, the ANSYS CRB model with fixed-base boundary sliding and uplift conditions was changed to:

1) Provide independence of the building and soil domain by establishing coincident joints/nodes for the building and soil in the finite element mesh.

2) Define a nonlinear frictional contact region with the coincident nodes as shown in Figure 3.8.5-26. A coefficient of friction of 0.5 (between the CRB walls and soil) was used so that the tangential force required to overcome the resistance from any compressive normal force is equal to half the normal force, allowing the building to slide and uplift relative to the soil.

3) Obtain, at a typical skin node near the CRB basemat, the seismic input acceleration time histories in the three orthogonal directions for the Soil Type 11 backfill in combination with the surrounding Soil Type 7 and Soil Type 11. Three time histories for each soil type were considered by uniformly applying the time histories from the typical skin node to the CRB and backfill soil nodes, as shown in Figure 3.8.5-27, which are in contact with the in-situ soil. The SASSI time histories for the Capitola input case were selected since that case produced the largest horizontal base reactions, as shown in Table 3.8.5-3. The three time histories are shown in

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

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10 CFR Part 50, Appendix A, GDC 1, 2, 4 and 5 provide the regulatory requirements for the design of the seismic Category I structures. DSRS Section 3.8.5 provides review guidance pertaining to the design of foundations.

FSAR Tier 2, 3.8.5.4.1.2 (Page 3.8-58), *"RXB Basemat Analysis Model Description," states "The SAP2000 model was created modeling the RXB basemat with solid elements in order to calculate forces and moments in the basemat."* Contrary to that statement, page 3.8-59 states "Figure 3.8.5-1 shows the SAP2000 model. The area elements shown in light red tinge are shell elements representing the base slab." Address this inconsistency. State what type of elements (solid or shell) were used in the SASSI 2010 model to calculate forces and moments in the basemat.

NuScale Response:

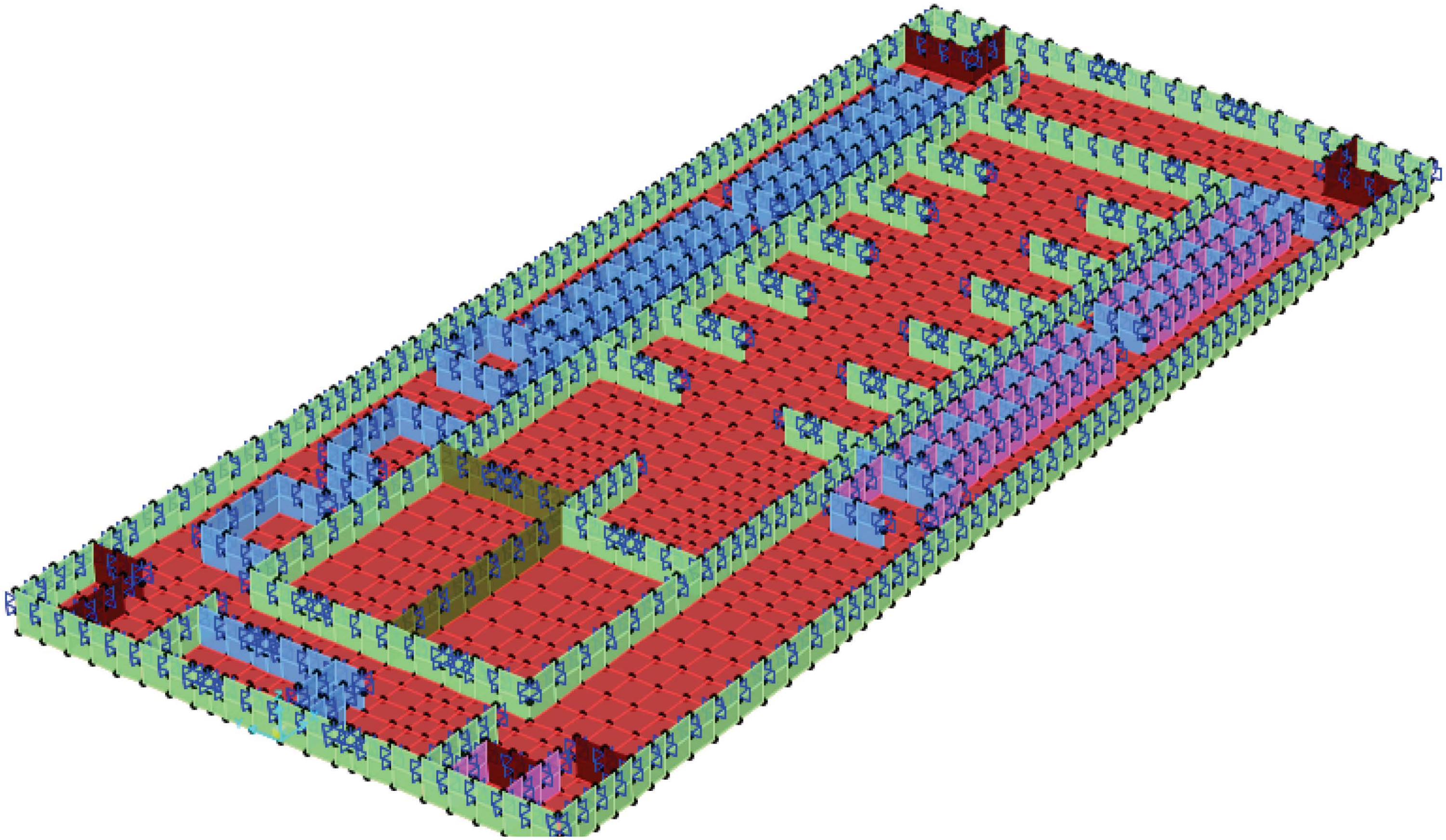
A supplement to NuScale's original response to RAI 8963 Question 03.08.05-11, as discussed in a public meeting on January 30, 2018, is provided to include, "RXB Basemat Model" in the titles of Figures 3.8.5-1 through 3.8.5-7.

Impact on DCA:

FSAR Tier 2, Figures 3.8.5-1 through 3.8.5-7 have been revised as described in the response above and as shown in the markup provided in this response.

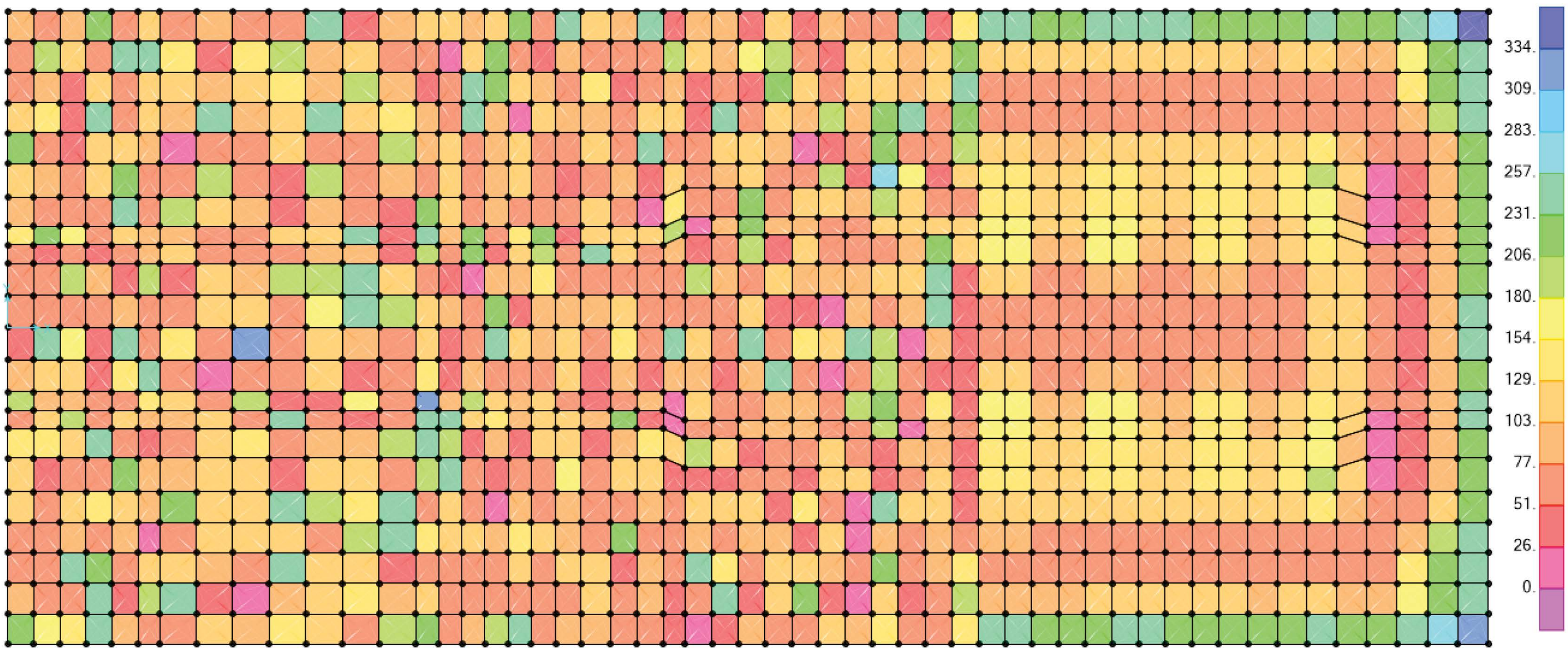
RAI 03.08.05-11S1

Figure 3.8.5-1: SAP2000 Model for Evaluation of Design Forces in ~~Basemat~~the Reactor Building Basemat Model



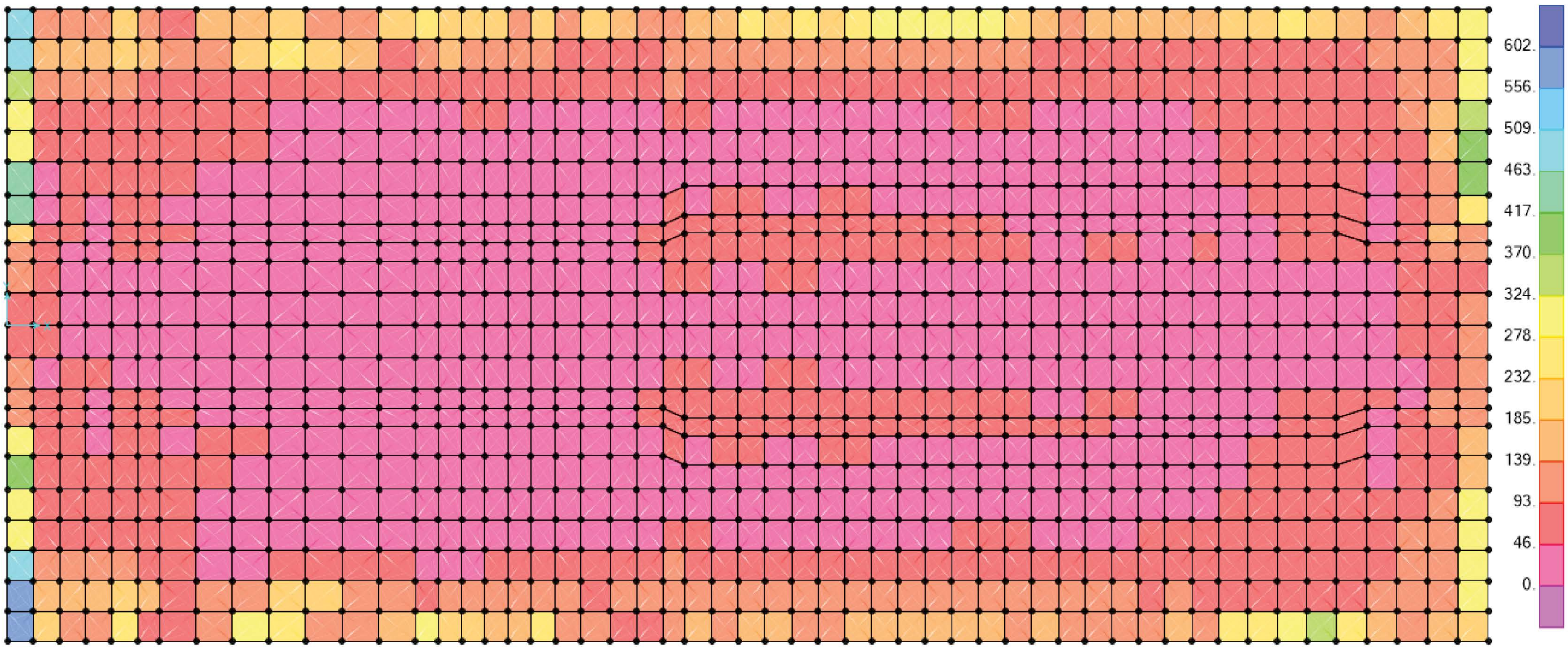
RAI 03.08.05-11S1

Figure 3.8.5-2: Static Base Pressure Contours for Governing Load Combination in the Reactor Building Basemat Model (Lb, in Units)



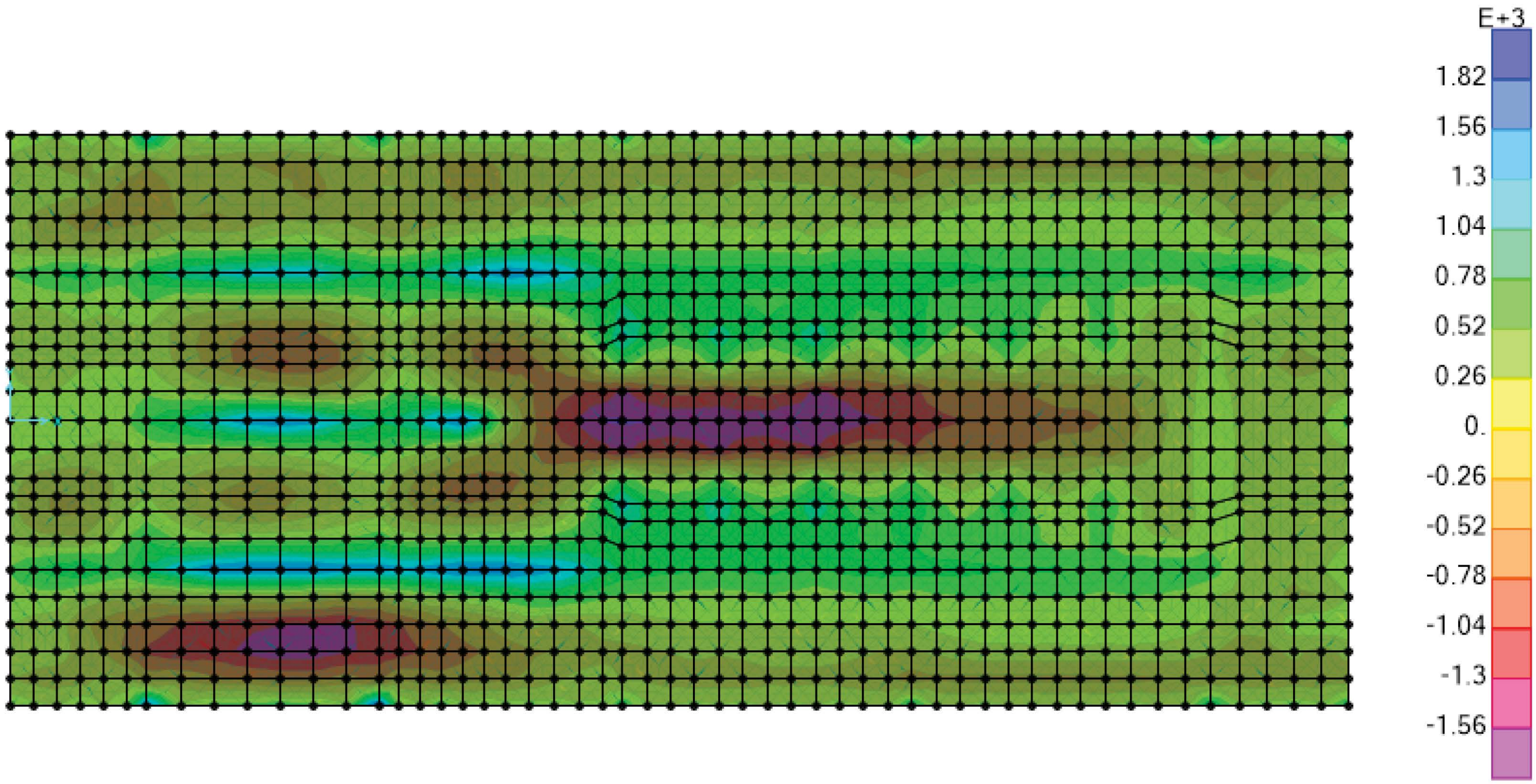
RAI 03.08.05-11S1

Figure 3.8.5-3: Seismic Base Pressure Contours from SASSI2010 Analysis
in the Reactor Building Basemat Model (Lb, inch Units)



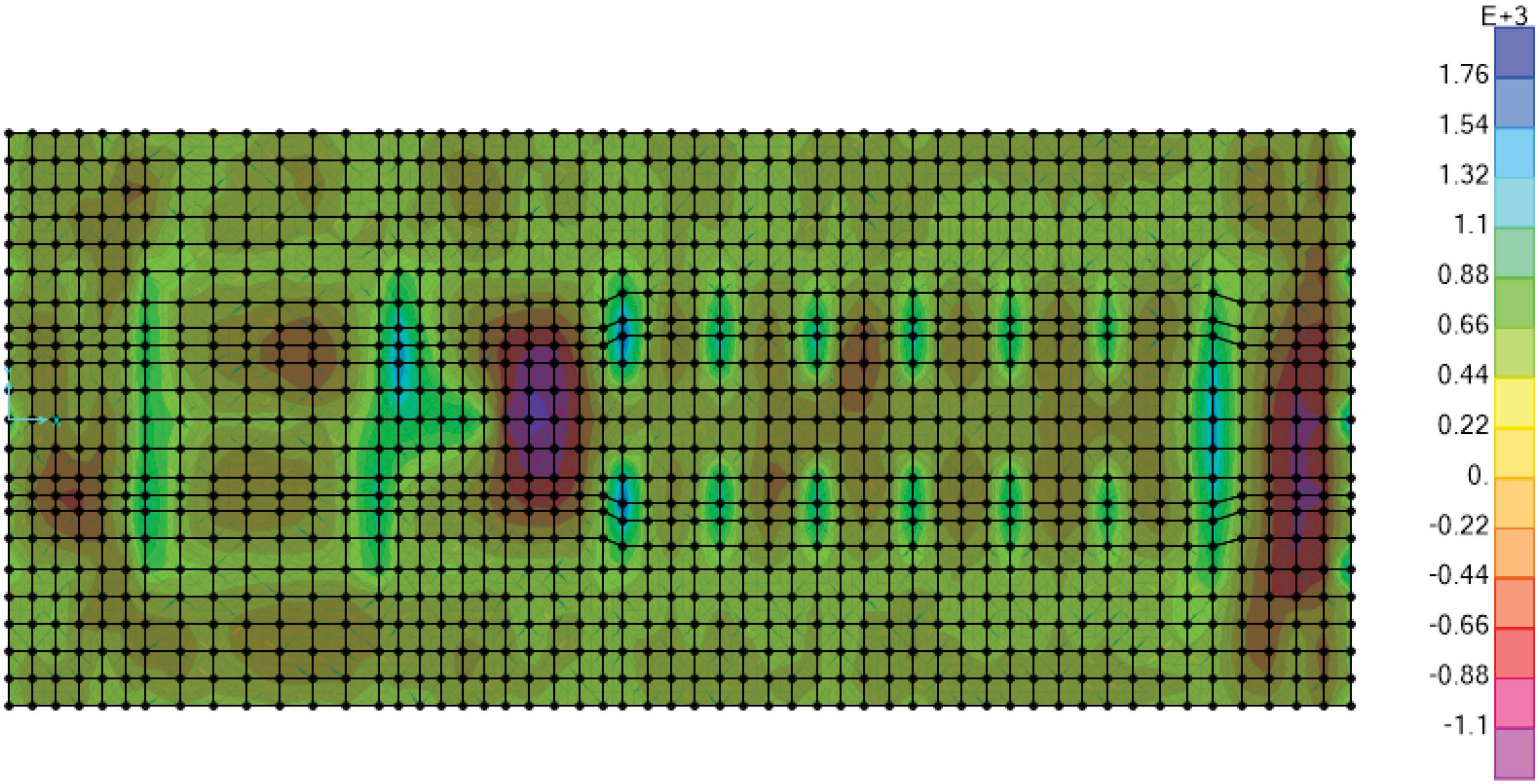
RAI 03.08.05-11S1

Figure 3.8.5-4: M22 due to Static Base Pressure in the Reactor Building Basemat Model



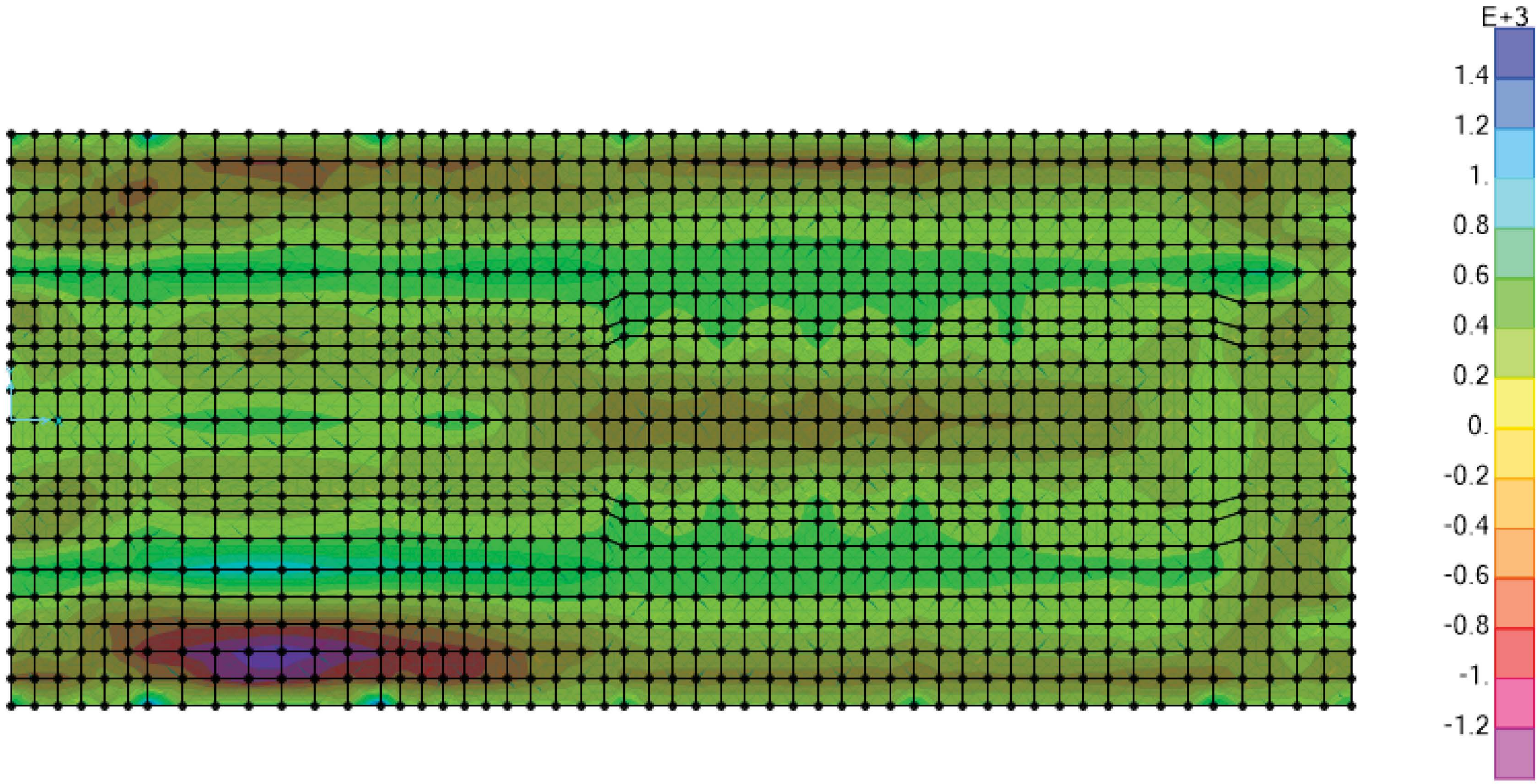
RAI 03.08.05-11S1

Figure 3.8.5-5: M11 due to Static Base Pressure in the Reactor Building Basemat Model



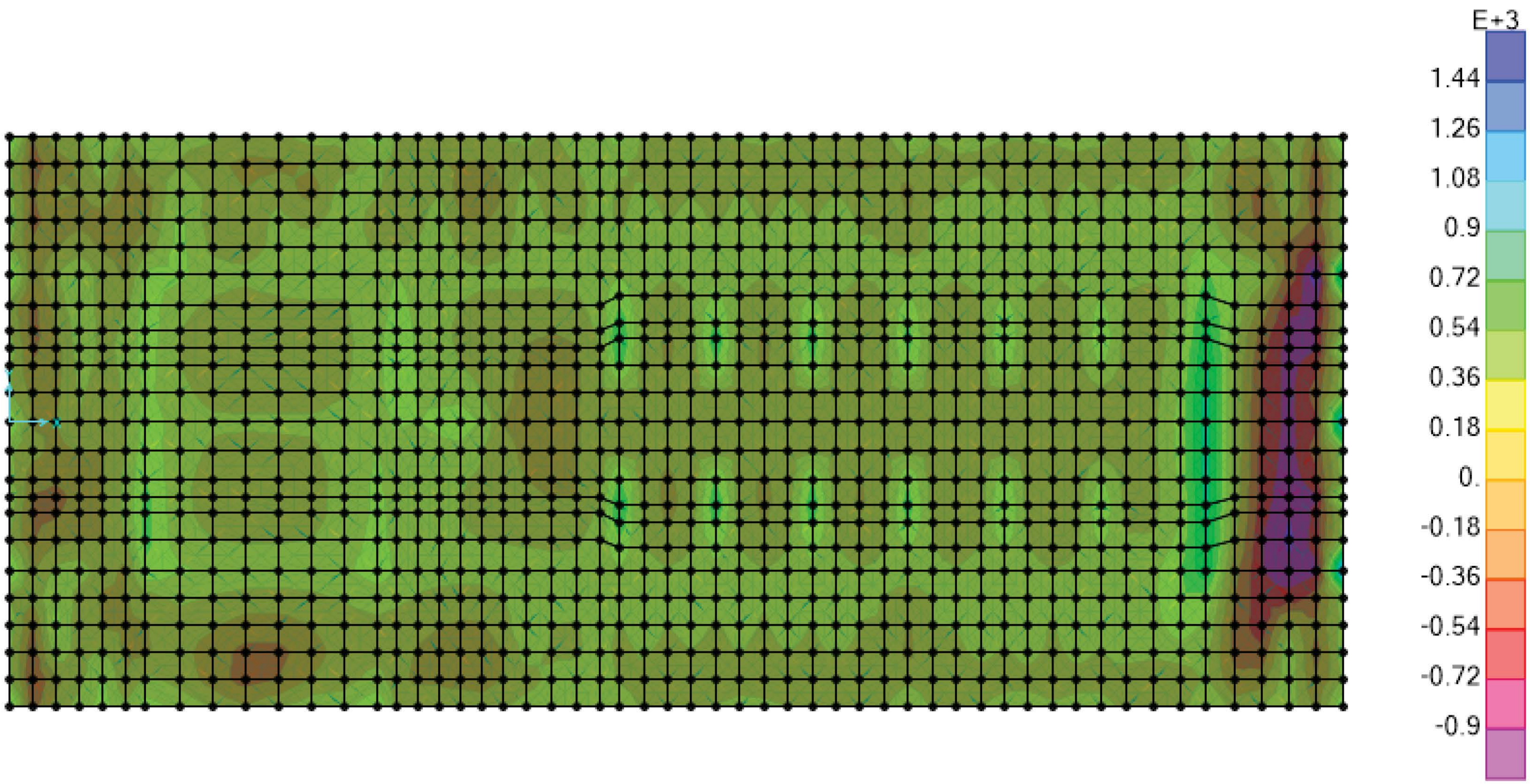
RAI 03.08.05-11S1

Figure 3.8.5-6: M22 due to Seismic Base Pressure in the Reactor Building Basemat Model



RAI 03.08.05-11S1

Figure 3.8.5-7: M11 due to Seismic Base Pressure in the Reactor Building Basemat Model



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Docket No. 52-048

eRAI No.: 8963
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NRC Question No.: 03.08.05-15

10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of the seismic Category I structures. DSRS Section 3.8.5 provides review guidance pertaining to the stability of foundations.

FSAR Tier 2, Section 3.8.5.6.1 “RXB Stability,” page 3.8-68, 4th paragraph, states “reinforcing pattern described above.” However, the staff could not find any description of reinforcement in the previous text. Therefore, provide/address reinforcing pattern as referenced.

NuScale Response:

As discussed, in a public meeting, on January 30, 2018, a supplement to NuScale's original response to RAI 8963 Question 03.08.05-15 is provided to address the deletions in FSAR Tier 2, Section 3.8.5.6.1, "RXB Stability." Upon review of text contained within Section 3.8.5.6.1, to respond to RAI 03.08.05-15, additional text was identified and determined to relate to design aspects of the RXB and not RXB stability. Therefore, it was removed from FSAR Section 3.8.5.6.1, although it was not pertinent to the original question.

Impact on DCA:

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

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10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of the seismic Category I structures. DSRS Section 3.8.5 provides review guidance pertaining to stability of foundations.

FSAR Tier 2, Section 3.8.5.6.1.2, “RXB Sliding,” states “…., a nonlinear sliding analysis has been performed to show that sliding is insignificant.” Describe the method, and results of basemat movement (in inches), of the nonlinear analysis, and justify why the results of horizontal sliding are insignificant.

NuScale Response:

The following response replaces NuScale's original response to RAI 8963 Question 03.08.05-18.

A description of the nonlinear analysis method for the reactor building is provided in FSAR Tier 2, Section 3.8.5.4.1.2. This methodology is the same as that provided in FSAR Tier 2, Section 3.8.5.4.1.4 for the control building. FSAR Table 3.8.5-12 provides nonlinear sliding results, the greatest of which is 0.11 in. This is less than 1/8 in., an insignificant amount for a large building. Sliding of this magnitude cannot cause any structural damage.

Impact on DCA:

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