RAIO-1217-57725

December 18, 2017

Docket No. 52-048

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

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 271 (eRAI No. 9147) on the NuScale Design Certification Application

REFERENCE: U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 271 (eRAI No. 9147)," dated October 25, 2017

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

The Enclosure to this letter contains NuScale's response to the following RAI Questions from NRC eRAI No. 9147:

- 06.02.06-4
- 06.02.06-5
- 06.02.06-6
- 06.02.06-7
- 06.02.06-8
- 06.02.06-9
- 06.02.06-10
- 06.02.06-11
- 06.02.06-12
- 06.02.06-13

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 Response to NRC Request for Additional Information eRAI No. 9147

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9147

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

eRAI No.: 9147
Date of RAI Issue: 10/25/2017

NRC Question No.: 06.02.06-4

Regulatory basis is 10 CFR 50, App. J and 10 CFR 50.12(a)(1)
In technical report TR-1116-51962, NuScale states "The NuScale CLIP(containment leakage integrity program) provides leakage integrity assurance equivalent to the containment leakage testing requirements of 10 CFR 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors." One of the purposes of the leakage tests is to assure that leakage through the primary reactor containment and systems and components penetrating the primary containment shall not exceed allowable leakage rate values as specified in the technical specifications or associated bases. Identify and provide for audit the calculation(s) which demonstrate that the Type B leak test pressure applied to the main containment flange would be equivalent to applying an internal CNV pressure of Pa during a Type A test. As part of the response, provide a decription of the calculations and how the calculation demonstrates the requested information.

NuScale Response:

A hydrostatic test at a minimum pressure of 125% of the design pressure is performed on every containment vessel (CNV) prior to going into service. No visual leakage indications while at the hydrostatic test examination pressure are permitted. Therefore, the hydrostatic test demonstrates that the CNV closure flange seal design and fabrication allows no leakage at a minimum pressure of 125% of the design pressure . The hydrostatic test pressure confirms the seal integrity due to an internal pressure greater than the design pressure once the O-ring seal is established.

After de-tensioning the closure flange studs, separating the upper and lower CNV sections, performing any maintenance or refueling, replacing the seals, reassembling the CNV and tensioning the closure flange studs, the as-left, proposed Type B leak test is performed which pressurizes the space between the O-ring seals. The proposed Type B pneumatic tests are performed at the maximum design basis accident pressure (Pa) of 951 psia, which would be the same pressure for performance of a Type A test. All tests must meet the 0.60La criteria established in 10 CFR 50 Appendix J. A Type A test pressurizes the inside of the vessel and would only confirm that one O-ring boundary O-ring is sealed. Whereas,the proposed Type B leak test confirms that both the inner and outer O-ring seal is established. Leakage through either O-ring will fail the proposed Type B test. The limiting design basis accident pressure (Pa) of 951 psia ,documented in FSAR Section 6.2.1, is below the 1,000 psia CNV design pressure. The CNV is analyzed for ultimate pressure integrity in accordance with the guidance provided by Regulatory Guide 1.216. The analysis of the CNV ultimate pressure is discussed in TR-0917-56119. The analysis determines the CNV internal pressure beyond the CNV design pressure that causes the CNV to reach established failure criteria. Using the design pressure as a bounding pressure for Pa, the CNV ultimate pressure integrity analysis (refer to Figure 4-13) demonstrates that a 1,000 psia internal pressure results in a deflection (gap) at the closure flange outer O-ring of less than 0.0003 inches. The inner O-ring is radially spaced less than 1.2 inches from the outer O-ring and has a maximum deflection of less than 0.0005 inches. These gaps are well below the gap expected to allow leakage past the O-ring seal. The metal O-rings are self energizing and installed without plastic deformation. These O-rings are designed to continue to seal with some flange movement due to the springback capability of the seal design. This confirms the closure flanges stay relatively flat and parallel to each other, showing there is an insignificant amount of prying occurring between the flanges. So the Type B leak test does not need to simulate any uneven separation of the flanges at 951 psia. Therefore, Type B leak testing that pressurizes the space between the inner and outer O-ring will test the seal similar to when a Type A leak test pressure is applied, but will ensure that both seals are satisfactory. Therefore, the proposed Type B test is equivalent to a Type A test for the purpose of demonstrating the integrity of the CNV flanges.

Impact on DCA:

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

NuScale Power

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eRAI No.: 9147
Date of RAI Issue: 10/25/2017

NRC Question No.: 06.02.06-5

Regulatory basis is 10 CFR 50, App. J and 10 CFR 50.12(a)(1)

NuScale calculation EC-A011-3036, rev 1, 28 Dec 2016, “CNV Ultimate Pressure Integrity Analysis” assumed a maximum allowable gap of 0.03” between the bolted flanges and the center of the O-rings. This is intended to represent a maximum gap before unacceptable flange leakage would occur. Provide the leakage rate at the accident pressure Pa for each CNV flange at the gap of 0.03” or their respective values for each of the bolted flanges.

For bolted flanges, the stud preload and the pressure to lose that preload could significantly affect the CNV leak rate. NuScale calculation EC-A011-3036, rev. 1, Table 5-1 provides the bolt preloads and the pressures to lose preload for several CNV flanges, including the main refueling flange. Identify and provide for audit the stud preload calculation for each of the bolted CNV flanges not included in the above calculation.

The above requested information is requested for all the bolted flanges, not just those of nominal pipe size (NPS) greater than 18”.

NuScale Response:

The containment vessel (CNV) ultimate pressure integrity analysis documented in TR-0917-56119, Section 4.2, determines the CNV internal pressure that causes the CNV to reach established failure criteria. The analysis follows the guidance provided by Regulatory Guide 1.216. The calculated CNV internal pressure which results in the failure criteria being exceeded is 1240 psia.

The maximum design basis accident pressure (Pa) is 951 psia, which is below the 1,000 psia design pressure. Using the design pressure as a bounding pressure for Pa, the CNV ultimate pressure integrity analysis shows at 1,000 psi internal pressure the gap at the outer O-ring of the following bolted connections are:

PZR heater access (CNV31) < 0.018” top & bottom, < 0.008” sides

SG Inspection access (CNV30) < 0.004” top & bottom, < 0.002” sides

CRDM access (CNV25) < 0.003” 90°-270° axis, < 0.004” 0°-180° axis

Head manway access (CNV24) < 0.001”

CRDM power access (CNV37) < 0.001”

Closure flanges < 0.001”

At the 1,000 psi design pressure the largest gap at the outer O-ring of any sealed opening is calculated to be 0.018 inches, well below the gap expected to allow leakage past the O-ring.

The gap at the inner O-ring will be slightly larger. However, the spacing between the inner and outer O-ring is less than 1 inch except for the closure flanges which have a distance between O-rings of about 1.2 inches. So the inner O-ring peak deflection (gap) at the 1,000 psi internal pressure is about the same as the outer O-ring. Therefore, at Pa the gap at the O-ring is less than 0.030 inches and no leakage is expected at the bolted connections.

The force on a bolt of a bolted flange cover is proportional to the ratio of the total area of the bolts to the area on which the pressure acts. On the CNV as the pressure area of the cover decreases the total bolt area decreases by a less than or equivalent percentage as the pressure area of the cover. So it is reasonable to assume that the larger diameter bolted openings will lose bolt preload before smaller diameter bolted openings. This is confirmed by examining the pressure required to lose bolt preload from the CNV ultimate pressure integrity analysis described by TR-0917-56119, Section 4.3. As demonstrated by TR-0917-56119, Table 4-2, the lowest pressure needed to lose bolt preload is well above the 1240 psia failure criteria. These calculated pressures show that as the cover diameter decreases the pressure needed to lose preload increases. The penetrations less than NPS 18 not evaluated [I&C division nozzles (NPS 3); PZR power nozzles (NPS 12); I&C channel A-D nozzles (NPS 8); and CRDM control nozzles (NPS 10)] will require higher pressure to overcome bolt preload. At a 17” opening the pressure needed to lose preload is 7.3 times greater than the accident pressure. Calculation of the pressure needed to overcome preload for penetrations less than NPS 18 will continue to increase by a factor of 7.3 or greater than the accident pressure. Therefore, pressure to lose preload is so significantly greater than the accident pressure that calculation for the small covers is not required.

Impact on DCA:

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

NuScale Power

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Date of RAI Issue: 10/25/2017

NRC Question No.: 06.02.06-6

Appendix J to 10 CFR 50, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors," states, in part:

The maximum allowable leakage rate, La (weight percent in 24 hours) is defined at accident pressure, Pa, as specified for preoperational tests in the technical specifications or associated bases, and as specified for periodic tests in the operating license or combined license. The combined leakage rate for all penetrations and valves subject to Types B and C tests shall be less than 0.60 La. NuScale's proposed technical specification for allowable leakage and containment operability is 0.20 % in 24 hrs. If leakage from Types B and C testing cannot exceed 0.60 La, or 0.12% in 24 hrs, describe how the Type A leakage is demonstrated to not exceed 0.08% in 24 hrs?

NuScale TR-1116-51962 states that the allowable pressure change in the CNV, which would meet the leakage criteria for the NuScale design, is approximately 0.06 psia. Explain the leakage criteria to which this pressure corresponds: the Technical specification. leakage value of 0.20 % in 24 hrs; the Type A equivalent allowable leakage of 0.12 % in 24 hrs; or other value.

The overall integrated leakage rate demonstrates containment Technical Specification operability. For that overall integrated leakage rate, which is obtained from a summation of leakage through all potential leakage paths, describe how the contribution from Type A testing is quantified to ensure and demonstrate containment operability.

NuScale Response:

The Type A leakage test margin is demonstrated by maintaining the Type B and C leakage at the < 0.60 La value at all times and maintaining the inservice inspection (ISI) program current. This along with the preservice testing preformed will ensure that leakage is maintained within the required limits.

The Section III preservice inspections include 100% volumetric exams on surfaces and welds and a 125% hydrostatic test with a no observed leakage acceptance criteria. This testing, along with the robust heavy walled, ASME Code Class 1 vessel has no credible paths for undetected leakage, that would not be detected by the proposed Type B and C testing. Therefore, the 0.08% in 24 hrs represents a 40% margin to the allowable leakage, which is maintained by the inspections.

The 0.06 psia value is a per hour pressure drop corresponding to the allowable leakage of 0.2 weight percent in 24 hrs while meeting the NuScale 0.60 La acceptance criteria. This value is based on the 1000 psia design pressure, not the currently calculated peak accident pressure of 951 psia. Type B and C LLRT leakage testing will be performed at the peak accident pressure (Pa).

The NuScale leakage criteria is based on the required Class 1 preservice tests verifying the leak tight integrity of the overall vessel and the continuing local leak rate test totals being maintained at <0.60 La at all times. This will be maintained along with an ongoing ISI program that provides 100% visual vessel surface inspections over an inpsection period in accordance with ASME BPVC IWB—2500-1 (B-N-1) Item No. B13.10, and 100% volumetric inspection of containment vessel welds over an ISI interval .

Standard Type A leakage test criteria acceptance is 0.75 La. The NuScale technical specification criteria is based on Type B/C leakage totals being maintained at <0.60 La for the allowable leakage of 0.2 weight percent in 24 hrs. This provides a 40% margin to the allowable 0.2 weight percent in 24 hours.

Impact on DCA:

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

NuScale Power

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Date of RAI Issue: 10/25/2017

NRC Question No.: 06.02.06-7

In NuScale TR-1116-51962-NP, “NuScale Containment Leakage Integrity Assurance Technical Report”, states that leakage rate test frequencies according to 10 CFR 50, Appendix J, will be established under Option A, Prescriptive Requirements. Since there would not be any performance history to the initially licensed NuScale plants, selecting Option B, Performance Based Requirements, would not be available.

RG 1.163 and NEI 94-01 describe the risk informed methods required to extend the leak rate test frequencies in order to select Option B. Among the minimum requirements, Type A, Type B and Type C tests must be performed on two successful, successive tests to demonstrate acceptable containment leakage performance.

The siting criteria in 10 CFR 52.47(a)(2)(iv) states, in part, “The applicant shall perform an evaluation and analysis of the postulated fission product release, using the expected demonstrable containment leak rate”. Explain how Type A containment leakage is demonstrated to meet the siting criteria, or to successfully apply risk informed methods to extend leak rate testing frequencies, to those allowed under Option B.

ANSI/ANS 56.8, “Containment System Leakage Testing Requirements”, 1994 is listed as a reference in NuScale TR-1116-51962. However, in the same TR, NuScale cites ANSI/ANS 56.8, 2002 version. Clarify to which version of 56.8 the NuScale design committed to comply.

NuScale Response:

NuScale is not seeking use of Option B as discussed by TR-1116-51962-NP, Revision 0. There is insufficient performance history to consider Option B. A licensee could consider a change to their program, in accordance with Appendix J and NRC approval, once sufficient performance history is obtained to utilize Option B.

The Type A limit (La) of 0.2 weight percent per 24 hrs is used in the fission product release calculations, and is considered the bounding value for the safety analyses to assure that the limits as applied to offsite dose are met. Local leak rate testing totals are limited to < 0.60 La as applied to the technical specification limit to assure that the plant leakage is maintained at less than La.

The citation for 2002 in TR-1116-51692, Section 2.2 quoted specific wording out of NEI 94-01 that references the version to support the discussion in that paragraph. This is not intended to indicate commitment to the 2002 Edition of the standard.

NuScale is committed to ANSI 56.8 1994 Edition.

Impact on DCA:

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

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eRAI No.: 9147
Date of RAI Issue: 10/25/2017

NRC Question No.: 06.02.06-8

In Service Inspection (ISI) and In-Service Testing (IST)

NuScale TR-1116-51962, **"NuScale Containment Leakage Integrity Assurance Technical Report"**, commits to ISI per the requirements of ASME XI, IWB, of 100% visual inspection of the CNV, both inside and outside, once every 10 years. This is to be accomplished at each refueling by inspecting 20% of the CNV both inside and outside the CNV.

NuScale indicates in the TR, section 5.1.1 that there will be cladding, both inside and outside the CNV in the low alloy steel region. Clarify how this region be visually inspected? What percentage of the CNV surface area does this represent?

NuScale Response:

The inspection criteria being used for the containment vessel (CNV) is for a Class I vessel (NB). The inspections for all wetted surfaces on the CNV surfaces will be by VT-3 standards per Table IWB-2500-1 (B-N-1). Non wetted surfaces (exterior of the CNV head) will be inspected with a general visual inspection as an augmented inspection to be consistent with the requirements of Table IWE-2500-1 (E-A). Per IWA-2213, VT-3 examinations are conducted to determine the general mechanical and structural condition of components and their supports by verifying parameters such as clearances, settings, and physical displacements; and to detect discontinuities and imperfections, such as loss of integrity at bolted or welded connections, loose or missing parts, debris, corrosion, wear, or erosion.

The Section XI preservice inspection requires 100% of the surface area be visually inspected to provide a baseline. Ongoing visual inspection of the surfaces will be completed consistent with the inspection periods in Table IWB-2411-1 where 100% of the surface is inspected in each period. All CNV surfaces (internal and external) are available for inspection during the refueling outage, with no surfaces hidden by concrete or other components. The entire upper CNV is clad, with the lower CNV section (from flange to bottom) as solid stainless steel. This is approximately 33% of the surface area for the stainless steel (both internal and external) with approximately 67% clad. All visual examinations of clad surfaces are to be completed as specified in IWA-2210.

Impact on DCA:

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

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eRAI No.: 9147
Date of RAI Issue: 10/25/2017

NRC Question No.: 06.02.06-9

Confirm that 10 CFR 50 App J Type B test of the double O-ring seals on all the containment bolted closures are performed by local pressurization at containment peak accident pressure, Pa during each reactor shutdown for refueling.

FSAR Table 6.2-3, “Containment Vessel Inspection Elements” describes the ASME XI Examination Categories and Methods for the bolting for the CNV main flange and for bolting two inches or less in diameter. Clarify if these two categories comprise all the bolting for all the CNV flanges. Explain how compliance will be ensured. Will all the bolts be examined each time they are removed? Are the flange bolts inspected only when they are removed?

NuScale Response:

There are double O-ring seals on all containment bolted closures. All of these closures will be as-found Type B tested every refueling outage, and as-left tested, if necessary.

Section XI of the BPVC provides two categories for bolts; B-G-1 for bolts greater than two inches and B-G-2 for bolts less than two inches. For the CNV design, the upper and lower shell flange bolts are greater than two inches and, therefore, must meet the requirements of the B-G-1 category. All other bolting on the CNV is less than two inches and must meet the requirements of the B-G-2 category.

Inservice inspection of the bolting will be in accordance with the NuScale Inservice Inspection Program and Section XI. All of the bolts are examined each time they are removed. The upper and lower shell flange bolts will be removed every fueling outage and inspected at least once during each inspection interval, as required by Table IWB-2500-1 (B-G-1). For all other bolting, the bolts will only be inspected when removed and are only required to be inspected once during inspection interval (e.g. if the flange cover is removed twice in 10 years, the bolts will only be inspected once) as per the requirements of Table IWB-2500-1 (B-G-2).

Impact on DCA:

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

NUSCALE POWER™

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eRAI No.: 9147
Date of RAI Issue: 10/25/2017

NRC Question No.: 06.02.06-10

Provide the calculation which according to the TR-1116-51962 establishes that the acceptable CNV leakage rate La at 0.20 % at design pressure would be 18.05 SCFH. Or, 0.226 SCFM at 1000 psia.

Clarify whether NuScale means 18.05 CFH at 1000 psia and 0.226 CFM at 1000 psia, or 18.05 SCFH and 0.226 SCFM.

NuScale Response:

EC-A013-5846 Revision 0 provides the latest calculation of leakage rate equivalent for the NuScale module. For Pa equals 951 psia, the allowable test leakage is 17.77 SCFH, or 0.296 SCFM. The calculation has been added to the containment and ventilation audit folder within the NuScale electronic reading room for NRC audit purposes.

The value of 18.05 is La at 1000 psia, in standard cubic feet per hour (SCFH). The value of 0.226 is in standard cubic feet per minute (SCFM), which is 0.75 La at 1000 psia. La at 1000 psia is based on an assumed leak rate equivalent to leakage of 0.2% of the containment air mass at 1000 psia in a 24 hour period.

Impact on DCA:

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

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eRAI No.: 9147
Date of RAI Issue: 10/25/2017

NRC Question No.: 06.02.06-11

In Exemption Request 10 CFR 50 App A, GDC 52, Containment Leak Rate Testing, NuScale states “Type B and C testing, inspections, and administrative controls (e.g., configuration management and procedural requirements for system restoration) to assure leakage integrity associated with activity- based failure mechanisms (i.e., assures that CNV penetrations and CIVs remain within allowable leakage rate values after system and component modifications or maintenance)”
Because the exemption requests relies upon adminstrative controls, in order for the staff to make its safety finding additional information is needed, as requested below.

OP-0000-10842, “NuScale Module Refueling Operations Procedure”, rev 0, 9 Mar 2015, and NuScale TR-1116-51962, **“NuScale Containment Leakage Integrity Assurance Technical Report”** describe the proposed refueling operation steps. For the following actions, indicate which are: being viewed remotely vs. directly; controlled directly, (i.e. not from a control station); accomplished remotely,(i.e. using special tools such as the containment flange tool;) performed or Inspected under water; ‘instrumentation readings which are viewed directly; and, which actions are automated.

In Reactor Bay:
Disassembly of CNV
Visual inspection of CNV, including lower flange and flange bolts

In Dry Dock:
Inspect upper containment flange
Replace containment flange O-ring seals, when necessary Inspect or replace containment flange nuts
Inspect ISI welds, forgings and surfaces Perform App J Type B leak tests
(App J Type A is conducted during pressurized air assisted containment drain down) Perform App. J Type C leak tests
Reassembly of upper module to lower module using CNV flange tool guides CNV main flange stud preload tension applied

In Reactor Bay:
CNV main flange Type B tested

NuScale Response:

Action	View		Control		Performed in water/air		Instrument readings		Performance Auto/manual	
	remote	direct	remote	direct	water	air	remote	direct	auto	man
	In Reactor Operating Bay:									
Disassembly of CNV (removal of spool pieces)	x	x		x		x	x			**Note 1**
	In Dry Dock:									
Inspect upper containment flange **Note 4**	x	x **Note 2**			x	x		x		
Inspect upper CNV	x	x **Note 2**	x	x		x		x	x	**Note 1**
Inspect ISI welds, forgings and surfaces	x	x **Note 2**	x	x		x	x		x	**Note 1**
Perform App J Type B leak tests		x		x		x		x		x
Perform App. J Type C leak tests		x		x		x		x		x
	In Refueling Stands									
Inspection of the CNV upper and lower flanges and all aspects of the lower CNV; which includes the flange bolts, ISI welds, forgings and surfaces.	x		x		x		x		x	**Note 1**
When necessary Inspect or replace containment flange nuts	x		x		x	x **Note 3**	x		x	**Note 1** **Note 2**
Replace containment flange O-ring seals.	x		x		x		x		x	**Note 1**
Reassembly of upper module to lower module using CNV flange tool guides CNV main flange stud preload tension applied	x		x		x		x		x	x **Note 1**
CNV main flange Type B tested	x		x		x		x		x	**Note 1**
Note 1	Operator/technician will be monitoring automation and tasked with taking manual control or aborting the task if a problem is encountered.									
Note 2	Some sections of the exterior may be directly viewed.									
Note 3	Upper flange CNV nuts changed in dry dock manually.									
Note 4	Inspection of the upper flange in the drydock is a contingency.									

Impact on DCA:

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

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eRAI No.: 9147
Date of RAI Issue: 10/25/2017

NRC Question No.: 06.02.06-12

NuScale's Exemption Request for 10 CFR 50, App A, GDC 52 is based upon providing CNV design specifications and design capability for local leak rate testing to demonstrate that the CNV leakage will not exceed the Technical Specification allowable leakage rate values. This reasoning is being applied to a first of a kind (FOAK) containment vessel design, and relies heavily on refueling, inspection and test procedures which have yet to be shown as successful. The proposed Type B and Type C testing will be done under non-traditional, ie yet to be demonstrated as successful, conditions. This testing and inspection will be done at least partially remotely and under water. Describe the NuScale testing of this entire proposed refueling and inspection program, under the conditions which would be encountered in the NuScale design. Explain how the leakage test results demonstrate equivalency to containment leak rate testing which normally includes local leak rate testing, and App J Type A testing?

The operating experience of some BWRs illustrates that drywell leakage paths developed due to inadequate drywell closures is well known. The BWR drywell is similar to the NuScale design due to the limited volume and bolted flange designs. The operating experience demonstrated that leakage paths were not identified by the Type B testing of the drywell head flange, but only during the Type A tests. See NRC Bulletin 78-09: "BWR Drywell Leakage Paths Associated with Inadequate Drywell Closures", 14 June 1978.

Given that the NuScale design is a FOAK design, and will be refueled every twenty four months under more challenging conditions than current plants, explain how NuScale has demonstrated that the local leak rate testing accurately reflects containment allowable leakage rate for Technical Specification operability.

NuScale Response:

Each Type B and C penetration will be as-found tested each outage. An as-left test will be performed if any activity is performed during the outage that could affect the seal. Leakage totals will be kept of the aggregate as-found and as-left configurations to meet the requirements of the Appendix J program. The as-found Type C valve tests will be performed in the individual module bays prior to module movement for refueling.

The module will be moved to the refueling pool and then the upper module section will be moved to the dry dock. Major valve maintenance will be performed in the dry dock, with as-left Type C testing performed in the dry dock. Most upper module flanged connections will be tested in the dry dock while the vessel is out of water. The containment closure flange test will be performed in the refueling area. The closure flanges will be underwater; however, the test connection for these flanges is located near the CNV Head Manway.

The location and settings for the proposed Type B and C tests are in similar conditions to what would be performed in current plants. Locations of the valves and flanges will be made accessible to the operations/testing staff under conditions that provide a safe environment to perform the testing. The main difference for the NuScale plant is the test pressure. Test equipment and gas supplies will need to be capable to safely and accurately test at an approximate pressure of 1,000 psi.

Test gas can be supplied by a standard high pressure nitrogen gas bottle, with appropriately rated test supply lines staged and attached.

Factory hydrostatic testing, preservice testing of valves and seals, comprehensive inservice inspection, continuous monitoring of vacuum during operation and performance of the proposed Type B and C testing assure integrity of the containment vessel.

The bolting of flanges requires specific procedures to be followed which will include verification of bolt preload. If the bolting is reworked for any flange, including opening and closing, then seal integrity is potentially affected and a Type B test is required and performed. Calculations for preload values for bolting will demonstrate that at peak containment pressure flange deflection will not cause the self energized O-ring seals to leak.

IE Bulletin No. 78-09, describes operational experience (OE) in which a BWR drywell head flange sucessfully completed LLTR but subsequently leaked during a Type A CILRT. Since NuScale is seeking an exemption to performing the Type A CILRT, this OE is assesed for applicability to the NuScale design.

Typical LWR test pressures are on the order of 40 to 60 PSI. The NuScale test pressure is 951 psia, which is more than fifteen times higher the the typical LWR test pressure. The proposed NuScale Type B test pressure will provide more assurance that the flange assembly errors are more readily detected since higher pressure is applied to the flange interface, providing more sensitive leak detection.

The NuScale flange assembly procedures will be utilized for vessel flange preparation for the vessel hydostatic testing as well as for normal operations and will address the improper torqueing experience identified in the past. As an ASME Class 1 vessel, comprehensive administrative controls are utilized to ensure the vessel is reassembled properly. Much of the torqueing will be performed using automated devices not available in the past.

ILRT intervals have been typically lengthened to a range of 10 to 15 years. Many LLRTs are performed in the period between successive CILRTs. It is the LLRT that provides assurance that the containment leakage is maintained. The CILRT is performed to periodically confirm and to verify no new leakage paths are discovered. The NuScale plant, being an ASME Class 1 pressure vessel with limited penetrations, relies on comprehensive ISI inspections to verify no new leakage paths.

Impact on DCA:

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

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eRAI No.: 9147
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NRC Question No.: 06.02.06-13

The NuScale FSAR section 6.2.6.2 states that all CNV bolted flanges have dual O-ring seals, with a testing port between the seals. Explain the success and/or failure criteria to determine if the O-rings may be re-used after unbolting. Explain the effect of minimal success of the O-rings on the leak rate. Identify and provide for audit the calculation and test(s) that demonstrate the extent of the varying acceptable levels of O-ring deformation on the leakage rate.

NuScale Response:

The dual O-ring seals are self-energizing, metallic O-ring that are based on plastic deformation of the jacket material to conform to the sealing flange surfaces to form the seal. The self-energizing O-ring is not dependent on the stud tensioning to maintain the seal but an elastic core composed of a close-wound helical spring. The spring is designed to have a specific compression resistance. During compression the spring will force the jacket to conform to the sealing faces creating a consistent seal. As the sealing faces begin to separate the spring will continue to apply pressure to the jacket material and follow the sealing face until the spring is no longer compressed. This allows for some separation of the seal faces before the seal is lost. The O-rings are intended to be a onetime use item. Once the studs have been tensioned, the O-rings are to be replaced.

Note: At the 1,000 psi design pressure the largest gap at the outer O-ring of any sealed opening is calculated to be 0.018 inches. Design criteria for the flanged joint ensures that the spring back of the O-ring exceeds the maximum calculated flange deflection for this application.

Impact on DCA:

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