June 08, 2018

Docket No. 52-048

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

SUBJECT: NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 83 (eRAI No. 8899) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 83 (eRAI No. 8899)," dated July 07, 2017
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 83 (eRAI No.8899)," dated January 18, 2018

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 Question from NRC eRAI No. 8899:

- 19.01-4

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 Paul Infanger at 541-452-7351 or at pinfanger@nuscalepower.com.

Sincerely,

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

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Rani Franovich, NRC, OWFN-8G9A

Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8899

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 8899

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

eRAI No.: 8899
Date of RAI Issue: 07/07/2017

NRC Question No.: 19.01-4

10 CFR 52.47(a)(27) states that a DCA must contain an FSAR that includes a description of the design-specific PRA and its results in lieu of a seismic PRA. SECY 93-087 approves an alternative approach to seismic PRA for the DCA and ISG-20 provide guidance on the methods acceptable to the staff to demonstrate acceptably low seismic risk for a design certification (DC).

In FSAR Tier 2, Subsection 19.1.5.1.1.3, the applicant provides a list of three criteria for selecting structures for fragility evaluation. The 2nd criterion states the structures directly connected to the module interface are the reactor bay walls, pool wall, and pool floor. The latter two are bounded in terms of fragility by the reactor building (RXB) outer wall failure. The 3rd criterion states that the roof of the RXB and the pool wall fragility are bounded by the outer wall fragility analysis. The staff requests that the applicant provide the technical basis for the assumption that the RXB roof, pool floor, and pool walls are bounded by the RXB outer wall failure.

NuScale Response:

NuScale is supplementing its response to RAI 8899 (Question 19.01-4) originally provided in letter RAIO-0118-58237, dated January 18, 2018. This supplemental information is provided as a result of discussions with the NRC during the PRA audit that began on March 06, 2018 (ML18053A216); information provided in the original response remains valid.

FSAR Section 19.1.5.1.1.3, "Reactor Bay Wall", states that seismically-induced failure of a bay wall is expected to be controlling relative to failure of the pool wall because the bay wall is supported only on one end. As described in NuScale's original response to Question 19.01-4 in letter RAIO-0118-58237, fragility calculations have been performed for each of the reactor bay walls and pool walls. Thus, the statement that the bay wall is expected to be the controlling failure is unnecessary and the discussion is deleted. Further, because fragilities for all of the modeled sub-structures within the reactor building, including the bay wall, are discussed in FSAR Section 19.1.5.1.1.3, the heading "Reactor Building Wall" is changed to "Reactor Building".

FSAR Section 19.1.5.1.2, "Significant Structural Failures", has been modified to reflect the results of fragility calculations performed to support the response to Question 19.01-4. As indicated in FSAR Table 19.1-35, this modification is consistent with the fragility calculations that have been performed and reflects that the assumed consequence of failure is core damage and large release.

Impact on DCA:

FSAR Sections 19.1.5.1.1.3 and 19.1.5.1.2 have been revised as described in the response above and as shown in the markup provided in this response.

component failures in that they do not correspond to a random event in the internal events PRA. In nearly all cases, the consequences of structural events are assumed to lead to both core damage and large release without opportunity for mitigation. This is a simplifying assumption for modeling catastrophic failure mechanisms.

The selection of structural failures to model is based on a qualitative assessment of the external mechanisms that can damage the NPM. Structures selected for analysis meet one of the following criteria:

RAI 19.01-8S1

- Structures directly in contact with the NPM: This applies to the NPM base support and module lug support system;

RAI 19.01-4

- Structures directly connected to the module interface: The reactor bay walls, pool wall, and basemat; or

RAI 19.01-4

- Structures located above the module, where collapse could lead to physical damage to the module. These include the Reactor Building crane (RBC) and the bioshield.

Figure 1.2-5 provides perspective on the locations of structural failures included in the SMA.

Reactor Building Crane

The RBC is located over the reactor pool and is suspended by girders. It runs the length of the reactor pool and is used primarily for raising and transporting NPMs to and from the refueling bay.

RAI 19.01-4, RAI 19.01-14S1

The crane is designed with seismic restraints. As illustrated in Figure 19.1-42, bridge girder failure cannot lead to catastrophic collapse without failure of the bridge seismic restraints. Failure of the bridge seismic restraints is the controlling failure mode by comparison to yielding of the bridge girder itself. The bounding consequence of crane failure is a collapse of the crane structure, which is assumed to impact the top of the module, and lead to core damage and large release. This modeling simplification is conservative because the bioshield, CNV, and RPV integrity are not credited following a crane collapse.

RAI 19.01-4S1

Reactor Building ~~Wall~~

RAI 19.01-4

The fragility of the RXB as a whole is modeled by separate fragility analyses of each of the wall types, as well as the RXB roof, and basemat:

RAI 19.01-4

- the four exterior RXB walls

The controlling failure mode for the module supports (for both the lug and floor locations) is evaluated as the shear failure of multiple concrete-embedded shear lugs.

RAI 19.01-4S1

~~Reactor Bay Wall~~

~~The NPM is surrounded by bay walls on two sides and the reactor pool wall on a third. The fourth side is open to the middle of the reactor pool. The bay wall failure is expected to be controlling compared to the reactor pool wall because it is supported only on one end. As for other structural failures, failure of the reactor bay wall is assumed to lead to core damage and a large release.~~

Bioshield

Each NPM is covered by a removable bioshield that rests over the module during normal operation. The bioshield consists of a concrete slab attached on three sides by anchor bolts to the bay walls and pool walls.

During refueling, the bioshield of the refueled module is placed on top of an adjacent module. Any operating module, therefore, may have two bioshields stacked over it. A separate fragility calculation is performed for two stacked bioshields and is included in the SMA.

Because the bioshield is a simple slab structure, four potential bioshield failure modes were identified:

- Vertical bioshield failure;
- Horizontal shear flexure;
- Pool wall anchor bolt shear;
- Bay wall anchor bolt shear.

Bioshield failure is expected to cause the entire horizontal slab section to collapse on top of the NPM, causing core damage and a large release.

Vertical bioshield failure has been screened from analysis because of the bounded consequences of failure. The controlling failure mode would involve detachment from its lower supports against the bay wall, its upper connection to the horizontal bioshield slab, and then sufficient flexing of the bay walls to allow the vertical section to separate from the rest of the bioshield and twist inwards to strike the CNV. Because bay wall twisting and shear cracking failure is evaluated by a separate fragility calculation, this fragility is screened from the analysis.

Due to the geometric configuration of the anchor bolts, different failure modes are controlling for each direction:

- East-West: Shear Failure of both bay wall and pool wall anchor bolts;

This section provides brief descriptions of the significant contributors to risk as determined by the SMA.

Structural events are by far the leading contributor to the seismic margin. The bounding structural event is weldment failure on the crane bridge seismic restraints, which is modeled to lead directly to crane collapse, core damage and large release.

RAI 19.01-8S1

A single SMA sequence contains all structural events and represents 99.8 percent of the large release conditional failure probability after a HCLPF-level earthquake. In accordance with the MIN-MAX method, the lowest HCLPF value between cutsets in the same sequence is controlling. This is why only the Reactor Building crane event HCLPF shows up at the sequence level.

Risk Significance

Potentially risk significant structures, components and operator actions are discussed below.

Significant Structural Failures

RAI 19.01-4S1, RAI 19.01-8S1

Table 19.1-35 lists ~~nine individual structural failure modes for which seismic fragilities are generated. Of these, eight represent structural failure modes assumed to lead directly to core damage and a large release. The fault tree logic for these structures is represented by an "OR" gate with all eight inputs, with any one failure leading to core damage and large release.~~the structural failure modes for which the seismic fragilities are calculated. Structural failure modes are assumed to lead directly to core damage and large release. ~~The most risk significant of these structural failures is for yielding of the RBC bridge seismic restraint weldments.~~As such, the structural failure modes modeled in the SMA contribute to the seismic margin.

Significant Component Failure Modes

The NuScale unique passive safety features limits the risk associated with failure of active components (such as pumps, compressors and switches) to perform during or after a seismic event. In addition, mitigating systems are largely fail safe, resulting in their actuation on loss of power or control. As such, very few component failures have the potential to contribute to seismic risk.

Moreover, component fragilities reported in Table 19.1-38 show very low seismic failure probabilities. The fail-safe design of PRA-critical components means that the only credible seismic failures of the valves required to achieve safe shutdown involves physical deformation of the valves themselves, which only occurs under extreme stresses. As a result, component failures (either seismic or random) do not contribute significantly to the potential for core damage or releases following a seismic event. Rather, similar to the internal events PRA, CCF of key functions have