September 17, 2019 Docket No. PROJ0769

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Submittal of Changes to the NuScale Topical Report, "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis," TR-0118-58005, Revision 0

REFERENCES:

1. NuScale Topical Report, "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis," TR-0118-58005, Revision 0, dated July 2018, ML18208A362

2. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 9676 (eRAI No. 9676)," dated April 17, 2019, ML1907A498

3. NuScale Power, LLC Response to NRC Request for Additional Information No. 9676 (eRAI No. 9676) on the NuScale Topical Report, “Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis,” TR-0118-58005, Revision 0, dated June 17, 2019, ML19168A249

Review of the NuScale Topical Report, "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis," TR-0118-58005, Revision 0, dated July 2018 (Reference 1), is ongoing with the U.S. Nuclear Regulatory Commission (NRC) Staff. The Request for Additional Information, NRC eRAI No. 9676 (Reference 2), resulted in the topical report mark-up provided by Reference 3. Subsequently, additional reviewer comments/requests for clarification on the Reference 3 RAI 9676 mark-ups were identified.

During a August 29, 2019 public teleconference with project manager Bill Ward, and reviewers Manas Chakravorty and Sunwoo Park of the NRC Staff, NuScale Power, LLC (NuScale) discussed potential updates to NuScale Topical Report, "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis,” TR-0118-58005, Revision 0. As a result of this discussion, NuScale changed the topical report. These revisions supplement those previously provided. The Enclosures to this letter provide the consolidated mark-ups of the report pages incorporating the Reference 3 and followup revisions to "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis," in redline/strikeout format. NuScale will include these changes as part of a future revision to the NuScale Topical Report.

Enclosure 1 is the proprietary version of the changes to NuScale Topical Report "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis." NuScale requests that the proprietary version be withheld from public disclosure in accordance with the requirements of 10 CFR § 2.390. The enclosed affidavit (Enclosure 3) supports this request. Enclosure 2 is the nonproprietary version of the changes to NuScale Topical Report "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis."

This letter makes no regulatory commitments or revisions to any existing regulatory commitments.

If you have any questions, please feel free to contact Marty Bryan at 541-457-7172 or at mbryan@nuscalepower.com

Sincerely,

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

Distribution: Samuel Lee, NRC, OWFN-8H12
Cregory Cranston, NRC, OWFN-8H12
William Ward, NRC, OWFN-8G9A

Enclosure 1: Changes to NuScale Topical Report, "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis," TR-0118-58005, Revision 0, proprietary
Enclosure 2: Changes to NuScale Topical Report, "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis," TR-0118-58005, Revision 0, nonproprietary
Enclosure 3: Affidavit of Zackary W. Rad, AF-0919-67003

Enclosure 1:

Changes to NuScale Topical Report, "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis," TR-0118-58005, Revision 0, proprietary

Enclosure 2:

Changes to NuScale Topical Report, "Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis," TR-0118-58005, Revision 0, nonproprietary

- It reduces SSI analysis costs. Soil impedances are calculated at a limited number of frequencies and interpolation is used at intermediate frequencies.Soil impedance and seismic load vectors are calculated once for a soil type, while the structure may be subject to multiple modifications. Additionally, the library can contain impedances at different soil sites simplifying the design of standard plants.

- It streamlines the analysis process by using the same model for both operational and seismic loads. This eliminates the need to develop, maintain, and properly document, simplified SSI analysis models in an environment with an evolving design.

Section 4.03.0 presents the Soil Library solution strategy. The theoretical basis for the seismic analysis is discussed in Section 5.04.0. Section 6.05.0 contains example problems that demonstrate the application of the Soil Library. Section 7.06.0 discusses the Soil Library implementation issues and includes an interpolation convergence study. Summary and conclusions are contained in Section 8.07.0.

The appendices contain a discussion of ancillary analysis issues and detailed responses for the analyses performed for the example problems.

2.1 Regulatory Requirements

2.1.1 10 CFR 50 Appendix A GDC 2

In accordance with General Design Criterion (GDC) 2, nuclear power unit structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

2.1.2 10 CFR 50 Appendix S

10 CFR 50 Appendix S requires applicants to design nuclear power plant structures, systems, and components important to safety to withstand the effects of natural phenomena, such as earthquakes, without the loss of capability to perform their safety function.

4.2 Frequency Domain Solution

Elastic soil impedances are frequency dependent; thus, soil structure interaction (SSI) problems are typically solved in the frequency domain. Fluid-structure interaction analyses using acoustic elements are viscoelastic and can be solved in either the time or the frequency domain. Thus, the coupled soil-structure-fluid interaction problem is solved in the frequency domain and incorporates frequency dependent soil impedances.

The quality of a frequency domain analysis is dependent on which frequencies are computed and which are interpolated. A complex building-fluid system, with interacting structures, equipment and fluid requires a large number of computed frequencies representing structural, equipment and fluid natural frequencies. On the other hand, Thethe soil impedance of a relatively uniform site varies slowly with frequency. Thus, there is an opportunity to calculate soil impedances at widely spaced frequencies and interpolate the soil impedances and load vectors between these values for each calculated structural frequency.

4.3 Soil Library

SASSI develops the excavated soil impedance by assembling the soil flexibility matrix for a layered half-space, inverting the flexibility matrix to obtain soil impedance for the layered half-space, and deducting the excavated soil volume as shown in Figure 4-2.

The numerical process of inverting the layered half-space flexibility matrix represents much of the SASSI computational effort. In a typical analysis, there are numerous building model iterations performed while the excavated soil impedance remains constant. The Soil Library consist of a series of pre-calculated excavated soil impedance super-elements that can be used with different building models, as shown schematically in Figure 4-3.

As discussed above, the soil impedance and seismic load vectors are frequency dependent. At a given analysis frequency, the soil impedance and load vectors can beare calculated directly using SASSI., or interpolated from calculated values. The use of impedance and load vector interpolation allows the impedances to be pre-calculated at discrete frequencies based on the frequency variation of the soil properties. This reduces analysis effort compared to traditional SSI analyses where the soil impedance is developed for each calculated frequency.

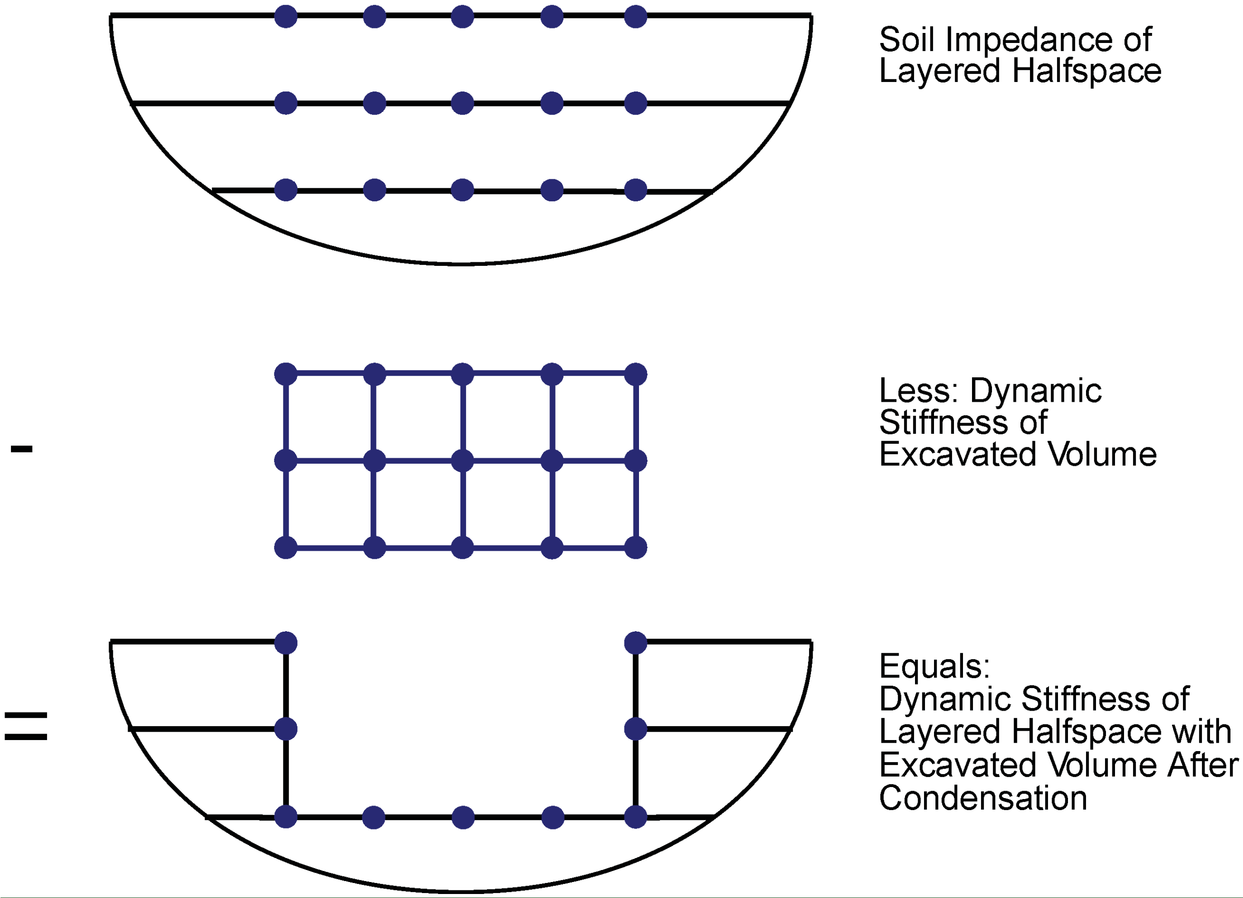

Figure 4-2 ~~Impedance~~ Dynamic stiffness of layered halfspace with excavation

5.0 Theoretical Basis

The theoretical basis for frequency domain analysis is discussed below to provide a framework to describe the proposed analysis.

5.1 Analysis Background

The following describe portions of the SASSI frequency domain solution required to implement the Soil Library in ANSYS. Enhancements to the SASSI analysis methodology are discussed in Section 5.26.0 and 5.3.

5.1.1 Equation of Motion

The equation of motion in the time domain for a damped linear elastic system is typically expressed as:

$$M\ddot{X}(t) + C\dot{X}(t) + KX(t) = F(t)$$

Equation 5-1

where M , C, and K are the mass, viscous damping and stiffness matrices, t is time, $X(t)$ is a vector of absolute displacements, $\dot{X}(t)$ is a vector of absolute velocities, $\ddot{X}(t)$ is a vector of absolute accelerations, and $F(t)$ is a vector of applied forces. For steady state harmonic motion, let:

$$X(t) = X(\omega)e^{i\omega t}$$

$$F(t) = F(\omega)e^{i\omega t}$$

Equation 5-2

Substituting Equation 5-2 into Equation 5-1 yields:

$$(-\omega^2 M + i\omega C + K)\ X(\omega)e^{i\omega t} = F(\omega)e^{i\omega t}$$

Equation 5-3

Subtracting Equation 5-18Equation 5-19 from Equation 5-16Equation 5-17 yields:

$$\left[\begin{array}{c|cc} S_{ii} & S_{ig} & S_{ib} \\ \hline S_{gi} & S_{gg} & S_{gb} \\ S_{bi} & S_{bg} & S_{bb} \end{array}\right] \left\{\begin{array}{c} X_i - X_i' \\ \hline X_g - X_g' \\ X_b - X_b' \end{array}\right\} = \left\{\begin{array}{c} F_i \\ \hline 0 \\ 0 \end{array}\right\}$$

Equation 5-19

Partitioning the matrix as shown, solving for $X_g - X_g'$ and $X_b - X_b'$ and back substituting into Equation 5-19Equation 5-20 yields

$$\{F_i\} = [Z]\{X_i - X_i'\}$$

Equation 5-20

where [*Z*] is the layered halfspace soil impedance of the excavated soil nodes. Equation 5-19Equation 5-20 could be used to develop [*Z*], but the assumption that the external boundary is far from the structure causes the solution to Equation 5-19Equation 5-20 to become more extensive than the solution in Section 5.1.5.

Substituting Equation 5-20Equation 5-21 into Equation 5-17Equation 5-18 yields:

$$\left[\begin{array}{cc} S_{ss} & S_{st} \\ S_{ts} & S_{tt} + Z - S_{ii}' \end{array}\right] \left\{\begin{array}{c} X_s \\ X_i \end{array}\right\} = \left\{\begin{array}{c} 0 \\ F_{EQ} \end{array}\right\}$$

Equation 5-21

Where F_{EQ} is the seismic load vector that is the product of the layered halfspace soil impedance, *Z*, and the free field ground motion X'_i:

$$\{F_{EQ}\} = [Z]\{X_i'\}$$

Equation 5-22

Both the soil impedance and free field ground motion vary with frequency, thus the seismic load vector also varies with soil frequency. The free field ground motion is developed by a site response analysis and represents vertically propagating horizontal shear waves or vertically propagating compression waves (P-waves).

The free field response for a vertically propagating shear and P-wave is a function of the layer where a unit motion is defined, referred to as the control layer.

and the lumped parameter impedance is:

$$[Z_{Lumped\ Parameter}] = [T] \cdot [Z_{Red}] \cdot [T]^T$$ Equation 5-38

The lumped parameter impedance is typically a 6x6 matrix which describes the impedance of a rigid massless foundation attached to each of the *t* DOF. Note, this transformation is not applied to the *j* DOF in Equation 5-32Equation 5-33 as it artificially constrains $\{X_j\}$.

5.3 SASSI Enhancements

ANSYS, and other commercially available finite element programs, have libraries of structural elements, acoustic elements, and constraint equations that can be implemented in SASSI analyses. Elements and constraints are described mathematically in the substructure mass, stiffness, and viscous damping matrices, which are exported from the commercial FEM program, along with a table identifying the degrees of freedom.

SDE-SASSI (Reference 9.1.6) has the ability to import mass, stiffness, viscous damping, and load matrices and sub matrices, and assemble these matrices with internal matrices from the SASSI HOUSE Module. Thus, SDE-SASSI has the ability to solve a SSI problem using an ANSYS substructure containing fluid-structure interaction.

Some formulations of fluid structure interaction problems have unsymmetric mass and stiffness matrices. SDE-SASSI implements an unsymmetric solver that is used to solve these fluid-structure interaction problems.

SDE-SASSI utilizes a split solver employing a sparse solver for the structural portion of the dynamic stiffness and a dense solver for the soil impedance interaction degrees of freedom. SDE-SASSI takes advantage of parallel distributed memory computing to solve various problem sizes.

SDE-SASSI also has the ability to write intermediate results such as the soil flexibility matrix, the free-field impedance matrix, and the combined impedance and excavated soil matrix. Additionally, SDE-SASSI has the ability to reduce the impedance and seismic load vectors using the transformation discussed in Section 5.2.1 5.1.2. The soil library is composed of reduced impedance and seismic load vectors calculated by SDE-SASSI.

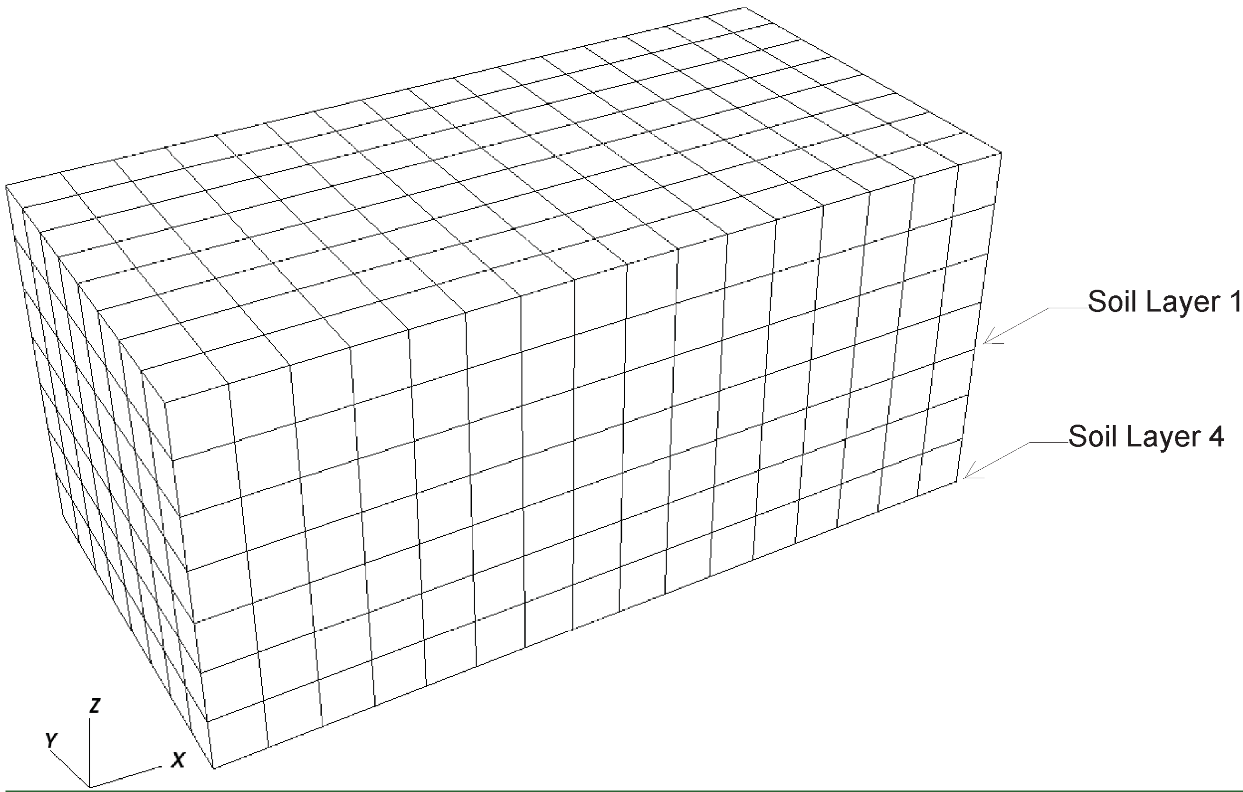

Figure 6-13 Example 2, building model, +Y is north and +X is east

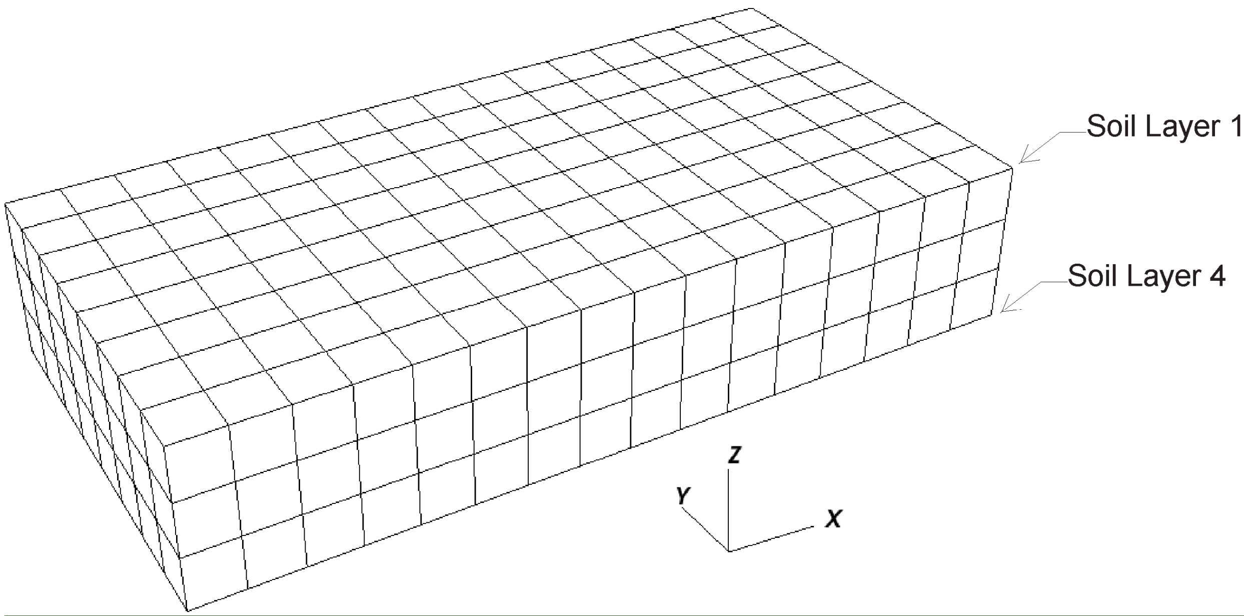

Figure 6-14 Example 2, excavated soil model, +Y is north and +X is east

6.3 Example 3: Embedded Building with Soil-Structure-Fluid Interaction

This example calculates the seismic response of a reinforced concrete building with an internal pool, and considers the interaction between soil, structure, and fluid substructures. This example demonstrates that the SASSI and ANSYS frequency domain solutions are functionally equivalent for Soil-Structure-Fluid Interaction (SSFI) problems.

The Soil Library impedance and building models from Example 2 are reused in this problem. The pool is modeled using ANSYS acoustic (Fluid 30) elements that are capable of representing pressure transients during a seismic event. Sloshing of the pool was not considered in this formulation, and is beyond the scope of this Topical Report. Sloshing occurs at very low frequencies - less than those in the harmonic analysis. Sloshing should be considered during a comprehensive structural analysis. These elements introduce pressure degrees of freedom to the mathematical model. The acoustic elements also introduce unsymmetric stiffness and mass coupling terms. Thus, an unsymmetric solver was used for Example 3.

Similar to Example 2, transfer functions are used to quantify the seismic response of the building and fluid. The Example 2 and Example 3 results are also compared to understand the effects of fluid interaction on this soil-structure system.

6.3.1 Analytical Model

This example problem consists of a 94.83 ft long by 47.45 ft wide by 25 ft high building embedded 18.75 ft in a stiff soil site, for a total building height of 43.75 feet. An 18.75 ft deep pool is located inside the building. Thus, the top of the pool and exterior grade are at the same elevation.

The Example 2 building model, shown in Figure 6-13, was used in this analysis. The Example 2 Soil Library consisting of soil impedance and seismic load vectors were also used in this analysis. Acoustic fluid properties used in the analysis are:

Fluid unit weight, γ	0.062 kcf
Fluid P-wave velocity	5003 fps
Shear viscosity	1.423 x 10^{-8} kip sec/ft^2
Bulk viscosity	0.6 x 1.423 x 10^{-8} kip sec/ft^2

The fluid mesh has the same geometry as the excavated soil mesh in Figure 6-14.

6.3.2 Fluid Structure Interaction

The equation of motion for the fluid structure interaction portion of the analysis, in the frequency domain, is:

$$\left(-\omega^2\begin{bmatrix}[M_S] & 0\\ \bar{\rho}_0[R]^T & [M_F]\end{bmatrix}+i\omega\begin{bmatrix}[C_S] & 0\\ 0 & [C_F]\end{bmatrix}+\begin{bmatrix}[K_S] & [R]\\ 0 & [K_F]\end{bmatrix}\right)\begin{Bmatrix}\{X\}\\ \{P\}\end{Bmatrix}=\begin{Bmatrix}F_S\\ F_F\end{Bmatrix} \quad \text{Equation 6-5}$$

Where,

X is the structural displacements,

P is the acoustic pressure with the units (ksf sec^2/ft),

F_S and F_F are applied structural and fluid loads, respectively,

[M_S], [C_S], and [K_S] are the mass, viscous damping and stiffness of the ANSYS Shell 181 elements. Note that the structural viscous damping[10] in this problem is zero,

[M_F], [C_F], and [K_F] are the acoustic fluid mass, acoustic fluid damping and acoustic fluid stiffness matrices of the ANSYS Fluid 30 element,

$\bar{\rho}_0$ is the acoustic fluid mass density constant, and

[*R*] is the acoustic fluid boundary matrix which relates acoustic pressure, P, to structural forces acting on the element at the water-solid interface, {*F* } = [*R*]{*P*}. Both [*R*] and $\bar{\rho}_0$ are generated by the ANSYS Fluid 30 element.

The terms in Equation 6-5 within the parentheses are the dynamic stiffness of the superstructure, S_{ss}, in Equation 5-21, considering the -fluid-structure interaction. ~~subsystem, denoted as *S*(*ω*) in Section 5.0~~

Recall that the acoustic pressure is due to an *x* =1 foot cyclic displacement of the control layer at the specified frequency, or:

$$h(\omega)e^{i\omega t} = TF(\omega)\cdot x(\omega)e^{i\omega t} \quad \text{Equation 6-6}$$

[10] The fluid elements, [C_F], have viscous damping while the structural elements do not have viscous damping. Structural damping is represented by a complex stiffness.

Table 6-66-4Example 3 low frequency acoustic pressure

Location	Depth	Acoustic Pressure (ksf sec^2/ft)		
		X Input	Y Input	Z Input
{{				
				}}2(a),(c)

Note that these pressures are independent of the ground motion input layer because there is no dynamic amplification at low frequency.

P is equal to the pressure at the bottom of the pool, in Table 6-6, with low frequency (nearly static) vertical acceleration. Scaling the pressure at the {{ }}2(a),(c) yields {{ }}2(a),(c) ksf sec^2/ft, which compares well with the pressures calculated by both ANSYS and SASSI.

For lateral base movement, the fluid is unrestrained and the only elements with pressure are on the surface perpendicular to the axis of motion.

Figure 6-36 compares the acoustic pressure time history at three depths on the west wall for an X direction h1 ground motion with input at Layer 1. The acoustic pressures calculated by SASSI and ANSYS compare well. Additional pressure time history comparisons are contained in Appendix F.

Fixed Base Response Comparisons With and Without Fluid

The fixed base response of the Example 2 building model with and without fluid are compared to understand how the fluid changes the buildings response. The basemat nodes, including the nodes at the base of the wall, are restrained in the fixed base analysis and unit cyclic base motions are imposed in the X, Y and Z direction. The fixed base response is computed using SDE-SASSI.

Typical transfer functions are shown in Figure 6-37. The effect of the fluid is to increase the amplitude of response for the overall building by roughly {{ }}2(a),(c) as seen by the center roof response in Figure 6-37a. The shift in overall building frequency from the added fluid mass is negligible.

The effect of the fluid on the first out-of-plane wall mode is to increase the amplitude by roughly {{ }}2(a),(c) and reduce the natural frequency slightly as seen in Figure 6-37b. Additional locations and input directions are examined in Appendix G. The

{{

}}2(a),(c)

Figure 6-33 Comparison of SASSI and ANSYS 5% damped ISRS, center roof structural response

6.4 Representative Reactor Building with Soil-Structure-Fluid Interaction

This example problem compares the dynamic response of a representative small modular Reactor Building (RXB), including twelve reactor power modules RXM, fluid-structure-RXM interaction, and soil structure interaction computed using ANSYS to the dynamic response using SASSI. The RXB is a concrete structure approximately 350 feet long in the x direction, 150 feet wide in the y direction, and 165 feet tall, with 85 feet of embedment. Inside the building is a large pool of water and the submerged RXMs. The walls of the structure are five feet thick, and there is a ten foot thick basemat and four foot thick roof. Outside the pool area there are multiple floor elevations, and each floor is three foot thick.

The purpose of this example problem is to demonstrate the implementation of the *Soil Library Methodology* using a complex structural model and to demonstrate that the ANSYS and SASSI solutions are consistent.

The impedance library was written using SDE SASSI (Reference 9.1.6) with inputs taken from the soil model for Soil Type 7 (Reference 9.1.13) and geometry of the RXB excavation.

The RXB ANSYS model is shown in Figure 6-40 and includes twelve RXMs, the reactor pool (shown in purple in Figure 6-40b), backfill soil and the Soil Library developed for soil type 7.

This example problem will demonstrate the soil library concept by comparing transfer functions and ISRS calculated using the ANSYS model plus soil impedance library methodology versus results computed using SASSI. The comparison will be performed at selected locations documented herein.

Appendix I. Example 4, Acceleration Transfer Functions

The following plots have a title on the plot legend that consists of the node number followed by two letters. The first letter corresponds to the direction of ground motion or input. The second letter corresponds to the response direction or output.

Results on a given page correspond to a common input direction, i.e. X, Y or Z. The top plot corresponds to output in the X direction, the center plot corresponds to output in the Y direction, and the bottom plot corresponds to output in the Z direction.

X is East, Y is North and Z is up.

Appendix J. Example 4, Acceleration Time Histories

The following plots have a title on the plot legend that consists of the node number followed by two letters. The first letter corresponds to the direction of ground motion or input. The second letter corresponds to the response direction or output.

Results on a given page correspond to a common input direction, i.e. X, Y or Z. The top plot corresponds to output in the X direction, the center plot corresponds to output in the Y direction, and the bottom plot corresponds to output in the Z direction.

X is East, Y is North and Z is up.

Appendix K. Example 4, In-Structure Response Spectra

All in-structure response spectra in this appendix are based on 4% damping.

The following plots have a title on the plot legend that consists of the node number followed by two letters. The first letter corresponds to the direction of ground motion or input. The second letter corresponds to the response direction or output.

Results on a given page correspond to a common input direction, i.e. X, Y or Z. The top plot corresponds to output in the X direction, the center plot corresponds to output in the Y direction, and the bottom plot corresponds to output in the Z direction.

X is East, Y is North and Z is up.

Appendix L. Example 4, Fluid Pressure Transfer Functions

The following plots have a title on the plot legend that consists of the node number followed by two letters. The first letter corresponds to the direction of ground motion or input. The second letter, 'P' corresponds to pressure response. The top plot on each page corresponds to input in the X direction, the center plot corresponds to input in the Y direction, and the bottom plot corresponds to input in the Z direction.

X is East, Y is North and Z is up.

Appendix M. Example 4, Fluid Pressure Time Histories

The following plots have a title on the plot legend that consists of the node number followed by two letters. The first letter corresponds to the direction of ground motion or input. The second letter, 'P' corresponds to pressure response. The top plot on each page corresponds to input in the X direction, the center plot corresponds to input in the Y direction, and the bottom plot corresponds to input in the Z direction.

X is East, Y is North and Z is up.

Appendix N. Example 4, Relative Displacement Transfer Functions

The following plots have a title on the plot legend that consists of the node number followed by two letters. The first letter corresponds to the direction of ground motion or input. The second letter corresponds to the response direction or output.

Results on a given page correspond to a common input direction, i.e. X, Y or Z. The top plot corresponds to output in the X direction, the center plot corresponds to output in the Y direction, and the bottom plot corresponds to output in the Z direction.

X is East, Y is North and Z is up.

Appendix O. Example 4, Relative Displacement Time Histories

The following plots have a title on the plot legend that consists of the node number followed by two letters. The first letter corresponds to the direction of ground motion or input. The second letter corresponds to the response direction or output.

Results on a given page correspond to a common input direction, i.e. X, Y or Z. The top plot corresponds to output in the X direction, the center plot corresponds to output in the Y direction, and the bottom plot corresponds to output in the Z direction.

X is East, Y is North and Z is up.

Appendix P. Example 4, RXM Lug Force Transfer Functions

The following plots have a title on the plot legend that consists of a Lug identifier followed by two letters. The first letter corresponds to the direction of ground motion or input. The second letter corresponds to the response direction or output.

X is East, Y is North and Z is up. The East and West Lugs resist motion in the Y or North-South Directions. The North Lugs resist motion in the X or East-West Directions. The top plot on each page corresponds to X direction input motion, the center plot corresponds to Y direction input motion, and the bottom plot corresponds to Z direction input motion.

Appendix Q. Example 4, RXM Lug Force Time Histories

The following plots have a title on the plot legend that consists of a Lug identifier followed by two letters. The first letter corresponds to the direction of ground motion or input. The second letter corresponds to the response direction or output.

X is East, Y is North and Z is up. The East and West Lugs resist motion in the Y or North-South Directions. The North Lugs resist motion in the X or East-West Directions. The top plot on each page corresponds to X direction input motion, the center plot corresponds to Y direction input motion, and the bottom plot corresponds to Z direction input motion.

Appendix R. Example 4, RXM Support Transfer Functions

The RXM base support section cuts have forces Fx, Fy and Fz along with moments Mx, My and Mz. The section cut plots have a title on the plot legend that consists of a cut identifier followed by two colon separated symbols. The first symbol corresponds to the direction of ground motion or input, X, Y or Z. The second symbol corresponds to the section cut force or moment.

X is East, Y is North and Z is up.

Appendix S. Example 4, RXM Support Time Histories

The RXM base support section cuts have forces Fx, Fy and Fz along with moments Mx, My and Mz. The section cut plots have a title on the plot legend that consists of a cut identifier followed by two colon separated symbols. The first symbol corresponds to the direction of ground motion or input, X, Y or Z. The second symbol corresponds to the section cut force or moment.

X is East, Y is North and Z is up.

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0919-67003

NuScale Power, LLC

AFFIDAVIT of Zackary W. Rad

I, Zackary W. Rad, state as follows:

(1) I am the Director of Regulatory Affairs of NuScale Power, LLC (NuScale), and as such, I have been specifically delegated the function of reviewing the information described in this Affidavit that NuScale seeks to have withheld from public disclosure, and am authorized to apply for its withholding on behalf of NuScale.

(2) I am knowledgeable of the criteria and procedures used by NuScale in designating information as a trade secret, privileged, or as confidential commercial or financial information. This request to withhold information from public disclosure is driven by one or more of the following:

(a) The information requested to be withheld reveals distinguishing aspects of a process (or component, structure, tool, method, etc.) whose use by NuScale competitors, without a license from NuScale, would constitute a competitive economic disadvantage to NuScale.

(b) The information requested to be withheld consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), and the application of the data secures a competitive economic advantage, as described more fully in paragraph 3 of this Affidavit.

(c) Use by a competitor of the information requested to be withheld would reduce the competitor's expenditure of resources, or improve its competitive position, in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

(d) The information requested to be withheld reveals cost or price information, production capabilities, budget levels, or commercial strategies of NuScale.

(e) The information requested to be withheld consists of patentable ideas.

(3) Public disclosure of the information sought to be withheld is likely to cause substantial harm to NuScale's competitive position and foreclose or reduce the availability of profit-making opportunities. The accompanying changes to the Topical Report reveal distinguishing aspects about the method by which NuScale has developed its 'Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis' analysis methodology.

NuScale has performed significant research and evaluation to develop a basis for this methodology and has invested significant resources, including the expenditure of a considerable sum of money.

The precise financial value of the information is difficult to quantify, but it is a key element of the design basis for a NuScale plant and, therefore, has substantial value to NuScale.

If the information were disclosed to the public, NuScale's competitors would have access to the information without purchasing the right to use it or having been required to undertake a similar expenditure of resources. Such disclosure would constitute a misappropriation of NuScale's intellectual property, and would deprive NuScale of the opportunity to exercise its competitive advantage to seek an adequate return on its investment.

(4) The information sought to be withheld is in the enclosed changes to the Topical Report titled 'Improvements in Frequency Domain Soil-Structure-Fluid Interaction Analysis.' The enclosure contains the designation "Proprietary" at the top of each page containing proprietary information. The information considered by NuScale to be proprietary is identified within double braces, "{{ }}" in the document.

(5) The basis for proposing that the information be withheld is that NuScale treats the information as a trade secret, privileged, or as confidential commercial or financial information. NuScale relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC § 552(b)(4), as well as exemptions applicable to the NRC under 10 CFR § 2.390(a)(4) and 9.17(a)(4).

(6) Pursuant to the provisions set forth in 10 CFR § 2.390(b)(4), the following is provided for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld:

(a) The information sought to be withheld is owned and has been held in confidence by NuScale.

(b) The information is of a sort customarily held in confidence by NuScale and, to the best of my knowledge and belief, consistently has been held in confidence by NuScale. The procedure for approval of external release of such information typically requires review by the staff manager, project manager, chief technology officer or other equivalent authority, or the manager of the cognizant marketing function (or his delegate), for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside NuScale are limited to regulatory bodies, customers and potential customers and their agents, suppliers, licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or contractual agreements to maintain confidentiality.

(c) The information is being transmitted to and received by the NRC in confidence.

(d) No public disclosure of the information has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or contractual agreements that provide for maintenance of the information in confidence.

(e) Public disclosure of the information is likely to cause substantial harm to the competitive position of NuScale, taking into account the value of the information to NuScale, the amount of effort and money expended by NuScale in developing the information, and the difficulty others would have in acquiring or duplicating the information. The information sought to be withheld is part of NuScale's technology that provides NuScale with a competitive advantage over other firms in the industry. NuScale has invested significant human and financial capital in developing this technology and NuScale believes it would be difficult for others to duplicate the technology without access to the information sought to be withheld.

I declare under penalty of perjury that the foregoing is true and correct. Executed on September 17, 2019.

Zackary W. Rad