UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 7, 2018

MEMORANDUM TO: Samuel S. Lee, Chief
Licensing Branch 1
Division of Licensing, Siting,
and Environmental Assessment
Office of New Reactors

FROM: Marieliz Vera, Project Manager ***/RA/***
Licensing Branch 1
Division of Licensing, Siting,
and Environmental Assessment
Office of New Reactors

SUBJECT: THE U.S. NUCLEAR REGULATORY COMMISSION STAFF'S REPORT OF THE REGULATORY AUDIT OF NUSCALE POWER, LLC., DESIGN DOCUMENTS FOR CONTAINMENT ISOLATION VALVES AND REACTOR SAFETY VALVES

On January 6, 2017, NuScale Power, LLC., (NuScale) submitted a design certification application (DCA) for a small modular reactor to the U.S. Nuclear Regulatory Commission (NRC) (Agencywide Documents Access and Management System Accession Number ML17013A229). The NRC staff started its detailed technical review of NuScale's DCA on March 15, 2017.

The purpose of this audit conducted by the NRC staff was to: (1) gain a better understanding of the NuScale design of the containment isolation valves and reactor safety valves; (2) verify information provided in the DCA; (3) identify information that may require docketing to support the basis of the licensing or regulatory decision; and (4) review related documentation and non-docketed information to evaluate conformance with regulatory guidance and compliance with NRC regulations.

The NRC staff conducted this audit by reviewing documents available at the NuScale office in Rockville, Maryland, and online via the NuScale electronic reading room. The audit began on September 4, 2018, and was completed on October 31, 2018. The audit report is enclosed with a list of follow-up items.

Docket No. 52-048

Enclosures:
1. CIV-RSV Audit Report
2. CIV-RSV Audit Follow-Up Items

cc w/encl.: DC NuScale Power, LLC Listserv

CONTACT: Marieliz Vera, NRO/DLSE
301-415-5861

SUBJECT: THE U.S. NUCLEAR REGULATORY COMMISSION STAFF'S REPORT OF THE REGULATORY AUDIT OF NUSCALE POWER, LLC., DESIGN DOCUMENTS FOR CONTAINMENT ISOLATION VALVES AND REACTOR SAFETY VALVES
DATED: December 7, 2018

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U.S. NUCLEAR REGULATORY COMMISSION
NUSCALE POWER, LLC.,
SUMMARY REPORT OF REGULATORY AUDIT OF DESIGN DOCUMENTS FOR CONTAINMENT ISOLATION VALVES AND REACTOR SAFETY VALVES

I. INTRODUCTION AND BACKGROUND

On March 15, 2017, the U.S. Nuclear Regulatory Commission (NRC or Commission) accepted for docketing, the design certification application (DCA) for the NuScale Power, LLC., (NuScale) small module reactor (SMR) design (Reference 1). NuScale submitted Revision 1 to the Standard Plant DCA on March 15, 2018 (Reference 2).

The NRC staff determined that efficiency gains would be realized by auditing the documents supporting the NuScale SMR design presented in the NuScale Final Safety Analysis Report (FSAR), in lieu of multiple requests for additional information (RAIs) for the applicant to submit design documents. The purpose of this audit was to allow the NRC technical staff to gain an understanding of the design of the containment isolation valves (CIVs) and reactor safety valves (RSVs) in the NuScale reactor to better focus the staff's inquiries to the applicant.

In this report, the NRC staff summarizes the results of the audit of the CIV and RSV design documents. This report also identifies the remaining items to be resolved for the staff's review of the CIV and RSV design.

II. REGULATORY AUDIT BASES

The audit basis was to confirm that the design of the NuScale CIVs and RSVs is consistent with the assumptions for the performance of those valves in the NuScale DCA.

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Section 47, "Contents of Applications; Technical Information," states the following:

> *The application must contain a level of design information sufficient to enable the Commission to judge the applicant's proposed means of assuring that construction conforms to the design and to reach a final conclusion on all safety questions associated with the design before the certification is granted. The information submitted for a design certification must include performance requirements and design information sufficiently detailed to permit the preparation of acceptance and inspection requirements by the NRC, and procurement specifications and construction and installation specifications by an applicant. The Commission will require, before design certification, that information normally contained in certain procurement specifications and construction and installation specifications be completed and available for audit if the information is necessary for the Commission to make its safety determination.*

The NRC staff reviewed the design documents for the CIVs and RSVs described in the NuScale FSAR Tier 2 including:

- Section 3.9.6, “Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints,”
- Section 5.2.2, “Overpressure Protection,” and
- Section 6.2.4, “Containment Isolation System.”

The NRC staff conducted this audit in accordance with the guidance provided in the NRC Office of New Reactors (NRO) Office Instruction NRO-REG-108, “Regulatory Audits” (Reference 3).

III. NRC AUDIT TEAM

- Thomas G. Scarbrough, Senior Mechanical Engineer, NRC, Audit Lead
- John Budzynski, Reactor Systems Engineer, NRC
- Clinton Ashley, Reactor Systems Engineer, NRC
- James Gilmer, Reactor Systems Engineer, NRC
- Marieliz Vera Amadiz, Project Manager, NRC

IV. AUDIT PURPOSE

The purpose of the audit was to evaluate the detailed design of the CIVs and RSVs in support of the NuScale Standard Plant DCA.

V. AUDIT PREPARATION

The NRC staff issued a detailed audit plan (Reference 4) that identified the information needed for this audit. The audit plan requested that documentation related to the CIV and RSV design be provided for review. NuScale made available specific design documents related to the CIVs and RSVs at the NuScale Rockville, Maryland office and in the NuScale electronic reading room.

VI. AUDIT SCOPE

The primary scope of this audit was the review of the design demonstration documentation, design drawings, design specifications, test plans, and qualification plans for the CIVs and RSVs to be used in the NuScale SMR to verify that the design and performance specifications of those valves are consistent with those assumed in the NuScale FSAR.

VII. AUDIT PERFORMANCE

In performing this audit, the staff reviewed specific NuScale documents related to the design of the CIVs and RSVs to be used in the NuScale SMR. A list of the reviewed documents is provided later in this audit report. In addition, the staff conducted several telephone conferences with NuScale representatives to discuss the design, performance, and testing of the CIVs and RSVs.

The NRC staff performance of the audit of the design of the CIVs and RSVs is described in the following paragraphs with the identification of the resolved items and follow-up items as applicable:

A. Containment Isolation Valves

With respect to the CIV design, the staff reviewed the design descriptions for the Primary System Containment Isolation Valves (PSCIVs) and Secondary System Containment Isolation Valves (SSCIVs) provided in the NuScale FSAR Tier 2. The staff evaluated whether the FSAR descriptions were consistent with the NuScale design specifications and drawings for the PSCIVs and SSCIVs.

1. CIV Resolved Items

From its audit review, the staff found that the design and operation of the PSCIVs and SSCIVs represent a new application for CIVs used in nuclear power plants. However, the staff determined that the design and operation of the PSCIVs and SSCIVs do not represent a significant safety question that requires design demonstration testing for the design certification of the NuScale SMR. In addition, the FSAR and design specifications for the PSCIVs and SSCIVs state that these valves will be qualified in accordance with American Society of Mechanical Engineers (ASME) Standard QME-1-2007, “Qualification of Active Mechanical Equipment Used in Nuclear Power Facilities,” which is endorsed in NRC Regulatory Guide (RG) 1.100 (Revision 3), “Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants,” to provide reasonable assurance of the capability of the PSCIVs and SSCIVs to perform their safety functions.

Specific areas of review are discussed in the following paragraphs:

a. PSCIV Containment Leakage Rate Testing

The staff evaluated the capabilities of the PSCIVs to facilitate containment leakage rate testing and other provisions. Examples of the staff’s observations where NuScale documents contain provisions which are consistent with NRC guidance are described below:

(1) PSCIV Design Specification EQ-A010-2235 includes provisions to accomplish 10 CFR Part 50, Appendix J local leakage rate testing. Specifically, the design specification contains provisions for test connections and test barriers necessary to establish a test volume to conduct leakage rate tests. PSCIV Drawing MD32226 (Revision A), “Primary Systems Containment Isolation Valve Assembly,” depicts an Appendix J test flange (test insert) to support PSCIV seat leakage rate testing (Type C) and an inservice flange with sealing material to support flange leakage rate testing (Type B).

(2) PSCIV Design Specification EQ-A010-2235 contains provisions to provide thermally induced overpressure protection for liquid-filled piping between containment isolation barriers to prevent damage when the PSCIVs are closed. PSCIV Drawing MD32226 depicts a

thermal relief valve that provides protection for the region between the isolation valves. The thermal relief valve is classified as safety-related.

(3) PSCIV Design Specification EQ-A010-2235 describes an exception to RG 1.141 (Revision 1), “Containment Isolation Provisions for Fluid Systems,” which endorses ANSI-N271-1976, “Containment Isolation Provisions for Fluid Systems.” NRC Design Specific Review Standard, Section 6.2.4 (Revision 0), “Containment Isolation System,” in its acceptance criteria provides a basis for this exception.

(4) PSCIV Design Specification EQ-A010-2235 contains a provision requiring stem packing and bonnet sealing to include double seals and a means to detect leakage. PSCIV Drawing MD32226 depicts double seals at the valve stem and the valve bonnet regions, and the capability to detect leakage past the seals.

(5) PSCIV Design Specification EQ-A010-2235 includes a provision that hydraulic fluid used in the hydraulic actuator shall be non-combustible. PSCIV Drawing Number MA32116 (Revision 0), “Bill of Material for Central Hydraulic Power Unit and Actuator Controls, Drawings,” depicts use of a hydraulic fluid that is non-combustible. This is consistent with the NuScale response to RAI 9048, Question 09.05.01-2, and FSAR Tier 2, Subsection 9A.6.4.3, “Fire at the Top of the Module.” During an audit teleconference on October 10, 2018, NuScale indicated that hydraulic fluid leakage (e.g., at the hydraulic connection to actuators) would be collected to prevent the hydraulic fluid from entering the reactor pool water.

(6) PSCIV Design Specification EQ-A010-2235 contains a provision requiring valve qualification to demonstrate functionality of the PSCIVs in accordance with ASME Standard QME-1-2007, as endorsed in RG 1.100 (Revision 3). The PSCIV qualification will demonstrate that the obturator is maintained in the safe position (valve closed) for the duration of the event.

b. CIV Design Specification Audit Deferred Item

The staff reviewed the specific items for the PSCIVs and SSCIVs that were deferred to the CIV-RSV audit during the staff’s audit of the NuScale design specifications. The deferred review item with its design specification audit identification number that was resolved as part of the CIV-RSV audit is as follows:

PSCIV Design Specification EQ-A010-2235 Item 21 (Design Specification Purpose): NuScale indicated that the design specification is intended to establish the valve requirements, but does not specify the valve size or type. The valve size will be the result of the specified flow coefficient. The valve type will be the result of the functional requirements that are

listed in the specification. The design specification provides the functional requirements, but not the design detail. Based on the staff's audit review, the NuScale response is acceptable and this item is resolved for the CIV-RSV audit.

2. CIV Follow-Up Items

The follow-up items from this audit related to the CIV design are as follows:

a. CIV FSAR Updates

(1) NuScale provided a proposed FSAR revision in its response dated September 17, 2018, to RAI 9565, Question 03.09.06-28, on the CIV design description. During the staff's audit review, NuScale described its actions planned to resolve the staff's comments on the proposed FSAR revision as indicated below. The staff will confirm the completion of those actions as a follow-up item to this audit.

(a) The proposed revision to the fourth paragraph (page 6.2-34) in FSAR Tier 2, Section 6.2.4.2.2, "Component Description," describes the ASME *Boiler & Pressure Vessel Code* (BPV Code), Section III Class of specific PSCIVs. In particular, the second sentence states that the PSCIVs in the Control Rod Drive System, Containment Evacuation System, and Containment Flooding and Drain System are designed and constructed to Class 1, while the third sentence states that these PSCIVs are designed, fabricated, constructed, tested, and inspected in accordance with ASME BPV Code, Section III, Class 2. NuScale will clarify the description in FSAR Tier 2, Section 6.2.4.2.2, of the ASME BPV Code Class of the specific PSCIVs.

(b) The proposed revision to the ninth paragraph (page 6.2-35) of FSAR Tier 2, Section 6.2.4.2.2, indicates that a thermal relief valve will be included in the design of the PSCIVs to release excessive pressurization between the two closed ball valves to the containment side of the PSCIV rather than a ball valve design that relieved pressure directly. NuScale will revise the description in the FSAR for the 10 CFR Part 50, Appendix J, containment leakage testing and 10 CFR 50.55a inservice testing (IST) program testing to include provisions for the PSCIV thermal relief valves.

(c) The proposed revision to the eleventh paragraph (page 6.2-36) of FSAR Tier 2, Section 6.2.4.2.2, indicates that the PSCIVs and SSCIVs are designed and qualified for torque closure using pneumatic pressure to provide sufficient wedging and sealing to prevent reopening and unseating for each ball valve for the extended time period

for the design-basis and beyond-design-basis functions assumed for each individual ball valve. NuScale will revise the description in the FSAR to clarify whether the: (1) rack and pinion mechanism, or (2) nitrogen gas cylinder, will be qualified to hold the valve closed for the time period specified for its design-basis and beyond-design-basis functions.

(d) The proposed revision to FSAR Tier 2, Section 6.2.4.2.2, does not address the potential for thermal binding of the CIVs as a result of cooling by the reactor pool. NuScale will revise the description in FSAR Tier 2, Section 6.2.4.2.2, as necessary, to address the design provisions to avoid thermal binding of the CIVs by reactor pool cooling.

(2) The diagrams of the CIVs include valves (such as relief and check valves) that perform safety functions for the proper performance of the CIV actuators, nitrogen gas cylinders, and hydraulic lines. NuScale will revise the FSAR to identify these CIV internal valves and specify the applicable IST testing of those valves consistent with the ASME Operation and Maintenance of Nuclear Power Plants, Division 1, OM Code: Section IST provisions, such as skid-mounted components where appropriate. The staff will confirm the completion of the update to the FSAR as a follow-up item to this audit.

(3) During the staff's audit review of PSCIV Design Specification EQ-A010-2235, NuScale indicated that when both valves are closed a solid water condition exists in the CIV body. A thermal relief check valve device is installed that will vent liquid to the containment vessel side of the valve if an overpressure condition exists. The staff will confirm that the FSAR is updated to reflect the thermal relief check valve in the CIV design with appropriate IST provisions as a follow-up item to this audit.

(4) During the staff's audit review of SSCIV Design Specification EQ-A010-2224, NuScale indicated that the design of the valve obturator should assure that the force required to open the valve is within the capacity of the actuator under all design conditions. NuScale noted that the qualification requirements specified will ensure that the valve strokes under all design conditions to demonstrate that the valve can perform its intended safety function and is free from adverse design deficiencies (such as pressure locking or thermal binding). The staff will confirm that the FSAR is updated, as necessary, to describe the design of the SSCIVs that will avoid pressure locking and thermal binding conditions as a follow-up item to this audit.

b. CIV Design Specification Updates

(1) During the staff's audit review of PSCIV Design Specification EQ-A010-2235 and SSCIV Design Specification EQ-A010-2224, NuScale indicated that ODI-16-0221 (Reactor Module Loading Specification for mechanical loads) remains open. The staff will confirm that this open item has been completed as a follow-up item to this audit.

(2) During the staff's audit review of PSCIV Design Specification EQ-A010-2235 and SSCIV Design Specification EQ-A010-2224, NuScale indicated that the purpose of the design specification is to communicate design requirements to the vendor. NuScale noted that the vendor will document the hydraulic actuator sizing and setting in its design documents. The staff will confirm the status of the PSCIV and SSCIV hydraulic actuator sizing and setting, including the need for a combined license action item, as a follow-up item to this audit.

B. Reactor Safety Valves

With respect to the RSV design, the staff reviewed the design descriptions for the RSVs provided in the NuScale FSAR Tier 2. The staff evaluated whether the FSAR descriptions were consistent with the NuScale design specifications and drawings for the RSVs.

1. RSV Resolved Items

From its audit review, the staff found that the design and operation of the RSVs to be used in the NuScale SMR are similar to overpressure protection valves used in current nuclear power plants. Therefore, the staff determined that the design and operation of the RSVs do not represent a significant safety question that requires design demonstration testing for the design certification of the NuScale SMR. The NuScale FSAR and design specifications indicate that the RSVs will be certified in accordance with the ASME BPV Code as incorporated by reference in the NRC regulations, and qualified in accordance with ASME Standard QME-1-2007, which is endorsed by RG 1.100 (Revision 3), to provide reasonable assurance of the capability of the RSVs to perform their safety functions.

During the staff's audit review of the RSV Capacity Calculation EC-A030-2463, the staff confirmed that NuScale complied with NRC NUREG-0800, Section 5.2.2 (Revision 3), "Overpressure Protection," Acceptance Criteria 3.B. The criteria provide the basis to determine that the safety valves have sufficient capacity to limit the pressure to less than 110 percent of the design pressure of the reactor coolant pressure boundary during the most severe anticipated operational occurrence. This is consistent with the NuScale's response to RAI 9557, Question 05.02.02-2.

The staff reviewed the specific items for the RSVs that were deferred to the CIV-RSV audit during the staff's audit of the NuScale design specifications. Those deferred review items with their design specification audit identification number that were resolved during the CIV-RSV audit are as follows:

a. RSV Design Specification EQ-A010-2179 Item 56 (RSV Qualification): NuScale indicated that the design specification references ASME Standard QME-1-2007, and requires the development of a qualification plan in accordance with the QME-1 provisions. NuScale noted that the

QME-1 provisions will be provided in a qualification specification that will be used in the development of the qualification plan. Based on the staff's audit review, the NuScale response is acceptable and the item is resolved for this audit.

b. RSV Design Specification EQ-A010-2179 Item 57g (Pressure Locking and Thermal Binding): NuScale indicated that the design of the valve seat, disk and pilot should assure that the force required to open the valve is within the capacity of the spring. NuScale stated that the qualification requirements will ensure that the valve strokes under all design conditions to demonstrate that the valve can perform its intended safety function and is free from adverse design deficiencies (such as pressure locking or thermal binding). NuScale noted that the RSVs are similar to proven designs that are used in the nuclear industry, and are not susceptible to these types of deficiencies. Based on the staff's audit review, the NuScale response is acceptable and the item is resolved for this audit.

c. RSV Design Specification EQ-A010-2179 Item 57h (RSV Sizing and Setting): NuScale indicated that the design specification provides RSV setpoints and capacity. NuScale stated that the RSVs must be sized and set to meet these requirements. Based on the staff's audit review, the NuScale response is acceptable and the item is resolved for this audit.

2. RSV Follow-Up Items

The follow-up items from this audit related to the RSV design are as follows:

a. RSV Design Specification Updates

(1) During the staff's audit review of RSV Design Specification EQ-A010-2179, NuScale indicated that the design specification is intended to establish requirements but does not specify size or type. NuScale noted that the size will result from the specified flow coefficient, and the type will result from the functional requirements listed in the design specification. However, NuScale stated that EQ-A0101-2179 does not include a table for "Piping and Nozzle Connections" to specify the valve size. Therefore, NuScale will revise the design specification to include this information. The staff will confirm that the design specification has been updated as a follow-up item to this audit.

(2) During the staff's audit review of RSV Design Specification EQ-A010-2179, NuScale indicated that ODI-15-0220 (Pressure and temperature for pneumatic leak testing and hydrostatic testing), 15-0329 (Minimum reactor pool temperature), 15-0472 (Inservice examination requirements), 16-0021 (Reactor Module Nozzle loads), and 16-0684 (Pressure and temperature curves for prototype and qualification testing) remain open. The staff will confirm that these open items have been completed as a follow-up item to this audit.

b. RSV Diagram Updates

(1) Target Rock Drawing No. 14Z539-RSV2 indicates an actuation time of 2-seconds. RSV Design Specification EQ-A010-2179 in Section 3.9.5, "Stroke Time," requires full open within 1-second after exceeding lift setpoint. NuScale will revise the Target Rock drawing to include the appropriate stroke time. NuScale will indicate any design changes or adjustments to the RSV that are necessary to satisfy the 1-second opening requirement. The staff will confirm that the Target Rock drawing has been updated as a follow-up item to this audit.

(2) Target Rock Drawing No. 14Z539-RSV2 (April 17, 2015), "Reactor Safety Valve 3 inch Class 1500 Inlet – 4 inch Class 600 Outlet," references the 2007 Edition of ASME BPV Code. NuScale FSAR Tier 2, Section 5.2.1, "Compliance with Codes and Code Cases," and RSV Design Specification EQ-A010-2179 specify that the 2013 Edition of the ASME BPV Code is the Code of record for the NuScale design certification. NuScale will revise the RSV diagram to specify the correct edition for the ASME BPV Code of record. The staff will confirm that the RSV diagram has been updated as a follow-up item to this audit.

C. NuScale Design Specification Audit

In addition to this CIV-RSV design audit, the staff reviewed the CIV and RSV design specifications as part of an overall audit of the NuScale design specifications. In the report for the NuScale Design Specification audit, the staff will list the follow-up items related to the CIV and RSV design specifications identified as part of the Design Specification audit. NuScale plans to update the CIV and RSV design specifications to resolve those follow-up items, such as incorporating provisions for the valve supplier to satisfy the 10 CFR Part 50, Appendix B, quality assurance requirements and to perform a weak link analysis for the applicable valves. The staff will track the completion of those follow-up items for the CIV and RSV design specifications through a Design Specification follow-up audit.

VIII. CONCLUSIONS

Based on this audit, the staff concludes that NuScale has provided sufficient information in the specifications for the CIVs and RSVs to be used in the NuScale SMR as required by 10 CFR 52.47 to support the NuScale DCA, with the exception of the follow-up items identified in an enclosure to this audit report. NuScale will notify the staff when the follow-up items from the CIV-RSV audit have been completed. The staff will conduct a review of the completed follow-up items to the extent necessary to finalize its safety evaluation related to the design of the CIVs and RSVs to support the staff's review of the NuScale DCA.

IX. NUSCALE PERSONNEL INTERVIEWED

- Greg Myers
- Marty Bryan
- John Fields
- Nadja Joergensen

- Scott Harris
- Gary McGee

X. DOCUMENTS REVIEWED

NuScale Design Specification, EQ-A011-2179 (Revision 0), “ASME Design Specification for Reactor Safety Valves,” dated May 24, 2016.

NuScale Design Specification, EQ-A010-2224 (Revision 1), “ASME Design Specification for Secondary Systems Containment Isolation Valves,” dated December 20, 2017.

NuScale Design Specification EQ-A010-2235 (Revision 2), “ASME Design Specification for Primary Systems Containment Isolation Valves,” dated December 19, 2017.

NuScale Drawing ED-A013-3627 (Revision 0), “Containment Isolation Valve Actuator Hydraulic Schematic,” dated October 22, 2018.

NuScale Drawing ED-A013-3690 (Revision 0), “Containment Isolation Valve Actuator Wiring Diagram,” dated October 30, 2018.

NuScale Drawing ED-A013-4087 (Revision 1), “Main Steam Isolation Valve Drawing,” dated October 30, 2018.

NuScale Drawing ED-A013-4088 (Revision 1), “Feedwater Isolation Valve Drawing,” dated October 30, 2018.

NuScale Drawing ED-A013-4089 (Revision 1), “Primary Systems Containment Isolation Valve Drawing,” dated October 30, 2018.

NuScale Drawing ED-A013-4142 (Revision 0), “Central Hydraulic Power Unit Drawing,” dated October 22, 2018.

NuScale Drawing ED-B030-2611 (Revision 1), “Decay Heat Removal Actuation Valve Drawing,” dated October 30, 2018.

NuScale Calculation EC-A030-2463 (Revision 0), “Reactor Safety Valve Capacity Calculation,” dated February 15, 2016.

Target Rock Drawing No. 14Z539-RSV2, “Reactor Safety Valve 3 inch Class 1500 Inlet – 4 inch Class 600 Outlet,” dated April 17, 2015.

XI. REFERENCES

NRC Letter, “NuScale Power, LLC. – Acceptance of an Application for Standard Design Certification of a Small Modular Reactor,” ADAMS Accession No. ML17074A087, March 23, 2017.

NuScale Standard Plant DCA, Revision 1, ADAMS Accession No. ML18086A090, March 15, 2018.

NRO-REG-108, “Regulatory Audits,” ADAMS Accession No. ML081910260, April 2, 2009.

"Audit Plan for Regulatory Audit of NuScale Power, LLC; Design Documents for Containment Isolation Valves and Reactor Safety Valves," ADAMS Accession No. M18229A114, August 22, 2018.

NRC Regulatory Guide 1.141, "Containment Isolation Provisions for Fluid Systems," Revision 1, dated July 2010.

ANSI-N271-1976, "Containment Isolation Provisions for Fluid Systems," American Nuclear Society, La Grange Park, IL, June 1976.

NRC Design Specific Review Standard, Section 6.2.4, "Containment Isolation System," Revision 0, dated June 2016.

ASME Standard QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Facilities."

NRC Regulatory Guide 1.100, Revision 3, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," dated September 2009.

NRC NUREG-0800, Section 5.2.2, "Overpressure Protection," Revision 3, dated March 2007.

NuScale Power, LLC Response to NRC Request for Additional Information No. 491 (eRAI No. 9557) on the NuScale Design Certification Application, dated July 20, 2018.

U.S. NUCLEAR REGULATORY COMMISSION
NUSCALE POWER, LLC.,
FOLLOW-UP ITEMS FROM REGULATORY AUDIT OF DESIGN DOCUMENTS FOR CONTAINMENT ISOLATION VALVES AND REACTOR SAFETY VALVES

I. Containment Isolation Valves (CIVs)

A. CIV FSAR Updates

1. NuScale provided a proposed Final Safety Analysis Report (FSAR) revision in its response dated September 17, 2018, to Request for Additional Information 9565, Question 03.09.06-28, on the CIV design description. During the staff's audit review, NuScale described its actions planned to resolve the staff's comments on the proposed FSAR revision as indicated below. The staff will confirm the completion of those actions as a follow-up item to this audit.

    a. The proposed revision to the fourth paragraph (page 6.2-34) in FSAR Tier 2, Section 6.2.4.2.2, "Component Description," describes the American Society of Mechanical Engineers (ASME) *Boiler & Pressure Vessel Code* (BPV Code), Section III Class of specific primary system containment isolation valves (PSCIVs). In particular, the second sentence states that the PSCIVs in the Control Rod Drive System, Containment Evacuation System, and Containment Flooding and Drain System are designed and constructed to Class 1, while the third sentence states that these PSCIVs are designed, fabricated, constructed, tested, and inspected in accordance with ASME BPV Code, Section III, Class 2. NuScale will clarify the description in FSAR Tier 2, Section 6.2.4.2.2, of the ASME BPV Code Class of the specific PSCIVs.

    b. The proposed revision to the ninth paragraph (page 6.2-35) of FSAR Tier 2, Section 6.2.4.2.2, indicates that a thermal relief valve will be included in the design of the PSCIVs to release excessive pressurization between the two closed ball valves to the containment side of the PSCIV rather than a ball valve design that relieved pressure directly. NuScale will revise the description in the FSAR for the Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix J, containment leakage testing and 10 CFR 50.55a inservice testing (IST) program testing to include provisions for the PSCIV thermal relief valves.

    c. The proposed revision to the eleventh paragraph (page 6.2-36) of FSAR Tier 2, Section 6.2.4.2.2, indicates that the PSCIVs and secondary system containment isolation valves (SSCIVs) are designed and qualified for torque closure using pneumatic pressure to provide sufficient wedging and sealing to prevent reopening and unseating for each ball valve for the extended time period for the design-basis and beyond-design-basis functions assumed for each individual ball valve. NuScale will revise the description in the FSAR to clarify whether the: (1) rack and pinion mechanism, or (2) nitrogen gas cylinder, will be qualified to hold the valve closed for the time period specified for its design-basis and beyond-design-basis functions.

d. The proposed revision to FSAR Tier 2, Section 6.2.4.2.2, does not address the potential for thermal binding of the CIVs as a result of cooling by the reactor pool. NuScale will revise the description in FSAR Tier 2, Section 6.2.4.2.2, as necessary, to address the design provisions to avoid thermal binding of the CIVs by reactor pool cooling.

2. The diagrams of the CIVs include valves (such as relief and check valves) that perform safety functions for the proper performance of the CIV actuators, nitrogen gas cylinders, and hydraulic lines. NuScale will revise the FSAR to identify these CIV internal valves and specify the applicable IST testing of those valves consistent with the ASME Operation and Maintenance of Nuclear Power Plants, Division 1, OM Code: Section IST provisions, such as skid-mounted components where appropriate. The staff will confirm the completion of the update to the FSAR as a follow-up item to this audit.

3. During the staff's audit review of PSCIV Design Specification EQ-A010-2235, NuScale indicated that when both valves are closed a solid water condition exists in the CIV body. A thermal relief check valve device is installed that will vent liquid to the containment vessel side of the valve if an overpressure condition exists. The staff will confirm that the FSAR is updated to reflect the thermal relief check valve in the CIV design with appropriate IST provisions as a follow-up item to this audit.

4. During the staff's audit review of SSCIV Design Specification EQ-A010-2224, NuScale indicated that the design of the valve obturator should assure that the force required to open the valve is within the capacity of the actuator under all design conditions. NuScale noted that the qualification requirements specified will ensure that the valve strokes under all design conditions to demonstrate that the valve can perform its intended safety function and is free from adverse design deficiencies (such as pressure locking or thermal binding). The staff will confirm that the FSAR is updated, as necessary, to describe the design of the SSCIVs that will avoid pressure locking and thermal binding conditions as a follow-up item to this audit.

B. CIV Design Specification Updates

1. During the staff's audit review of PSCIV Design Specification EQ-A010-2235 and SSCIV Design Specification EQ-A010-2224, NuScale indicated that ODI-16-0221 (Reactor Module Loading Specification for mechanical loads) remains open. The staff will confirm that this open item has been completed as a follow-up item to this audit.

2. During the staff's audit review of PSCIV Design Specification EQ-A010-2235 and SSCIV Design Specification EQ-A010-2224, NuScale indicated that the purpose of the design specification is to communicate design requirements to the vendor. NuScale noted that the vendor will document the hydraulic actuator sizing and setting in its design documents. The staff will confirm the status of the PSCIV and SSCIV hydraulic actuator sizing and setting, including the need for a combined license action item, as a follow-up item to this audit.

II. Reactor Safety Valves (RSVs)

A. RSV Design Specification Updates

1. During the staff's audit review of RSV Design Specification EQ-A010-2179, NuScale indicated that the design specification is intended to establish requirements but does not specify size or type. NuScale noted that the size will result from the specified flow coefficient, and the type will result from the functional requirements listed in the design specification. However, NuScale stated that EQ-A0101-2179 does not include a table for "Piping and Nozzle Connections" to specify the valve size. Therefore, NuScale will revise the design specification to include this information. The staff will confirm that the design specification has been updated as a follow-up item to this audit.

2. During the staff's audit review of RSV Design Specification EQ-A010-2179, NuScale indicated that ODI-15-0220 (Pressure and temperature for pneumatic leak testing and hydrostatic testing), 15-0329 (Minimum reactor pool temperature), 15-0472 (Inservice examination requirements), 16-0021 (Reactor Module Nozzle loads), and 16-0684 (Pressure and temperature curves for prototype and qualification testing) remain open. The staff will confirm that these open items have been completed as a follow-up item to this audit.

B. RSV Diagram Updates

1. Target Rock Drawing No. 14Z539-RSV2 indicates an actuation time of 2-seconds. RSV Design Specification EQ-A010-2179 in Section 3.9.5, "Stroke Time," requires full open within 1-second after exceeding lift setpoint. NuScale will revise the Target Rock drawing to include the appropriate stroke time. NuScale will indicate any design changes or adjustments to the RSV that are necessary to satisfy the 1-second opening requirement. The staff will confirm that the Target Rock drawing has been updated as a follow-up item to this audit.

2. Target Rock Drawing No. 14Z539-RSV2 (April 17, 2015), "Reactor Safety Valve 3 inch Class 1500 Inlet – 4 inch Class 600 Outlet," references the 2007 Edition of ASME BPV Code. NuScale FSAR Tier 2, Section 5.2.1, "Compliance with Codes and Code Cases," and RSV Design Specification EQ-A010-2179 specify that the 2013 Edition of the ASME BPV Code is the Code of record for the NuScale design certification. NuScale will revise the RSV diagram to specify the correct edition for the ASME BPV Code of record. The staff will confirm that the RSV diagram has been updated as a follow-up item to this audit.