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Sent: Friday, August 11, 2017 8:24 AM
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Cc: NuScaleDCRaisPEm Resource; Lee, Samuel; Chowdhury, Prosanta; Lupold, Timothy; Law, Yiu; Vera Amadiz, Marieliz
Subject: RE: Request for Additional Information No. 162, RAI 8901 (3.9.5)
Attachments: Request for Additional Information No. 162 (eRAI No. 8901).pdf

Attached please find NRC staff's request for additional information concerning review of the NuScale Design Certification Application.

Please submit your technically correct and complete response within 60 days of the date of this RAI to the NRC Document Control Desk.

If you have any questions, please contact me.

Thank you.

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Request for Additional Information No. 162 (eRAI No. 8901)

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Docket No. 52-048
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Application Section: 3.9

QUESTIONS

03.09.05-1

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5 states that the reactor vessel internals (RVI) is comprised of several sub-assemblies which are located inside the reactor pressure vessel (RPV). The RVI support and align the reactor core system, which includes the control rod assemblies (CRAs), support and align the control rod drive rods, and include the guide tubes that support and house the in-core instrumentation (ICI).

DCD Tier 2 Section 3.9.5 states that the RVI assembly is comprised of these subassemblies:

1) core support assembly (CSA)
2) lower riser assembly
3) upper riser assembly
4) flow diverter
5) pressurizer (PRZ) spray nozzles

DCD Tier 2 Section 3.9.5 Figures 3.9-2 to 3.9-4 provide basic sketch of the upper riser assembly, lower riser assembly and the core support assembly respectively. In these figures, multiple reactor internals components are referenced. TR-0716-50439-P, Rev. 0, "NuScale Comprehensive Vibration Assessment Program Technical Report" and TR-0916-51502-P, Rev. 0 "NuScale Power Module Seismic Analysis" both provide more detailed figures of the reactor internals assemblies.

However, the applicant did not provide a list of core support structures and reactor internals components. SRP Section 3.9.5 area of review specifies the physical or design arrangements of all reactor internals structures, components, assemblies, and systems, including the positioning and securing of such items within the RPV, the provision for axial and lateral retention and support of the internals assemblies and components, and the accommodation of dimensional changes due to thermal and other effects. SRP Section 3.9.5 Review procedure states that the configuration and general arrangement of all mechanical and structural internal elements covered by the SRP section are to be reviewed and compared to those of previously licensed similar plants.

Since NuScale is a first of a kind reactor that has a different reactor internals design than other PWRs, similar plant experiences cannot be drawn to compare with the NuScale design. Therefore, the applicant is requested to provide a complete list and description of all RVI components identifying which are core support structures and which are reactor internals, the positioning and securing of these components within the RPV, and the provision for axial and lateral retention and support of these components.

03.09.05-2

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5.1 provides a brief description of the RVI assembly. The CSA is located near the bottom of the RPV, below the RPV flange. Above the CSA are the lower riser assembly and upper riser assembly.

TR-0716-50439-P, Rev. 0, "NuScale Comprehensive Vibration Assessment Program Technical Report" further provides detail of the RVI assembly and description of the steam generator and pressurizer, which are located inside and above the upper riser assembly respectively. Specifically, details are provided regarding the steam plenum and the pressurizer baffle plate, in which the pressurizer baffler plate forms plenum tube sheet which allows the steam to travel through on the secondary side. This report also provides detail of the steam generator tube inlet flow restrictors and mounting plate, the helical steam generator tube bundle, and the steam generator support bars that provide structural integrity for the tube bundle. However, it is unclear to the staff where is the jurisdiction of boundary, or classification break for the reactor internals relative to the steam generator, pressurizer and RPV. Therefore, the applicant is requested to provide detailed explanation at locations in which the jurisdiction for components that are categorized as reactor internals end and explain the design code/standard for these components where the transition takes place. For instance, Figure 2-5 of the report TR-0716-50439-P, Rev. 0 shows the steam plenum region. The plenum tube sheet has penetrating holes where the top end of the tube bundles end. The categorization (reactor internals or pressure boundary) and design code/standard for the plenum tube sheet design is unclear to the staff.

The same conclusion can be drawn for other components inside the RPV. In a traditional PWR, all the components inside the reactor vessel are considered reactor internals (either core support or internal structure) with the exception of the CRDM, fuel elements, and instrumentation. However, due to the integrating nature of the NuScale design, the staff recognizes that this historical jurisdiction of boundary may no longer be true for the NuScale design. Nevertheless, there are components inside the NuScale RPV that don't seem to perform functions that would otherwise have deemed to be part of the reactor internals components. For instance, the steam generator tube support bars and lower tube support cantilevers are such components. Therefore, the applicant is requested to provide a list of components (and provide detail drawings if they are not already available to the staff in either the DCD or the reports TR-0716-50439-P, Rev. 0 and TR-0916-51502-P, Rev.0) of the components that are inside of the RPV but are not considered as part of the reactor internals. In addition, the applicant is requested to provide the design code/standard for these components and clearly explain where the jurisdiction is. For pressure boundary components, provide the ASME design code/standard at such locations.

03.09.05-3

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5.1 states that the upper riser assembly is located immediately above the lower riser assembly and extends upward to the pressurizer baffle plate. The upper riser channels the reactor coolant leaving the core upward through the central riser and permits the reactor coolant to turn in the space above the top of the riser and below the pressurizer baffle plate, the reactor coolant then flows downward through the annular space outside of the riser and inside of the RPV where the steam generator helical tube bundles are located.

TR-0716-50439-P, Rev. 0, "NuScale Comprehensive Vibration Assessment Program Technical Report" provides more detailed explanation of the upper riser assembly. The upper riser section is supported by the steam generator plenums and the lower riser assembly. The upper riser section itself is an open cylinder than allows reactor coolant to flow through it. This report further explains that a friction joint is located at the junction between the upper riser assembly and the lower riser assembly. This friction joint is required to separate to allow disassembly during refueling. A gap exists between the friction joint and the lower riser assembly. This report also explains that an upper riser hanger brace connects the upper riser section to the pressurizer baffle plate. Fasteners are used to attach the hanger ring to the baffle plate.

In order for the staff to make a safety finding, the following information is requested from the applicant:

1) Provide detailed design description, including drawing, of the upper riser hanger brace and explain how the hanger brace is connected to the upper riser assembly and the pressurizer baffle plate, its classification, and its design code/standard. Provide detailed design description of the fasteners used.
2) Provide detailed design description, including drawing, of the slip joint and explain how the slip joint is connected to the upper riser assembly, its classification, and its design code/standard.
3) Provide detailed design description, including drawing, of the upper riser supports that are used to support the in-core instrument guide tubes and control rod drive shafts, its classification, design/standard and means in which these supports are attached to the upper riser.

DCD Tier 2 Section 3.9.5.1 states that the upper riser assembly hangs from the pressurizer baffle plate. It also states that the upper riser assembly is supported from the RPV integral steam plenum (e.g. below the bottom of the pressurizer). The applicant is requested to provide detailed description, including the point of attachment, of how the upper riser hangs from the pressurizer baffle plate as stated in DCD Tier 2 Section 3.9.5.1.

03.09.05-4

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5.1 states that there is a bellows assembly in the lower portion of the upper riser to provide added flexibility in the vertical direction to accommodate circumstances that involve sufficient thermal growth to close the vertical gap between the upper and lower riser assemblies.

The applicant is requested to provide detailed design description, including drawing, of this bellows assembly in the lower portion of the upper riser and explain how it is connected to the upper riser assembly, its classification, and its design code/standard.

The applicant is also requested to describe the vertical gap that exists between the upper riser assembly and the lower riser assembly and how this vertical gap is affected under normal operating conditions and Level D condition such as a SSE.

Furthermore, if the upper riser assembly is not physically attached to the lower riser assembly, it would mean that the upper riser assembly is only attached to the pressurizer baffle plate at the top of the upper riser, and thus, the upper riser assembly essentially behaves like a vertical cantilever attached at the top. The applicant is requested to provide more detailed explanation about this design, and what is the mechanism to prevent the upper riser assembly from swinging laterally during all service level conditions and how this affects the structural integrity of the in-core instrumentation guide tubes and the control rod drive shafts.

03.09.05-5

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5.1 states that the lower riser assembly includes the lower riser, upper core plate, CRA guide tubes, CRA guide tube support plate and ICI guide tube support structure. The lower riser assembly is located immediately above the CSA and is aligned with and supported on the CSA by four upper support blocks.

TR-0716-50439-P, Rev. 0, “NuScale Comprehensive Vibration Assessment Program Technical Report” provides a more detailed explanation of the lower riser assembly and provides a more detailed figure of the lower riser assembly.

In order for the staff to make a safety finding, the following information is requested from the applicant:

1) Provide detailed design description, including drawing, of the CRA guide tube support plate, its classification, design code/standard, and the means in which it is attached to the lower riser.
2) Provide detailed design description, including drawing, of the CRDS support structure, its classification, design code/standard, and the means in which it is attached to the lower riser and CRA guide tube support plate.
3) Provide detailed design description, including drawing, of the ICI guide tube support structure, its classification, design code/standard, and the means in which it is attached to the lower riser.
4) Provide detailed design description, including drawing, of the upper core plate and fuel pins, its classification, design code/standard.
5) DCD Tier 2 Section 3.9.5.1 briefly states that the upper core plate is attached to the bottom of the lower riser by lock plate assemblies. Provide detailed design description, including drawing and its design code/standard, of this lock plate assembly.
6) Provide detailed explanation of the load transfer as briefly described in the report TR-0716-50439-P.

03.09.05-6

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5.1 states that there are 16 CRA guide tubes that are attached to the upper core plate and extend upward to the CRA guide tube support plate. These guide tubes house the portion of the CRAs that extend above the top of the reactor core.

TR-0716-50439-P, Rev. 0, “NuScale Comprehensive Vibration Assessment Program Technical Report” provides a more detailed explanation of the CRA guide tubes. Specifically, each CRA guide tube consists of 4 CRA cards, a CRA lower flange and an alignment cone. All of these components are welded to the CRA guide tubes.

The applicant is requested to provide the detailed design, including drawing, of the CRA guide tubes including the guide tube’s internal mechanism such as guide cards and continuous section, if applicable, its classification and the design code/standard. Provide the means which the guide tubes are attached to the CRA guide tube support plate and the upper core plate. If fasteners or split pins are used, the applicant is requested to provide detailed design description, including drawing, of these components, their classification and design code/standard.

The applicant is also requested to provide information on the relative location of a control rod relative to a guide tube when the control rod is at its fully inserted and fully withdrawn positions.

03.09.05-7

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5.1 states that an ICI guide tube support structure is located inside the lower riser to support and align ICI guide tubes with their respective fuel assemblies. Figure 3.9-3 shows a typical ICI guide tube.

The applicant is requested to provide detailed description, including drawing, of the ICI guide tubes, its classification and design code/standard. In addition, the applicant is requested to describe the means at which the ICI guide tubes are attached to the ICI guide tube support plate, the CRA guide tube support plate and the upper core plate.

03.09.05-8

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5.1 states that the core support assembly includes the core barrel, upper support blocks, lower core plate, lower fuel pins and nuts, reflector blocks, lock plate assembly, lower core support lock inserts, and the RPV surveillance specimen capsule holder and capsules. The core barrel is a continuous ring with no welds. The upper support blocks, which are welded to the core barrel, serve to center the core barrel in the lower RPV. One of the upper support blocks engages a core barrel guide feature on the lower RPV to provide circumferential positioning of the core barrel as it is lowered into the lower RPV. The lower core plate, which is welded to the bottom of the core barrel, serves to support and align the bottom end of the fuel assemblies. Locking devices align and secure the lower core plate to the core support blocks located on the RPV bottom head. TR-0716-50439-P, Rev. 0, "NuScale Comprehensive Vibration Assessment Program Technical Report" provides a brief description of each of the major components for the CSA.

In order for the staff to make a safety finding, the following information is requested from the applicant:

1) Provide detailed design description, including drawing, of the core barrel, its classification and design code/standard. Both DCD Tier 2 Figure 3.9-4 and report TR-0716-50439-P Figure 2-18 show the top of the core barrel to have the shape of a castle nut, but it is unclear to the staff how the top of the core barrel is fitted with the bottom of the lower riser assembly. The applicant is requested to describe how the lower riser assembly fits onto the core barrel, and what mechanism is there to align these two components.

2) Provide detailed design description, including drawing, of the upper support blocks, its classification, design code/standard and the number of upper support blocks that are welded on the core barrel. DCD Tier 2 Section 3.9.5.1 states that one of the upper support blocks engages a core barrel guide feature on the lower RPV to provide circumferential positioning of the core barrel as it is lowered into the lower RPV. It is unclear to the staff why only one upper support block is engaged. In addition, the applicant is requested to provide detailed design description, including drawing, of the core barrel guide feature on the lower RPV that a upper support block is engaged to when the core barrel is at its normal operation position, its classification and design code/standard.

3) Provide detailed design description, including drawing, of the lower core plate, its classification and design code/standard. The applicant is also requested to describe what kind of locking devices are used to align and secure the lower core plate to the core support blocks. DCD Tier 2 Figure 3.9-4 shows two inverted pins at the bottom of the lower core plate, while report TR-0716-50439-P Figure 2-22 shows two pins that are located at the top of the core support block. Figure 2-18 also shows a lower core support lock insert and lock plate assembly. The applicant is requested to provide detailed design description, including drawing, of this lock plate assembly and the corresponding lock inserts/pins, how they function, their classification and design code/standard.

4) Provide detailed design description, including drawing, of the core support blocks, its classification and design code/standard. Specify the number of core support blocks and the mechanism at which they are attached to the RPV bottom head. Specify under which conditions, if not all conditions, at which the core support blocks directly support the core. In some large light water PWRs, a spring like structure is built in at the bottom of the reactor vessel to absorb the impact load from a beyond design basis core drop event so the bottom of the reactor vessel would not be damaged,

provide detail description that in such event, how the core support blocks would prevent the CSA assembly from dropping to the bottom of the RPV bottom head.

5) Provide detailed design description, including drawing, of the reflector blocks, its classification and design code/standard. DCD Tier 2 Figure 3.9-4 and report TR-0716-50439-P Figure 2-18 both show that there are 6 levels of reflector blocks attached to each other with alignment pins. Provide detailed design description, including drawing, of these reflector block alignment pins, how they function, their classification and design code/standard. In addition, provide detailed description on how the reflector blocks are attached and secured to the core barrel.

6) Provide detailed design description, including drawing, of the fuel pins and nuts at the lower core plate, its classification and design code/standard.

7) Provide detailed design description, including drawing, of the surveillance capsule holders and capsules, their classification and design code/standard. The applicant is also requested to specify the number of surveillance capsule holders and the mechanism at which they are attached to the core barrel. If fasteners and dowel pins are used, provide detailed design description of such, their classification and design code/standard.

03.09.05-9

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

10 CFR 50 Appendix A GDC 2 requires that structures, systems and components important to safety are designed to withstand the effects of natural phenomena, such as earthquakes, without loss of capability to perform their safety-related functions.

DCD Tier 2 Section 3.9.5.1 states that a flow diverter is attached to the RPV bottom head under the CSA. This flow diverter smooths the turning of the reactor coolant flow from the downward flow outside the core barrel to upward the flow through the fuel assemblies. The flow diverter reduces flow turbulence and recirculation and minimizes flow related pressure loss.

The applicant is requested to provide detailed design description, including drawing, of the flow diverter, its classification and design code/standard. In addition, the applicant is requested to provide the method at which the flow diverter is attached to the RPV bottom head and how it interfaces with the core support blocks and clarify if the flow diverter supports any load from the CSA during all service level conditions.

03.09.05-10

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5 provides no information about core bypass flow. The applicant is requested to provide detailed design description about core bypass flow, the locations at which core bypass flow are expected to occur, and the percentage of core bypass flow to full flow at these locations. A figure similar to Figure 2-3 in report TR-0716-50439-P, Rev. 0 showing core bypass flow is needed for the staff to understand where core bypass flow is expected to occur.

03.09.05-11

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5 provides no information about reactor internals gap fit up during both hot and cold conditions. The applicant is requested to provide detailed design information regarding reactor internals components hot gap and cold gap fit up, and the effect of thermal expansion of various reactor internals components and if there is potential for any interference.

03.09.05-12

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

10 CFR 50 Appendix A GDC 2 requires that structures, systems and components important to safety are designed to withstand the effects of natural phenomena, such as earthquakes, without loss of capability to perform their safety-related functions.

DCD Tier 2 Section 3.9.5.1 states that under normal operation, the reactor core is supported by the core support structures of the CSA that surround the fuel assemblies. The deadweight and other mechanical and hydraulic loads from the fuel are transferred to the upper and lower core support plates. The motion of the upper and lower core support plates is coupled through the core barrel. Under seismic and accident conditions, the core barrel transfers lateral loads to the RPV shell through core support blocks at the bottom of the RPV and the upper support blocks that are attached to the upper portion of the core barrel. The vertical loads are transferred from the core barrel to the RPV head through the core support blocks.

It is unclear to the staff that in this particular paragraph in DCD Tier 2 Section 3.9.5.1, which are the upper and lower core support plates the applicant refers to. The applicant is requested to clarify, in the next revision of the DCD, the nomenclature used for upper core plate versus upper core support plate, as well as for lower core plate versus lower core support plate.

In addition, it is unclear to the staff that during seismic and accident conditions, how the lateral load is transferred from the core barrel to the RPV shell through the core support blocks, which are located at the bottom of the RPV, and through the upper support blocks, which are located at the upper portion of the core barrel. The applicant is requested to provide a simple figure of the load transfer from component to component during both normal and accident conditions, and to provide more detailed description of the load path during accident condition.

03.09.05-13

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5.1 states that during refueling and maintenance outages, the upper riser assembly stays attached to the upper section of the NuScale Power Module (NPM) (upper containment vessel (CNV), upper RPV and SG) while providing physical access for potential inspection of the feedwater plenums, SG, RPV and control rod drive shaft supports. The lower riser assembly and CSA remain with the lower NPM lower CNV, lower RPV, core barrel and core plates) when the module is parted for refueling and maintenance.

In order for the staff to make a safety finding, the following information is requested from the applicant:

1) Provide detailed design description, including drawing, of the location and stand at which the upper section NPM is located in the refueling pool during refueling. Describe the location(s) on the upper section NPM (whether it’s the CNV, RPV or upper riser assembly) at which the upper NPM will rest on the stand and describe the impact of the deadweight load on the upper riser assembly.

2) Provide detailed design description, including drawing, of the location and stand at which the lower riser assembly is located in the refueling pool during refueling. Describe the point of rigging attachment of the lower riser assembly. Describe the location(s) on the lower riser assembly at which the lower riser assembly will rest on the stand; depending on this location on lower riser assembly, describe if any of the fuel pins located below the upper core plate will be adversely affected due to the weight of the lower riser assembly.

03.09.05-14

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Table 3.9-5 provides a list of load combinations under all four service level conditions. Under plant event rod ejection accident, the service level is categorized as service level D, however, the allowable limit is categorized as level C.

Acceptance criterion 2 under SRP Section 15.4.8 requires that the postulated reactivity accident would result in neither damage to the reactor coolant pressure boundary greater than limited local yielding nor sufficient damage to impair significantly core cooling capacity. The applicant is requested to explain the rational of using level C allowable limit for a service level D condition.

03.09.05-15

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.5 provides no information regarding deformation limits, such as an acceptable deformation limits for reactor internals at which safety function can still be maintained, and the justification of which. Therefore, the applicant is requested to provide information regarding deformation limits for reactor internals components under all service level conditions.

03.09.05-16

10 CFR 50 Appendix A GDC 1 requires that structures, systems, and components important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

DCD Tier 2 Section 3.9.3.1.2, “Load Combinations and Stress Limits” Subsection “Core Support Structures” states that the steam generator tube supports are internal supports and are designed to the same criteria as the core support structure. It is unclear to the staff the meaning of this statement. Specifically, it is unclear to the staff whether the steam generator tube supports are classified as core support structure and are thus designed to ASME Subsection NG, or if they are classified as internal structures and are designed to ASME Subsection NG as a guide. Therefore, the applicant is requested to clarify the classification of the steam generator tube supports, including its seismic classification.