June 2, 2021 Project No. 99902078

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

SUBJECT: NuScale Power, LLC Submittal of the Approved Version of NuScale Topical Report, "NuScale Control Room Staffing Plan," TR-0420-69456, Revision 1

REFERENCES:
1. NRC Letter to NuScale, "Final Safety Evaluation for NuScale Control Room Staffing Plan Topical Report (TR)-0420-69456, Revision 1," dated May 26, 2021
2. Letter from NuScale to NRC, "NuScale Power, LLC Submittal of 'NuScale Control Room Staffing Plan,' TR-0420-49456, Revision 1," dated December 17, 2020 (ML20352A473)

By referenced letter dated May 26, 2021, the NRC issued a final safety evaluation report documenting the NRC Staff conclusion that the NuScale topical report "NuScale Control Room Staffing Plan," TR-0420-69456, Revision 1, is acceptable for referencing in licensing applications for the NuScale small modular reactor design. The referenced NRC letter requested that NuScale publish the approved version of TR-0420-69456, within three months or receipt of the letter.

Accordingly, Enclosure 1 to this letter provides the proprietary version of the NRC safety evaluation report (SER). Enclosure 2 is the nonproprietary enclosure that includes the May 26, 2021 NRC letter and its final safety evaluation report, the NRC requests for additional information, and documentation of the final topical report submittal, Revision 1.

Enclosure 1 contains proprietary information. NuScale requests that the proprietary version of the NRC safety evaluation report be withheld from public disclosure in accordance with the requirements of 10 CFR § 2.390. The enclosed affidavit (Enclosure 3) supports this request. Enclosure 2 contains the nonproprietary version of the approved topical report package.

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

If you have any questions, please contact Nadja Joergensen at 541-452-7338 or at njoergensen@nuscalepower.com.

Sincerely,

Mark W. Shaver

Mark Shaver
Regulatory Affairs Manager
NuScale Power, LLC

Distribution: Michael Dudek, NRC
Bruce Bavol, NRC
Getachew, Tesfaye, NRC

Enclosure 1: "NuScale Safety Evaluation for NuScale Topical Report, TR-0420-69456, 'NuScale Control Room Staffing Plan'"
Enclosure 2: "NuScale Control Room Staffing Plan," TR-0420-69456-NP-A, Revision 1, nonproprietary version
Enclosure 3: Affidavit of Mark Shaver, AF-103282

Enclosure 1:

"NuScale Safety Evaluation for NuScale Topical Report, TR-0420-69456, 'NuScale Control Room Staffing Plan,'" proprietary version

NuScale Power, LLC
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Enclosure 2:

"NuScale Control Room Staffing Plan," TR-0420-69456-NP-A, Revision 1, nonproprietary version

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Contents

Section A

From: Tesfaye, Getachew <Getachew.Tesfaye@nrc.gov>
Sent: Wednesday, May 26, 2021 6:52 PM
To: Osborn, Jim <josborn@nuscalepower.com>
Cc: English, Liz <EEnglish@nuscalepower.com>; Shaver, Mark <mshaver@nuscalepower.com>; Chitty, Mark <MChitty@nuscalepower.com>; Dudek, Michael <Michael.Dudek@nrc.gov>
Subject: Final Safety Evaluation for NuScale Control Room Staffing Plan Topical Report (TR)-0420-69456, Revision 1

Dear Mr. Osborn:

By letter dated June 11, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), NuScale Power, LLC (NuScale), submitted licensing
Topical Report (TR)-0420-69456, Revision 0, "NuScale Control Room Staffing Plan." By letter dated December 17, 2020 (ADAMS Accession No. ML20352A473), NuScale submitted
Revision 1 of TR-0420-69456. The U.S. Nuclear Regulatory Commission (NRC) staff has prepared a final safety evaluation for Topical Report TR-0420-69456, Revision 1. The proprietary (password protected) and the non-proprietary versions of the final safety evaluation are enclosed. The NRC staff has found that TR-0420-69456, Revision 1, acceptable for referencing in licensing applications for the NuScale small modular reactor design to the extent specified and under the conditions and limitations delineated in the enclosed final safety evaluation.

The NRC staff requests that NuScale publish the accepted proprietary and non-proprietary versions of this TR within three months of receipt of this electronic mail. The accepted versions shall incorporate this electronic mail and the enclosed final safety evaluation after the title page. They must be well indexed such that information is readily located. Also, they must contain historical review information, including NRC requests for additional information and accepted responses. The accepted versions of the TR shall include an "-A" (designated accepted) following the report identification number.

If the NRC's criteria or regulations change such that the NRC staff's conclusion in this electronic mail (that the TR is acceptable) is invalidated, NuScale and/or the applicant referencing the TR will be expected either to revise and resubmit its respective documentation or to submit justification for continued applicability of the TR without revision of the respective documentation.

If you have any questions or comments concerning this matter, I can be reached at (301) 415-8013 or via e-mail address at Getachew.Tesfaye@nrc.gov.

Sincerely,
Getachew Tesfaye, Senior Project Manager
New Reactor Licensing Branch
Division of New and Renewed Licenses
Office of Nuclear Reactor Regulation

Docket No. 99902078

NUSCALE POWER, LLC

SAFETY EVALUATION FOR NUSCALE TOPICAL REPORT, TR-0420-69456,

"NUSCALE CONTROL ROOM STAFFING PLAN"

1.0 Introduction

By letter dated June 11, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), NuScale Power, LLC (NuScale), submitted licensing Topical Report (TR)-0420-69456, Revision 0, "NuScale Control Room Staffing Plan." By letter dated December 17, 2020 (ADAMS Accession No. ML20352A473), NuScale submitted Revision 1 of TR-0420-69456 (hereafter referred to as the TR). NuScale requested U.S. Nuclear Regulatory Commission (NRC) approval of the control room staffing plan as described in the TR, which is a minimum control room crew of three licensed operators and no shift technical advisor (STA). The TR is designed to be used by a NuScale facility licensee or license applicant to support exemption requests from the staffing requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) 50.54(m) or other alternative control room staffing regulations, such as those included in the proposed NuScale design certification rule (i.e., proposed Appendix G to Part 52), and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

By letter dated December 17, 2020 (ADAMS Accession Nos. ML20352A475 (nonproprietary) and ML20352A476 (proprietary)), NuScale submitted "Concept of Operations," Revision 1, which describes the individual roles, operating crew structure, and operating techniques for the minimum control room crew and is referenced in the TR. By letter dated December 17, 2020 (ADAMS Accession Nos. ML20352A471 (nonproprietary) and ML20352A472 (proprietary)), NuScale submitted "Revised Staffing Plan Validation Test Report," Revision 2 (hereafter referred to as the RSPV Test Report). The RSPV Test Report provides the results of performance-based tests using test personnel as operators in a 12-unit NuScale plant control room simulator, which focused on evaluations of operator performance, workload, and situation awareness (SA) during challenging plant operating conditions, such as design-basis events (DBEs), beyond design-basis events (BDBEs), and multimodule events.

An information paper to the Commission is planned to describe the staff's approach to reviewing NuScale's proposal to eliminate the STA role from the staffing plan.

The staff's review of the TR focused on whether the proposed minimum control room staffing could successfully accomplish the most demanding tasks under conditions that reflect real-world challenges, including the demands of multitasking. The staff assessed the methods NuScale used to conduct the RSPV tests, including the scenarios NuScale developed to create challenging, high-workload conditions for the test operators in the simulator, and the task performance, workload, and SA results. Section 2.0 of this safety evaluation (SE) discusses the regulations, Commission policies, and NRC staff guidance relevant to the staff's review of the TR. Section 3.0 documents the staff's evaluation of the TR, and Section 4.0 provides the staff's conclusion on the acceptability of the TR for use by a NuScale combined license (COL) applicant or holder. Section 5.0 provides the conditions of applicability of the TR.

2.0 Regulatory Basis

2.1 Shift Staffing

The requirements in 10 CFR 50.54(k) and 50.54(m) identify the minimum number of licensed operators that must be on site, in the control room, and at the controls. The requirements are conditions in every nuclear power reactor operating license issued under 10 CFR part 50, "Domestic Licensing of Production and Utilization Facilities." The requirements also are conditions in every combined license (COL) issued under 10 CFR part 52; however, they are applicable only after the Commission makes the finding under § 52.103(g) that the acceptance criteria in the COL are met.

In a letter to the NRC, dated September 15, 2015 (ADAMS Accession No. ML15258A846), NuScale proposed that 6 licensed operators will operate up to 12 power modules from a single control room. However, the staffing proposal would not meet the requirements in 10 CFR 50.54(m)(2)(i) because the minimum requirements for the onsite staffing table in 10 CFR 50.54(m)(2)(i) do not address operation of more than two units from a single control room. The proposal also would not meet 10 CFR 50.54(m)(2)(iii) because the regulation requires a licensed operator at the controls for each fueled unit (i.e., up to 12 licensed operators). Absent alternative staffing requirements, future applicants referencing the NuScale design would need to request an exemption from these requirements.

In the NuScale Design Certification Application (DCA) Revision 5 (ADAMS Accession No. ML20225A071), Part 7, Section 6.2, "Justification for Rulemaking," NuScale provided a technical basis for rulemaking language that would address control room staffing in conjunction with control room configuration. The technical basis included the results of a staffing plan validation (SPV) test that NuScale conducted to demonstrate that its proposed complement of six licensed operators (i.e., three reactor operators and three senior reactor operators) could safely operate the plant during challenging, high workload conditions while maintaining workload within acceptable levels, maintaining adequate SA of plant conditions, and demonstrating acceptable task performance. NuScale's approach is consistent with SECY-11-0098, "Operator Staffing for Small or Multi-Module Nuclear Power Plant Facilities," dated July 22, 2011 (ADAMS Accession No. ML111870574). In Chapter 18, Section 18.5.4.2, "Evaluation of the Applicant's Technical Basis," of the final safety evaluation report (ADAMS Accession No. ML20023B605), the NRC found that NuScale's proposed staffing level, as described in the DCA Part 7, Section 6, is acceptable.

Because Section V, "Applicable Regulations," of the proposed rule (i.e., proposed Appendix G to Part 52) includes the alternative requirement provisions, staffing table, and appropriate table notes, a future licensee that references proposed Appendix G to 10 CFR Part 52 would not need an exemption from 10 CFR 50.54(m). However, a future licensee or applicant that references proposed Appendix G to 10 CFR Part 52 will need to request an exemption from the control room staffing requirements in proposed Appendix G to Part 52 if it chooses to use the control room staffing plan described in this topical report.

Additionally, an applicant for a construction permit or operating license under 10 CFR Part 50 or an application for a combined license or manufacturing license under 10 CFR Part 52 that references a NuScale standard design approval only (i.e., not the certified standard design) will need to request an exemption from 10 CFR 50.54(m)(2)(i) and 10 CFR 50.54(m)(2)(iii). It would not need to request an exemption from the control room staffing requirements in proposed

Appendix G to Part 52 because these requirements are applicable only to the certified standard design.

2.2 Shift Technical Advisor

Following the accident at Unit 2 of the Three Mile Island plant (TMI-2) on March 28, 1979, NRC staff and industry conducted several studies to determine why the accident occurred and what could be done to prevent the recurrence of the same or a similar accident. These studies concluded, among other things, that a number of actions should be taken to improve the ability of the shift operating personnel to recognize, diagnose, and effectively deal with plant transients or other abnormal conditions. To address the recommended improvements, the NRC initiated short- and long-term efforts. One short-term effort required each nuclear power plant to have on duty by January 1, 1980, an STA whose function was to provide engineering and accident assessment expertise and advice to the shift supervisor (i.e., shift manager) in the event of abnormal or accident conditions. The STA was required to have a Bachelor's degree in engineering or the equivalent and specific training in plant response to transients and accidents. The NRC published guidance on the STA requirement through NUREG-0578, “TMI-2 Lessons Learned Task Force Status Report and Short-term Recommendations,” issued July 1979 (ADAMS Accession No. ML090060030), and NUREG-0737, “Clarification of TMI Action Plan Requirements,” Section I.A.1.l, “Shift Technical Advisor,” issued November 1980 (ADAMS Accession No. ML051400209), and later mandated it by plant-specific confirmatory orders.

On September 25, 1985, the Commission approved the final “Policy Statement on Engineering Expertise on Shift,” published in Volume 50 of the *Federal Register*, page 43621 (50 FR 43621; October 28, 1985). The policy provides facility licensees with two options for providing engineering expertise on shift: a dedicated STA or a combined senior reactor operator (SRO)/STA, which the Commission stated as its preference. The background section of the FR notice promulgating the policy statement described the staff's long-term initiatives for improving the capabilities and qualifications of the members of shift crews and for enhancing their ability to diagnose and respond to accidents. It also states, “At the time the STA requirement was imposed, it was intended that the use of the dedicated STA would be an interim measure only until these longer-term goals were achieved.”

The Commission’s Policy Statement on “Education for Senior Reactor Operators and Shift Supervisors at Nuclear Power Plants,” dated August 15, 1989, presents the policy on education for senior operators and shift supervisors at nuclear power plants. It states, in part, the following:

> The Commission believes that the safety of commercial power reactors is enhanced by having on each shift a team of NRC licensed professionals that combine technical and academic knowledge with plant-specific training and substantial hands-on operating experience.... The Commission reaffirms its position, set forth in the Policy Statement on Engineering Expertise on Shift, that it is important to have engineering and accident assessment expertise available to the operating crew at all nuclear power plants. The STA has proven to be a worthwhile addition to the operating staff by providing an independent engineering and accident assessment capability, and we support continuation of this position.

In SECY-93-193, “Policy on Shift Technical Advisor Position at Nuclear Power Plants,” dated July 13, 1993, (ADAMS Accession No. ML12257A691), the staff discussed the achievement of

the long-term efforts, such as the implementation of symptom-based emergency operating procedures (EOPs), the systems approach to training (SAT) process for operator and SRO training programs, and incorporation of much of the STA training program material into SRO training programs. SECY-93-193 also states the following:

> The staff believes that the need for an assigned STA at individual reactor sites remains and should be considered with respect to the primary goal of maintaining a control room staff organization that is effective in responding to plant events…
>
> The staff also believes that NRC and industry long-term initiatives have collectively led to significant improvements in on-shift engineering expertise, including the capabilities, training, and qualifications of the shift crews and their ability to diagnose and respond to events.

Under 10 CFR 50.120, "Training and qualification of nuclear power plant personnel," each nuclear power plant operating license applicant, by 18 months before fuel load; each holder of an operating license; and each holder of a COL, by no later than 18 months before the scheduled date for initial loading of fuel, shall establish, implement, and maintain a training program for various categories of nuclear power plant personnel, including STAs, that is derived from the SAT concept. The NRC defines SAT in 10 CFR 55.4, "Definitions," as a training program that includes the following five elements: (1) systematic analysis of the jobs to be performed, (2) learning objectives derived from the analysis which describe desired performance after training, (3) training design and implementation based on the learning objectives, (4) evaluation of trainee mastery of the objectives during training, and (5) evaluation and revision of the training based on the performance of trained personnel in the job setting. Therefore, an applicant for a construction permit or operating license under 10 CFR Part 50 or an applicant for a combined license or manufacturing license under 10 CFR Part 52 that references a NuScale standard design approval or the NuScale certified standard design and intends to use the TR will need to request an exemption from CFR 50.120(b)(2)(iii), which requires a training program for the STA.

2.3 Relevant Guidance

NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)" issued July 2005 (ADAMS Accession No. ML052080125), contains guidance the staff uses to determine whether an applicant's staffing proposal provides adequate assurance that public health and safety will be maintained at a level comparable to that afforded by compliance with the current regulations. Specifically, NUREG-1791 describes a process for systematically reviewing and assessing alternative staffing plans. This process includes reviewing the results of validation tests specifically performed to demonstrate that the proposed staffing plan is acceptable.

NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Chapter 18, "Human Factors Engineering," Revision 3, issued December 2016, Attachment B, "Methodology to Assess the Workload of Challenging Operational Conditions In Support of Minimum Staffing Level Reviews," (ADAMS Accession No. ML16125A114), provides a methodology to identify high-workload operational conditions and analyze the associated workload.

NUREG-0711, “Human Factors Engineering Program Review Model,” Revision 3, issued November 2012 (ADAMS Accession No. ML12324A013) contains guidance related to staffing and qualifications of nuclear power plant personnel and HFE validation testing.

3.0 Technical Evaluation

This section documents the staff’s evaluation of NuScale’s proposed control room staffing plan as described in the TR. Section 3.1 provides a detailed description of the proposed control room staffing plan. Section 3.2 discusses the RSPV test methods. Section 3.3 discusses the results of the RSPV test. Section 3.4 discusses additional information NuScale provided in support of the staffing plan. Section 3.5 gives the staff’s assessment of the proposal to eliminate the STA position.

As part of the technical review, the NRC staff conducted a regulatory audit in August 2020 (audit plan, ADAMS Accession No. ML20210M065, and audit summary report, ADAMS Accession Nos. ML20339A004 (nonproprietary) and ML20332A146 (proprietary)). Following the audit, the NRC staff issued Request for Additional Information (RAI) 9789, Questions NTR-01–NTR-15 (ADAMS Accession No. ML20296A161), on October 21, 2020. By letter dated December 17, 2020 (ADAMS Accession No. ML20352A483), NuScale submitted “Response to NRC Request for Additional Information (RAI No. 9789) on the NuScale Standard Design Approval Application.” The results of the audit and the staff’s evaluation of the RAI responses are discussed as applicable in the sections below.

3.1 Description of the Proposed Staffing Plan

TR Table 6-1, “Minimum Onsite Licensed Operator Staffing,” shows the proposed minimum staffing level for a 12-module NuScale plant as one licensed reactor operator (RO) and two licensed SROs for up to 12 modules. Four notes below TR Table 6-1 state the following:

- Table note a states, “A person holding a senior operator license for all fueled units at the site who is assigned responsibility for overall plant operation shall be onsite at all times when there is fuel in any reactor vessel.” This statement is also in DCA Part 4, “Generic Technical Specifications,” Section 5.0, “Facility Staff,” and 10 CFR 50.54(m)(2)(ii) and is the requirement for the shift manager role.
- Table note b requires that whenever there is fuel in any reactor vessel, a person holding an SRO license shall be in the control room, and a licensed RO or SRO shall be present at the controls at all times. This statement is also in the DCA Part 4, Section 5.0, and is consistent with the guidance in Regulatory Guide 1.114, “Guidance to Operators at the Controls and to Senior Operators in the Control Room of a Nuclear Power Unit,” Revision 3, issued October 2008 (ADAMS Accession No. ML082380236).
- Table note c states, “Shift crew composition may be less than the minimum requirement for a period of time not to exceed two hours in order to accommodate unexpected absence of on-duty shift crew members provided immediate action is taken to restore the shift crew composition to within the minimum requirements.” This is consistent with administrative controls in the Standard Technical Specifications (e.g., NUREG-1431, “Standard Technical Specifications: Westinghouse Plants—Volume 1, Specifications,” Revision 4.0, issued April 2012 (ADAMS Accession No. ML12100A222)).
- Table note d requires a person holding a senior operator license or a senior operator license limited to fuel handling to directly supervise alteration or movement of the core of

a nuclear power unit (including fuel loading, fuel transfer, or movement of a module that contains fuel). This person shall not be assigned other duties, and this person is in addition to the two SROs specified in TR Table 6-1. Table note d is also a requirement in 10 CFR 50.54(m)(2)(iv).

TR Section 5.3.1, "Licensed Operator Staffing Levels, Position Descriptions, and Qualifications used during Second Validation Trials," shows that the three licensed operators fill the roles of a combined shift manager (SM)/control room supervisor (CRS), which is filled by an SRO licensed individual; RO 1, which is filled by either an SRO licensed individual or an RO licensed individual; and RO 2, which also is filled by either an SRO licensed individual or an RO licensed individual. An SRO-licensed individual must fill one of the two RO positions. Concept of Operations, Section 2.2.1, "Operating Crew Composition," describes these roles as follows:

- The SM is in charge of overall shift operations. The SM is the senior licensed operator assigned to the crew and acts as the senior manager on site when the plant manager and operations manager are not available. The SM is the initial person in charge to implement the emergency plan. The emergency plan responsibilities must be maintained until properly relieved in accordance with the station emergency plan requirements. The SM acts as the conduit between station management and the on-shift plant staff. This position is combined with the CRS when there are only three licensed operators on site.
- The CRS is responsible for the command and control of the control room. The CRS is responsible for all units and directs and oversees the activities of the licensed and nonlicensed operators. The CRS holds an SRO license.
- RO 1 {{

}}

- An additional RO[1] {{

}}

3.2 Revised Staffing Plan Validation Test Methodology

3.2.1 Deviations from Methodology Used for Previous Tests

TR Section 5.1, "Staffing Plan Validation Methodology Overview," states that "Control Room Staffing Plan Validation Methodology," issued December 2016 (Revision 0, ADAMS Accession No. ML16364A353 (nonproprietary) and Revision 3, ADAMS Accession No. ML16365A179 (proprietary)), which the staff reviewed previously during the DCA review and found to be

[1] The TR also refers to the additional reactor operator as "RO 2."

acceptable for the conduct of the SPV test, was also used to conduct the RSPV test, with two minor exceptions (discussed in more detail in the next paragraph). The methods described in "Control Room Staffing Plan Validation Methodology" conform to the guidance in NUREG-1791 and NUREG-0800, Chapter 18, Appendix B.

NuScale identified two changes to the methodology for the RSPV test: the addition of an independent observer role and elimination of weighting factors to the National Aeronautics and Space Administration Task Load Index (NASA TLX) scores. The RSPV Test Report, Section 5.0, "Observation Team Overview," states {{ }} (i.e., the observer was not responsible for the HFE design). As discussed in FSER Section 18.10.4.3.1, "Validation Team," the ISV observers included both personnel who were "independent" observers and personnel who were part of the HFE design team. As such, this change to the methodology is consistent with the methodology used for ISV, which the staff evaluated and concluded was acceptable. Weighting factors are not required to be applied to NASA TLX scores, so this change to the methodology was also evaluated and found to be acceptable.

During the August 2020 audit, the staff also observed the RSPV scenario test trials and observed that the methods used to administer the scenario trials conformed to the test procedures discussed in "Control Room Staffing Plan Validation Methodology."

3.2.2 Changes to Revised Staffing Plan Validation Test Scenarios, Testbed, and Test Participants

The staff assessed the new scenarios NuScale developed for the RSPV test, changes that were made to the NuScale control room simulator (i.e., testbed) after the ISV test and before the RSPV test, and the test participants (i.e., operators) used for the RSPV test. These are discussed below.

3.2.2.1 Revised Staffing Plan Validation Test Scenarios

NUREG-1791, Section 2, "Overview of the Process," states, in part, "Of particular interest are those operational conditions that present the greatest challenges to the performance of licensed personnel." The staff evaluated the operational conditions NuScale selected for the RSPV test to assess whether they adequately simulated high-workload, challenging conditions.

TR Section 5.3, "Second Validation Trials," states, "Three new scenarios from the ones used for SPV were used for the trials." TR Section 5.3.4, "Staffing Plan Validation Test Design Summary," states the following:

> One scenario included the performance of a PRA-credited IHA [important human action]. Two scenarios were designed to test varying multi-module events. Automation failures were then incorporated into these scenarios. A comprehensive sampling-of-conditions approach was then used to ensure that a representative high-workload sample was tested.

RSPV Test Report, Section 3.2, "Scenario Descriptions," contains detailed descriptions of the events in each of the three scenarios, which are proprietary.

TR Section 5.3.4 also explains that NuScale used the same method of selecting challenging events for the RSPV test scenarios as it used for the SPV test (i.e., the method described in

"Control Room Staffing Plan Validation Methodology"). As discussed in FSER Section 18.5.4.2, under "Step 3: Review the Operational Conditions," the staff concluded that the method used to select scenario events was adequate to simulate challenging, high-workload conditions.

During the August 2020 audit, the staff observed video recordings of each scenario trial. By design, Scenario 1 simulated core damage, which would be expected to increase the stress level of the test participants. Scenario 2 simulated another event described in the low power shutdown probabilistic risk assessment (PRA), which also had severe safety consequences for a module. The scenario was made more challenging, by design, by including additional events on another module to increase workload. Scenario 3 simulated an event that affected all of the units at the same time, and the crew had procedural guidance to manually shut down all of the affected modules. Although the crew was under no time pressure to take these actions, the scenario presented the challenge of performing a relatively high number of actions to complete manual shutdown procedures for all the modules. The staff also observed that the scenarios for the RSPV were comparable to the scenarios the staff had observed during the initial SPV in terms of the number of events that the operators had to manage simultaneously. Each of the scenarios simulated BDBEs for which the safety consequences for one or more modules are relatively high compared to the consequences of the analyzed DBEs. Therefore, if the operators could satisfactorily perform in these scenarios with relatively higher safety consequences, that involve multiple modules, and would likely cause increased stress, then it is reasonable to conclude that operators could likewise satisfactorily manage events with relatively fewer operator actions and likely less stress. Because the scenarios were developed using the same method that NuScale previously used to develop challenging, high-workload scenarios for the SPV, and this method is consistent with guidance in NUREG-1791, the staff concludes the scenarios created high consequence, high-workload conditions to adequately test the viability of the three-operator crew.

During the scenarios, all three operators were in the control room simulator at the start of each scenario and for its duration. The staff observed that the staffing plan as defined in TR Table 6-1 allows one of the three operators to be anywhere on site. In RAI 9789, Question NTR-06, the staff requested that NuScale explain whether the results of the RSPV test were impacted by not simulating that one of the three crew members could be elsewhere on site at the start of a potentially challenging, high-workload situation. In the response to RAI 9789, Question NTR-06, NuScale stated there is ample time to consider any required operator actions in response to plant transients or other events due to the overall low operational complexity, simple passive engineered safety features actuation systems that are designed as fail-safe, no required operator actions for DBEs, and the limited number of risk important human actions for BDBEs. Also, since at least one RO and one SRO are required to be in the control room, actions to stabilize the affected modules can begin as soon as the event is recognized. The evaluation of emergency action levels and other remaining emergency planning tasks, including notifications and facility activations, could either be performed by the SRO within the control room for lower workload events, or may be deferred until the third operator returns to the control room for higher-workload events.

Based on TR Table 6-1, note b, one SRO must be in the control room, and one RO or SRO must be at the controls at all times when there is fuel in any reactor vessel. These two operators will be in the control room at the start of any event that occurs. As discussed in TR Section 1.5, "Conditions of Applicability," the accident analyses cannot credit operator actions to mitigate the consequences of design basis accidents if the TR is to be used by a facility licensee. Therefore, operator actions are not required to mitigate DBEs. Also, operators are assumed to perform only two actions in certain BDBEs that occur as a result of multiple failures

of the plant safety systems. Operators can perform these two actions from the control room, and, as the staff observed during the RSPV and the ISV and SPV, one operator can perform these relatively simple actions. In the unlikely event that either of these two actions needs to be accomplished, and only one RO and one SRO are in the control room to perform them, the staff concludes that there is reasonable assurance that performing these actions is well within the capabilities of one RO and one SRO. Therefore, the staff concludes that not simulating one of the operators having a delayed return to the control room during the RSPV test is not significant.

3.2.2.2 Testbed

In NUREG-0711, Section 11.4.3.3(2) states that "[t]he testbed's HSIs and procedures should be represented with high physical fidelity to the reference design, including the presentation of alarms, displays, controls, job aids, procedures, communications equipment, interface management tools, layout, and spatial relationships." As discussed in FSER Section 18.10.4.3.3.5, "Verification," the staff confirmed the testbed/simulator represented the as-designed plant and control room human-system interface (HSI) with adequate fidelity before the ISV. During the August 2020 audit, the staff reviewed simulator software release notes that described changes to the simulator that occurred between the performance of the ISV and the RSPV. In the response to RAI 9789, Question NTR-09, NuScale stated the following:

> The simulator was updated with two releases between the integrated system validation (ISV) and the version of the simulator used for the RSPV. The changes were made to address human engineering discrepancies that were generated as a result of the ISV, improvements to the human-system interface (HSI), and procedures based on ISV operator feedback. The second release was to support scenario administration and to complete additional minor improvements to the HSI and procedures based on ISV operator feedback. The changes that support scenario administration were the creation of three new scenario controllers to administer the RSPV test, and an update to the data historian to produce records. These are limited to simulator tools and not part of the MCR design. The additional minor HSI and procedure improvements improve simulator fidelity to the plant design.

Because the changes that were made to the simulator HSI before the RSPV test were intended to model changes made to the actual plant HSI design to resolve the human engineering discrepancies identified during ISV, the staff concludes that these changes ensured the simulator continued to model the control room HSI design with adequate fidelity.

During the August 2020 audit, the staff also reviewed the results of the scenario-based testing conducted for the RSPV test validation scenarios. The staff concluded that these scenario-based testing reports documented the exercise of plant procedures, parameter trends that corresponded with expected responses, and appropriate alarm responses and confirmed that the simulator was capable of modeling expected plant response during the scenarios.

The simulator used for the RSPV test modeled the design described in the NuScale DCA (i.e., the 600-megawatt electrical (MWe) design consisting of up to 12 units capable of producing up to 50 MWe each). At the time of the August 2020 audit, NuScale planned to submit a standard design approval application for a 720-MWe plant, which would include up to 12 units capable of producing 60 MWe each. The staff considered whether the increased power output of the module(s) would have any impacts on operator tasks and workload. For example, the staff considered the possibility that an increase in the power output for each module might

result in changes to the transient and accident analyses of DBEs and possibly also the analyses of BDBEs. Such changes might result in newly identified operator actions essential to mitigating abnormal events. Since the impacts of a power uprate on operator workload and tasks were not known at the time of the staff's review of this TR, the staff considered whether the conditions and limits of applicability in TR Section 1.5 are adequate to ensure that impacts of a power uprate on operator tasks and licensed operator control room staffing are assessed before implementation of the TR at a NuScale plant with a power output greater than 50 MWe per module.

The staff considers two conditions of applicability in TR Section 1.5 important for resolving the issue. One is that no operator actions are credited during DBEs. (This is true for the NRC-approved, 600-MWe NuScale standard plant design that was modeled in the ISV and RSPV testbed simulator.) The second condition is that there are only two important human actions (IHAs), which are easily recognizable and can be completed from the main control room (MCR) by a single licensed operator. (The NRC-approved, 600-MWe NuScale standard plant design has only two risk-important IHAs.) In the response to RAI 9789, Question NTR-10, NuScale stated the following:

> The two IHAs are not specifically identified because the IHAs are irrelevant to the staffing plan. The characteristics of the responses to the IHAs are the important factors and potentially impactful. The important considerations are, in order of importance: the IHA actions can be accomplished by a single licensed operator, they can be accomplished from the main control room, and there are only a small number of IHAs (e.g., two) that are easily recognized by straightforward cues from the HSI. As long as the plant design retains these characteristics as they pertain to IHAs, then adding more operators to the control room staff does not improve the chances of successfully completing the task(s).

The staff agrees that the SPV test, ISV test, and RSPV test results have shown it is feasible for these actions to be completed from the control room by a single licensed operator, and the cue for performing these actions is recognizable. Also, when there is little to no reliance on operator actions to respond to abnormal events, such as with the NuScale 600-MWe standard plant design, the workload during these situations is reduced, and the stress during these events is also lowered due to the absence of significant consequences of either failing to perform an essential task or not performing it within a certain time limit. Therefore, the staff concludes these two conditions help to bound the types of high-workload, challenging conditions operators may encounter, which have been simulated and shown to be manageable by a minimum crew of three control room operators. If the conditions of the TR are not met, then additional evaluations would be needed to show there is no significant impact on operator workload and tasks that would require one or more additional licensed control room operators.

3.2.2.3 Test Participants

TR Section 5.3.3 states that the RSPV test participants were chosen based on previous experience as crew members during the ISV. As discussed in FSER Section 18.10.4.4.1, "Participant Sample Composition," the staff concluded that the ISV test participants adequately represented the population of operators who are likely to operate a NuScale plant, and NuScale used criteria for selecting those test participants who minimized bias in the test results.

NUREG-0711, Section 11.4.3.4, "Plant Personnel," states that test personnel should vary in age, skill/experience, and qualifications. NUREG-0711 also states that test participants should

not be selected for specific characteristics, such as good performance. In the response to RAI 9789, Question NTR-11, NuScale stated that it selected participants for the RSPV test from the group of ISV test participants based on their availability to participate in the RSPV test and location and did not consider prior performance during the ISV test. During the scenarios trials, the staff observed that participants varied in age and performance levels. The staff also reviewed RSPV Test Report, Section 4.1, "Crew Biographies," and observed that the test participants also varied in operating experience and education. Thus, the staff concludes there was variation in the age, skill, experience and qualifications of the RSPV test personnel.

Following the ISV test, the RSPV test participants underwent 30 hours of simulator training. RSPV Test Report, Section 4.2.1, "Simulator Familiarization," describes the events included in the simulator training. The staff compared these events to the RSPV scenario events listed in the scenario-based test reports and determined there was minimal overlap of the events included in the RSPV test scenarios and the training scenarios (i.e., of the 20 events in the RSPV test scenarios, only 3 were included in training scenarios). Additionally, in the response to RAI 9789, Question NTR-11, NuScale stated the RSPV test participants did not have access to the RSPV scenario contents before the RSPV test and did not participate in RSPV test development or pilot testing. Therefore, the staff concludes that the RSPV test participants did not have prior knowledge of the test scenarios, which would have biased the results.

3.2.3 Conclusion on Revised Staffing Plan Validation Test Methodology

As discussed in Section 3.2.1 of this SE, the staff concluded that the methods used to administer the RSPV test were acceptable. As discussed in Section 3.2.2 of this SE, the staff concluded that the test scenarios designed for the RSPV test were appropriately challenging and simulated high-workload situations, the test participants were sufficiently representative of potential operators at a NuScale plant, and the testbed had adequate fidelity to the NuScale MCR design. Therefore, the staff concludes the RSPV test method are acceptable.

3.3 Revised Staffing Plan Validation Test Results

An acceptable minimum staffing level is one that can successfully accomplish the most demanding tasks under conditions that reflect real-world challenges, including the demands of multitasking. Successful task performance is the main criterion for evaluating a proposed staffing level. It is also important to measure workload levels and find they are not excessive because high workload may cause degraded task performance, especially under stressful situations, which may leave the operators with little or no margin for dealing with added complications. Another factor impacting task performance is SA. A crew may not perform a task accurately and on time because they misunderstand the current plant state.

RSPV Test Report, Section 7.0, "Summary and Conclusions," states the following:

> The results of the validation testing confirm that up to a 12-module NuScale Power Plant and the associated plant facilities can be operated safely and reliably by a minimum staffing contingent of three licensed operators from a single control room during high-workload conditions.

The staff reviewed the task performance, workload, and SA data and discusses the results of the staff's review below.

3.3.1 Task Performance

TR Section 5.3.5, "Workload and Situational Awareness Data for Second Validation Trials," states, "The completion times for the required tasks were performed within the scenario acceptance criteria, with margin." Appendix A to the RSPV Test Report shows the list of all tasks in the RSPV scenarios, whether the task was completed, and, for tasks with a time limit, the time it took the crew to complete the task. The staff found that all tasks in all three scenarios, except for one task in one trial of Scenario III, were completed satisfactorily during the scenarios. The one task that was not completed was an independent, administrative task with no time limit. Independent actions may be stopped when any plant transient occurs because these tasks will be of lower priority than any task the crew performs to stabilize the transient. In the scenario, the staff observed that both crews stopped the task to address a transient that occurred on a unit, which was reasonable given that the independent task was a lower priority task. Accordingly, the task performance results support the proposed staffing plan.

3.3.2 Workload and Situation Awareness

TR Section 7.0, "Summary and Conclusions," states the following:

> As was expected because of the scenario design, the testing tools such as TLX showed at certain points in the scenarios, operators experienced higher levels of workload. However, when examining all of the tools used to measure workload, a preponderance of evidence shows that individuals, and the crew as a whole, experienced acceptable levels of workload.

TR Table 5-1, "RSPV Average Workload Data," shows the average, lowest, and highest workload scores by crew position. Workload was measured on a scale of 0–100. The lowest average workload was 10 (for RO 2), and the highest average workload was 28 (for RO 1). TR Section 5.3.5 states that the maximum workload measured during all trials was 80, which occurred during one scenario for one CRS. RO 1 and RO 2 had relatively low workload levels during the same scenario. The subscale was frustration, which is reasonable considering that the crew was, by design, not able to do anything to preclude core damage for a module during the scenario. This was intentionally part of the scenario design to force the crew into the situation in the scenario in order to increase stress and make the scenario more challenging. Given the relatively low workload scores, the staff concludes that the workload results support the proposed staffing plan.

With regard to SA, TR Section 5.3.5 states, "The range of scores were 90%–100%. The average situational awareness score was 97%." Given the consistent high SA scores and that they remained high during the challenging, high-workload conditions, the staff concludes that the SA results support the proposed staffing plan.

3.3.3 Conclusions on Revised Staffing Plan Validation Test Results

The staff considered the task performance, workload, and SA results collectively. Task performance was successful, workload scores were relatively low, and SA scores were relatively high. Even when measured workload reached relatively higher levels, task performance was not negatively affected during these scenarios. Also, SA remained high during the peaks in measured workload, which demonstrates that the test participants

maintained awareness of the condition of the plant even during the most challenging situations. Therefore, the staff concludes that the RSPV test results show that the staffing proposal is acceptable.

3.4 Additional Information to Support the Proposed Staffing Plan

RSPV Test Report, Section 4.2.2, "Crew Readiness Assessment," describes a readiness assessment NuScale performed before the RSPV test. RSPV Test Report, Appendix D, "Comparison of Staffing Plan Validation Results," describes the readiness assessment and states the following:

> The original three staffing plan validation scenarios were incorporated into the validation training performed before the start of the current validation testing. {{
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RSPV Test Report, Appendix D, also states that all acceptance criteria for the original SPV test were met, which included successful task performance. The scenario events, acceptance criteria, task performance results, and workload and SA results for the original SPV test are included in the "Control Room Staffing Plan Validation Results," Revision 1, issued December 2016 (ADAMS Accession Nos. ML16364A356 (nonproprietary) and ML16365A190 (proprietary)) (hereafter referred to as the SPV Results Report).

In the response to RAI 9789, Question NTR-13, NuScale stated, "Using the original SPV scenarios for the readiness assessment allowed benchmarking of the results against the SPV results." The response to RAI 9789, Question NTR-13, also shows the results of task performance for the readiness assessment as compared to the SPV task performance results. It states, "The task timing ratios for the three scenarios shows, generally, that the RSPV crew data was consistent with the SPV data with all the tasks were [sic] performed within the allowed time by all crews." The staff reviewed the data provided in the RAI response and observed that all tasks with time as an acceptance criterion were completed during the readiness assessment within the time available.

In the response to RAI 9789, Question NTR-13, NuScale also described the workload and SA results for the readiness assessment. The response states, "The average of TLX workload index scores gathered during the RSPV readiness assessment were similar to the 2016 SPV results." The RAI response includes the workload results, which show that, in general, average workload scores during the readiness assessment were relatively low and were generally comparable to those measured in the SPV test. The average SA results were the same as those for the SPV (93 percent), which is relatively high.

In the response to RAI 9789, Question NTR-13, NuScale also stated the following:

> Although there were no safeguards in place to ensure participants had not seen the original 2016 SPV scenarios, it was clear through observation of the crew performances that the scenarios were not reviewed by the crews prior to the assessment. The scenario files were maintained on a corporate drive and would only be accessible for someone actively searching for those files. Although not

used for official validation purposes, they do provide an opportunity for comparison.

During the August 2020 audit, NuScale explained that the participants were not informed that the readiness assessment would include the SPV test scenarios. Although access to the readiness assessment scenarios was not controlled as strictly as the RSPV test scenarios before the readiness assessment, the NRC staff agrees it is unlikely the participants had knowledge of the readiness assessment scenarios before the assessment. Given that the results of the readiness assessment were acceptable, the staff agrees these results provide additional evidence to support the revised staffing plan.

3.5 Elimination of Shift Technical Advisor Position

The proposed staffing plan eliminates the STA position. The TR's executive summary states the following:

> NUREG-0737 (Reference 8.1.6) states "the need for the STA position may be eliminated when the qualification of the shift supervisors and senior operators have been upgraded and the man-machine interface in the control room has been acceptably upgraded." These conditions have been met in the NuScale Power Plant, and the minimum operating crew of three operators does not include the STA role.

Although the STA was initially intended to be an interim or short-term measure implemented following the accident at TMI-2, the 1985 Commission Policy Statement on Engineering Expertise on Shift, which was issued after NUREG-0737, states, "The STA has proven to be a worthwhile addition to the operating staff by providing an independent engineering and accident assessment capability, and we support continuation of this position." In SECY-93-193, the staff acknowledged that "NRC and industry long-term initiatives have collectively led to significant improvements in on-shift engineering expertise, including the capabilities, training, and qualifications of the shift crews and their ability to diagnose and respond to events." It also stated, "the staff believes that the need for an assigned STA at individual reactor sites remains and should be considered with respect to the primary goal of maintaining a control room staff organization that is effective in responding to plant events."

NuScale provided the bases for eliminating the STA position in TR Section 3.0, "Analysis of the Shift Technical Advisor Position." These included NuScale control room upgrades, reduced reliance on operator actions, results of a task analysis and validation activities, and industry upgrades to qualifications of shift supervisors and senior operators. The staff assesses each below, with specific focus on whether "an independent engineering and accident assessment capability" is either not needed for a NuScale plant or is provided by an alternative to an STA.

3.5.1 NuScale Control Room Human-System Interface

TR Section 3.2, "NuScale Control Room Upgrades," states the following:

> The NuScale control room design includes safety function monitoring that is integrated into the man-machine interface. The HSI design provides "at-a-glance" assessment of plant conditions and facilitates early detection of degrading conditions. The features of the HSI, such as design of the overview screens, safety function displays, ease of navigation, and universal display of

active processes, keep the operators situationally aware of plant status. The emergency operating procedures are embedded into the interface and directly linked to the safety functions. The control room design also includes active monitoring of emergency action levels in the emergency plan. These features are upgrades to the conditions facing plant operators during the TMI accident when the need for an STA position was identified.

As discussed in FSER Chapter 18, the staff concluded that the NuScale control room design reflects state-of-the-art human factors principles in accordance with 10 CFR 50.34(f)(2)(iii). The purpose of the regulation, which was established after the accident at TMI-2, is to ensure that HFE principles are implemented during the design of the control room HSIs to support safe plant operation by ensuring (1) the personnel tasks can be accomplished within time and performance criteria, (2) the HSIs, procedures, staffing/qualifications, training, and management and organizational arrangements support personnel SA, (3) the design will support personnel in maintaining vigilance over plant operations and provide acceptable workload levels, and (4) the HSIs will minimize personnel error and will support error detection and recovery capability. Additionally, the staff observed during the SPV test, ISV test, and RSPV test that the test personnel could interpret plant indications to understand actions to be taken and the condition of the units and that SA was high for the test personnel, which was consistent with overall SA measurements from all validation testing.

A significant task an STA performs for a large, light-water, operating reactor is monitoring the status of the critical safety functions (CSFs) during abnormal events. Typically, the STA must use multiple, distinct control room indications to periodically assess each CSF. At a NuScale plant, a central operator interface in the MCR displays trend monitoring for up to 12 units, reducing the need for operators to scroll through multiple unit interfaces to view operational parameters. The NuScale plant has fewer CSFs to monitor than a traditional large, light-water reactor, and module systems provide for automatic and continuous CSF monitoring. The MCR HSI design includes a unique feature for monitoring the CSFs that provides “at-a-glance” assessment and understanding of CSF status and {{

}}. MCR operators can directly view CSF status using dedicated displays at their workstations and at the standup workstation for each unit. These dedicated CSF displays also {{

}}. If necessary, any MCR operator can quickly cross check CSF status using the spatially dedicated and continuously visible Safety Display Information (SDI) System, which also displays CSF status in conjunction with the postaccident monitoring variables using two independent divisions, sensors, and display panels for each unit. Since there are fewer CSFs to monitor and the crew can easily view the CSF status for each unit, even though there may be up to 12 units, the staff observed the crew was able to assess the CSFs well within the time that was established as the time-related performance criterion for that task in the validation test scenario guides.

The staff concludes that features of the NuScale MCR HSI function as an acceptable alternative to a dedicated STA for assessing off-normal conditions and determining the status of CSFs.

3.5.2 Reduced Reliance on Operator Actions

TR Section 3.5, “Conclusion,” states the following:

> For NuScale Power Plants, the use of passive safety features and lower operational complexity have resulted in no required operator actions for DBEs as well as improvement in overall safety. The design only has two IHAs associated with events that have a very small probability of occurrence. Both IHAs are simple, straight-forward actions that can be completed from the MCR by a single operator. These IHAs also have large time margins to complete tasks that historically would need to be performed without delay. These design features reduce the need for additional oversight.

The 1985 Commission Policy Statement states the following:

> The Commission continues to stress the importance of providing engineering and accident assessment expertise on shift. In this Policy Statement, "accident assessment" means immediate actions needed to be taken while an event is in progress.

The initial rationale for having an STA was to provide engineering expertise during abnormal operations to ensure the effectiveness of the operating crew. The staff concludes that the role of an STA in supporting operator actions during abnormal and emergency conditions would not be significant at a NuScale plant, especially when compared to operating reactors, because operators at a NuScale plant do not need to perform any operator actions for the design-basis transients and accidents, and there are also no immediate operator actions for any of the BDBEs that have been analyzed. Because there are no required operator actions for DBEs at a NuScale plant, the 1985 Commission Policy Statement's discussion of the value of accident assessment expertise to support operator actions during anticipated events is not applicable.

3.5.3 Task Analysis and Revised Staffing Plan Validation Results

TR Section 2.1, "Task Analysis Inputs to Determine Control Room Staffing," states that NuScale used an HFE task analysis as an input to the initial staffing levels and considered several factors to assign tasks to staffing positions. TR Section 3.3, "Validation Activities," states, "During the three-person crew validation tests, the STA was not manned, and the SM and CRS positions were combined as a dual role assigned to one SRO. Initial emergency plan duties were assigned to that role." TR Section 3.4, "Shift Technical Advisor HFE Task Analysis and Conclusions," explains that as part of the activities for the revised staffing plan, NuScale reassessed the 32 tasks originally assigned to the STA position. The majority of the STA tasks were for oversight functions that were redundant to tasks assigned to the CRS position. NuScale determined that the CRS position could sustain the oversight tasks independently without impacting CRS workload because the CRS position was already responsible for all oversight tasks, including those previously assigned to the STA. Tasks associated with emergency plan assessment and implementation were reassigned to the SM or the CRS when functioning in the dual role CRS/SM. For emergency plan tasks, the control room operators will also be able to rely on the emergency response organization (ERO) for assistance. Tasks associated with administrative duties for nonemergency notifications were also reassigned to the SM or dual role CRS/SM. If necessary, the crew can delay these two tasks until they have time to address them.

After reassigning the STA tasks to the SM, CRS, or dual role CRS/SM, NuScale concluded that the three-person crew is adequate to support the task reassignments because of "the low number of tasks, the high amount of time available to identify and complete the tasks, and the redundant nature of how specific HFE tasks assigned to the CRS can also be peer checked by

the second SRO on the crew." While the CRS is primarily responsible for completing the tasks, the second SRO on shift is qualified to complete the same CRS-designated tasks and can back up the CRS when necessary.

During the August 2020 audit, the staff reviewed the list of tasks that had previously been allocated to the STA and the way in which they were dispositioned when NuScale eliminated the position. The staff observed that tasks the STA previously performed were (1) eliminated because the task was a duplicate task and already assigned to the CRS and ROs (e.g., evaluate plant conditions during transients) or (2) reassigned to the CRS and ROs (e.g., monitor parameters on the SDI display).

While reviewing video recordings of the RSPV test trials, the staff observed that the test personnel were able to perform the tasks that had been reassigned from the STA task list to them. For example, RO 2 completed safety function status checks. The task performance, workload and SA results of the RSPV and readiness assessment show that the tasks were completed successfully in these scenarios without the STA. Therefore, the test results support the elimination of the STA position by demonstrating that the tasks previously allocated to the STA can be performed by the other crew members while maintaining task performance, workload, and SA at acceptable levels.

A significant function performed by the STA is advising or making recommendations to the CRS, SM, or both. RP-0215-10815, "Concept of Operations," Revision 3, issued May 2019 (ADAMS Accession Nos. ML19133A293 (nonproprietary) and ML19133A292 (proprietary)), was submitted with the NuScale DCA and describes the roles and responsibilities of the six-member crew of licensed operators. RP-0215-10815, Section 2.2.1, "Operating Crew Composition," states, in part, the following:

> The STA provides an objective oversight role for the MCR crew. The STA provides additional on-shift technical support and knowledge to the SM and CRS in the areas of operational event evaluation and accident assessment. The primary duties of the STA include providing technical and engineering advice in assuring safe operation of the event.

For example, at existing operating plants and as part of the six-member crew at a NuScale plant, the STA provides technical advice to the SM and the CRS on topics including implementation of the emergency plan, assessment of equipment operability and adherence to technical specifications, and proper procedure selection and implementation during abnormal events. In the revised staffing plan described in the TR, the SM (when this person is different from the CRS) and the second SRO on shift can assist or make recommendations to the CRS during normal operations and abnormal events. The second SRO on shift is trained on the emergency plan, operability, and technical specifications the same as the SRO in the CRS role. TR Section 3.4 states that there is "adequate time for the second on-shift senior reactor operator to independently assess and provide advice to the CRS in a reasonable amount of time or to engage off-site or off-shift resources for assistance. There are HFE tasks primarily assigned to the CRS, that are also assigned to the second senior reactor operator on the crew. Both are qualified to complete the task. The second SRO on shift is available to perform independent assessment and provide advice to the CRS."

While reviewing the RSPV test trials, the staff observed that the second SRO on shift was available to assist the CRS in this capacity and that the SRO's workload as a crew member in the RO position did not preclude the SRO from acting in this backup role.

The staff observed that specific features of the NuScale HSI design enable the crew to perform these actions correctly in the absence of advisement or concurrence by an STA who is specifically trained in emergency action levels (EALs), technical specification implementation, and EOPs. For example, a highly visible notification prompts the crew to assess whether an EAL has been exceeded, and displays show at a glance the status of the critical safety functions. The procedures are integrated into the HSI design, and, as discussed in FSER Chapter 13, "Conduct of Operation," the generic technical guidelines are structured for developing symptom-based EOPs, which do not require operators to diagnose an event in order to respond to it. Rather, the operators implement procedures based on plant indications in the MCR. Furthermore, the integration of plant procedures into the HSI automates the selection of applicable plant procedures. {{
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The staff concludes that the task analysis and RSPV results support the elimination of a dedicated STA. Additionally, staff concludes that the second SRO on shift is qualified and available to perform independent assessment and provide advice to the CRS similar to the role of an STA. Finally, the staff concludes that the crew has time to engage off-shift and offsite resources if more assistance is necessary.

3.5.4 Training

TR Section 1.5 states the licensed operator training programs for an applicant that is using the staffing plan includes the following attributes and items:

- developed using an SAT approach, as described in 10 CFR Part 55, "Operators' licenses"
- math, physics, thermodynamics, and component design topics that are of specific relevance to the operation of a nuclear power plant
- training for mitigating core damage
- plant-specific training on the following topics:
  - plant systems
  - plant specific reactor technology (including core physics data)
  - plant chemistry and corrosion control
  - reactor plant material
  - reactor plant thermal cycle
  - transient/accident analysis
  - emergency procedures

TR Section 3.1, "Industry Upgrades to Qualifications of Shift Supervisors and Senior Operators," states, "Applicable engineering principles are now an integral part of any licensed operator training program." Further, TR Section 2.3, "Control Room Staff Level Based on Staffing and Qualification Analysis," states the following:

> Licensed operators are selected, trained, and qualified with standards that are comparable to the approved standards of Guidelines for Initial Training and Qualification of Licensed Operators, ACAD 10-001 (Reference 8.2.4), and fully comply with the applicable license operator training programs described in 10 CFR Part 55 and 10 CFR Part 50.120.

ACAD 10-001, which is a proprietary document maintained by the National Academy for Nuclear Training (NANT), lists topics included in the fundamentals portion of the initial operator licensing training program. The NRC has reviewed ACAD 10-001, Revision 1, and found it acceptable for complying with the Commission's regulations for training and qualification of nuclear power plant personnel as stated in NUREG-1021, "Operator Licensing Examination Standards for Power Reactors," Revision 11, issued February 2017 (ADAMS Accession No. ML17038A432). Generic fundamentals are the mathematical and engineering principles, theories, and concepts that are specifically relevant to the operation of a commercial nuclear power plant. They are organized into three main categories: thermodynamics, components, and reactor theory. Enclosures 2 and 3 of NUREG-0737 list the criteria for establishing training on heat transfer, fluid flow, thermodynamics, and mitigating core damage. These topics were required to be included in the initial operator licensing training program after the accident at TMI-2, and they are part of the generic fundamentals portion of the accredited initial operator training program, as described in ACAD 10-001.

Additionally, Institute of Nuclear Power Operations (INPO)-accredited training programs are developed using the SAT process. Initial license and licensed operator requalification programs must also use a plant-referenced simulator (PRS) or a Commission-approved simulator (CAS) in the licensing and requalification of operators. The requirement to establish a PRS or a CAS at each site for operator licensing and training was also established after the accident at TMI-2 to help ensure that operators are trained to identify and respond to abnormal events. All applicants for an operator's license must pass an NRC examination, which includes an operating test administered in the plant simulator.

The staff agrees that the accredited, SAT-based training program provides job-related training to operators to safely operate the plant. However, it is a licensee responsibility to establish the operator training programs, and a facility is not required to achieve INPO/NANT accreditation. As discussed in 10 CFR 55.31(a)(4), an applicant for an operator's license must pass the facility licensee's requirements to be licensed. The facility licensee's initial operator training program must either include training on topics prescribed in 10 CFR 55.31(a)(4) or it must be an SAT-based, Commission-approved program. The staff has not yet reviewed and approved the training program for a NuScale plant design facility licensee. However, the staff has reasonable assurance that it will be an SAT-based program due to the existing regulations and, thus, will include generic fundamental topics that are relevant to the operation of a NuScale plant.

The role of the STA has traditionally been a defense-in-depth measure for situations during which abnormal events occur. The STA is a layer of defense for influencing human actions. Current qualification standards do not require an SRO or RO to have a degree. However, current qualification standards require an on-shift STA to have a technical degree or a professional engineer license. The staff asked NuScale if there is any impact from not having at least one person on shift who has a technical degree. In the response to RAI 9789 (ADAMS Accession No. ML20352A483), NuScale explained that there is "no impact to not having at least one person on shift who has a technical degree," and that the licensed operator training program requirements listed in TR Section 1.5 provide sufficient engineering knowledge for a NuScale MCR operator.

The staff concludes that the additional defense in depth provided by a standalone, dedicated person who has an engineering degree is not needed for the NuScale design because there are no operator actions during any DBE, and the on-shift operating crew has time to get engineering-related assistance from off-shift personnel, such as plant system engineers, reactor engineers, or other subject matter experts when faced with a situation that is not covered by

training or procedures. The staff agrees that training on generic fundamentals (math, physics, thermodynamics, and component design topics that are of specific relevance to the operation of a nuclear power plant) and mitigating core damage, use of a PRS during training, and implementation of SAT-based training programs are significant improvements to operator training programs that have been implemented following the accident at TMI-2, and such additions help provide assurance that operators will effectively identify and respond to abnormal events in the plant. However, these upgrades to operator training programs do not alone provide justification to eliminate the STA. The staff concludes that the licensed operator training program, detailed in TR Section 1.5, in conjunction with aspects of the NuScale design (i.e., low operational complexity, no credited operator actions, and MCR HSI design) support the elimination of the STA at a NuScale facility.

3.5.5 Conclusion on Shift Technical Advisor Elimination

The staff recognizes that the STA position has been a valuable addition to the operating crew at operating reactors; however, the staff finds that the STA position is not necessary to ensure the safe operation of a NuScale plant. The staff finds that the NuScale control room HSI design, which reflects state-of-the-art HFE principles; the results of the RSPV test, which have demonstrated that operators can interpret the indications provided on the HSI with adequate performance across a variety of measures; a plant system design that reduces operational complexity (compared to operating reactors), does not require operator actions during DBEs, and provides an overall improvement in safety; and the NuScale MCR HSI design features that alert the crew when a CSF is challenged and when a plant parameter has exceeded an EAL all together support the elimination of the STA for a NuScale plant. Operators at a NuScale plant will receive training on the engineering concepts that are relevant to operating a commercial nuclear power plant and mitigating core damage, in addition to other plant-specific training. NuScale has demonstrated that its minimum staffing complement can perform successfully in challenging operational scenarios without the use of an STA. The second SRO on shift (as one of the two ROs) can provide the CRS with advice, assistance, and an independent assessment of events. The MCR operators also have ample time to ask for assistance from other off-shift resources without challenging plant safety functions. Because of the combination of these items, the staff finds that the STA role is not required for the safe operation of a NuScale plant.

4.0 NRC Staff Conclusion

TR Section 3.5 states the following:

> An exemption from the regulations is not appropriate for a standard design applicant because 10 CFR 50.54(m) and 10 CFR 50.120 are applicable only to a licensee. Therefore, NuScale is requesting approval for the design-specific MCR staffing requirements presented in this topical report, in lieu of the current requirements of 10 CFR 50.54(m) and 10 CFR 50.120(b)(2)(iii).

The requirements of 10 CFR 50.120 apply to each applicant for and each holder of an operating license issued under 10 CFR Part 50 and each holder of a COL issued under 10 CFR Part 52. Similarly, the requirements of 10 CFR 50.54(m) are conditions in every nuclear power reactor operating license issued under 10 CFR Part 50 and every COL issued under 10 CFR Part 52 after the Commission makes the finding under 10 CFR 52.103(g).

The NRC staff has completed its review of TR-0420-69456, Revision 1. Based on the results of the staff's technical evaluation documented in Section 3.0 of this SE, the staff concludes there is

reasonable assurance that the proposed minimum number of licensed operators is adequate to ensure safe operation of the plant. Therefore, subject to the conditions of applicability listed in Section 5.0 of this SE, a NuScale facility licensee or COL applicant may use the TR as the technical basis for an exemption request from the staffing requirements in 10 CFR 50.54(m), or an alternative staffing requirement in the DC rule, and STA training requirements in 10 CFR 50.120. The staff reviews exemption requests to 10 CFR Part 50 in accordance with 10 CFR 50.12, "Specific exemptions."

5.0 Conditions of Applicability

TR Section 1.5 lists the conditions of applicability:

> The conditions of applicability of the staffing plan comprise a set of attributes that, if met by a license applicant, justify the applicant's control room staff complement. The control room staffing plan described here can be used by a combined license applicant for a NuScale small modular reactor plant of up to 12 NuScale power modules that meets the following features:
>
> - no operator actions are credited in DBEs
> - two important human actions (IHAs) which are easily recognizable and can be completed from the MCR by a single licensed operator
> - a human-system interface (HSI) design that retains the following features: critical safety function and defense in depth monitoring and display, which provide direct links to response procedures; tiered alarm scheme computer based alarm response procedures that are directly linked to assist the operator in efficiently locating the correct instruction; twelve module trend monitoring
>
> An applicant can show the proposed design complies with the conditions of applicability by performing an evaluation or demonstration of their design to these attributes.

Section 3.2.2.2 of this SE discusses the first two bullets related to operator actions. With respect to the third bullet, the staff agrees that these HSI design features help to keep workload within acceptable levels for the crew, help maintain SA by alerting the crew of abnormal conditions, and help the crew identify the appropriate tasks to perform to respond to abnormal conditions so that task performance, workload, and SA will be acceptable. (Although "twelve-module trend monitoring" is listed as one of the features that must be retained, the staff acknowledges that trend monitoring for 12 modules would not be required for a plant with fewer than 12 modules. Rather, trend monitoring will be provided for each module, up to 12 modules.)

TR Section 1.5 also states, "Additionally, any changes or differences from the control room staffing assumptions listed in Section 5.2.1 by a license applicant have to be evaluated to understand potential impact to control room staff workload before this staffing plan can be used." TR Section 5.2.1, "License Operator Staffing Assumptions Used During SPV and RSPV," includes the following assumptions:

- Refueling operations and module assembly and disassembly are not directed from the MCR; a work control center is available to assist the control room with work management during periods of significant workload, which reduces the

distractions to the control room crew and is common practice among existing nuclear plants.

- The crew staffing complement includes one non-licensed operator acting as a communicator to offsite agencies during emergencies.
- The crew responsibilities do not include the fire brigade, supplemental emergency plan responder, or emergency medical team responder.

These assumptions were part of the RSPV test assumptions; if they were to change, then the staff agrees it would be necessary to evaluate the impact on the staffing plan since any changes to these assumptions have the potential to increase the number of tasks the crew must perform and the workload.

Finally, TR Section 1.5 states the following:

> The applicants' licensed operator training programs for the plant include the following attributes and items:
>
> - developed using a systems approach to training, as described in 10 CFR Part 55
> - the math, physics, thermodynamics, and component design topics that are of specific relevance to the operation of a nuclear power plant
> - training for mitigating core damage
> - plant specific training, including:
>   - plant systems
>   - plant specific reactor technology (including core physics data)
>   - plant chemistry and corrosion control
>   - reactor plant materials
>   - reactor plant thermal cycle
>   - transient/accident analysis
>   - emergency procedures

The staff agrees this condition is appropriate to ensure that licensed ROs and SROs at a NuScale facility are trained on site-specific topics and the generic fundamental topics that are of specific relevance to operation of the facility.

Section B

Licensing Topical Report

NuScale Control Room Staffing Plan

May 2021

Revision 1

Docket No. 99902078

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Abstract

This report documents the technical basis of the NuScale Power, LLC (NuScale) control room staffing plan. The conditions of applicability of the staffing plan comprise a set of attributes that, if met by a license applicant, justify the applicant's control room staff complement.

This analysis employed an alternative approach to control room staffing in lieu of 10 CFR 50.54(m), that was conducted in accordance with the applicable NRC guidance contained in NUREG-0800, Chapter 18; NUREG-0711; NUREG-1791; SECY-11-0098; and NUREG/CR-6838. Because of the NuScale plant's passive safety systems, simple operation, automation, expected reduced licensed operator workload, and limited number of important human actions, an initial minimum main control room shift contingent of six licensed operators was established. After reviewing the results of initial validation efforts, NuScale conducted an additional study to evaluate a minimum shift contingent of three licensed operators.

NuScale validation tested the staffing plan to evaluate licensed operator workload in challenging, high-workload situations within a NuScale 12-module control room environment. The goal was to validate with a high level of confidence the cognitive workload, situational awareness, and task completion times associated with safely operating a 12-module facility remained acceptable while using the minimum licensed operator crew.

The results of the analysis confirm that up to 12 NuScale Power Modules and the associated plant facilities can be operated safely and reliably by a minimum staffing contingent of three licensed operators from a single control room during high-workload conditions.

NuScale requests NRC approval of the NuScale control room staffing plan as described in this topical report in lieu of staffing requirements set forth by 10 CFR 50.54(m) or other alternative control room staffing regulations.

Executive Summary

The NuScale Power Plant (NPP) is designed to operate up to 12-modules from a single main control room, which is not specifically addressed in 10 CFR 50.54(m). The NuScale plant has been designed with the assumption that there will be an alternate staffing solution from 10 CFR 50.54(m). NuScale performed a staffing and qualifications analysis to determine the number and qualifications of licensed operator personnel required for safe and reliable plant operation. Licensed operator personnel include licensed operators and senior operators as defined by 10 CFR 55.4.

This topical report requests NRC review and approval of the control room staffing plan detailed herein. It is intended that a license applicant using an NRC-approved NPP design as described by 10 CFR Part 52 may use this topical report as an alternate method to establish their minimum licensed operator control room staff.

This topical report provides the technical justification for an NPP to be operated with a minimum operating crew of three licensed operators and no shift technical advisor (STA). Two of those operators perform the roles of reactor operator 1 and reactor operator 2. The third operator performs the role of shift manager and control room supervisor. NUREG-0737 (Reference 8.1.6) states "the need for the STA position may be eliminated when the qualification of the shift supervisors and senior operators have been upgraded and the man-machine interface in the control room has been acceptably upgraded." These conditions have been met in the NPP, and the minimum operating crew of three operators does not include the STA role (see Table 6-1).

To validate the staffing plan, NuScale conducted high-workload, performance-based, staffing plan validation tests to provide assurance that the licensed operator control room staff complement is sufficient to safely operate an NPP with up to 12 modules.

Summary of the test results:

- The staffing validation tests demonstrated the proposed NuScale licensed operator staffing is sufficient to protect public health and safety while operating an NPP with up to 12 modules from a single control room.
- All required tasks were performed within the times established by the scenario acceptance criteria with margin. Diagnostic criteria were used to identify potentially high-workload tasks using a holistic approach by using a convergence of measured results. For example, the Task Load Index data collection methodology and the data analysis approach were designed to identify potential high workload by examining deviations in data with less emphasis on the absolute value. This was done so even small deviations at low workload levels would be identified. When workload met predetermined criteria, other tools, such as direct questioning, observations, and self-critiques, were used to validate or gather further evidentiary information.
- The scenarios included evaluation criteria that were met during all trial scenarios. No additional tests or retests were required.
- During the tests, no discrepancies were identified that warranted being entered into the NuScale Corrective Action Program. No identified human engineering

discrepancies (HEDs) were designated as a nuclear safety concern that would require retest (category priority 1).

1.0 Introduction

1.1 Purpose

The purpose of this report is three-fold:

- Establish the minimum number and qualifications of licensed operator personnel required for safe and reliable NuScale Power Plant (NPP) operation under operating conditions based on task analysis (TA) and validation testing of the staffing plan.
- Request NRC review and approval of the control room staffing plan. A license applicant using an NRC-approved NPP design as described by 10 CFR Part 52 may use this topical report as an alternate method to establish their minimum control room staff provided the conditions of applicability are satisfied.
- Describe the results of staffing plan validation testing performed to evaluate licensed operator workload in challenging, high-workload situations within a NuScale 12-module control room environment. Testing was performed to provide a high level of confidence that up to a 12-module NPP can be safely operated with a three-person licensed operator control room crew.

1.2 Scope

This topical report addresses the minimum number and qualifications of licensed operator personnel required for safe and reliable NPP operation under challenging, high-workload operating conditions based on task analysis and validation testing of the staffing plan. For the purposes of this report, licensed operator personnel include reactor operators (ROs) and senior reactor operators (SROs) as defined by 10 CFR 55.4.

The NuScale licensed operator control room staffing plan has been developed in two stages. The first stage uses the human factors engineering (HFE) analysis to set an initial staffing level. The second stage uses control room crews in performance-based testing using a simulator. The focus of the testing is on operator performance, workload, and situational awareness during challenging plant operating conditions that included design basis events (DBEs), beyond design basis events, and multi-module events in series and in parallel. This topical report presents the results of the HFE analysis and describes how validation testing was used to check and adjust the number of operators. The results of the HFE analysis, the validation testing methodology, and the first validation testing have been previously reviewed by the NRC staff. An additional validation test has been performed and is also presented here. This topical report also describes why the role of the STA is not required for the NuScale control room.

1.3 Regulatory Acceptance Criteria

Standard Review Plan, NUREG-0800, Chapter 18.0, Table 1 (Reference 8.2.2), lists Chapter 18 Attachment B as the acceptance criteria for work load evaluation. The attachment provides a methodology to identify high-workload operational conditions and analyze the associated workload. The methodology is rooted in task analysis and relies on the identification of appropriate challenging scenarios, realistic portrayals of task

performance that is complicated by separate, but often necessary, dependent and independent tasks, and the judgment of subject matter experts (SMEs) obtained in a manner conducive to obtaining realistic workload estimation.

1.4 Regulatory Requirements

10 CFR 50.54(m) specifies minimum licensed operator staffing requirements and responsibilities as a license condition on operating licenses. These requirements do not address a design with more than three units on a site or more than two units operated from a single control room. Further, licensee decisions regarding licensed operator staffing, including the number, composition, and qualifications of licensed personnel, are more appropriately based on features unique to the design rather than on the existing large, light water reactor-based staffing levels. 10 CFR 50.120 requires a program for training and qualifying plant personnel, including the STA position.

1.5 Conditions of Applicability

The conditions of applicability of the staffing plan comprise a set of attributes that, if met by a license applicant, justify the applicant's control room staff complement. The control room staffing plan described here can be used by a combined license applicant for a NuScale small modular reactor plant of up to 12 NuScale power modules that meets the following features:

- no operator actions are credited in DBEs
- two important human actions (IHAs) which are easily recognizable and can be completed from the main control room (MCR) by a single licensed operator
- a human-system interface (HSI) design that retains the following features:
  - critical safety function and defense-in-depth monitoring and display, which provide direct links to response procedures
  - tiered alarm scheme
  - computer-based alarm response procedures that are directly linked to assist the operator in efficiently locating the correct instruction
  - twelve-module trend monitoring

An applicant can show the proposed design complies with the conditions of applicability by performing an evaluation or demonstration of their design to these attributes. Additionally, any changes or differences from the control room staffing assumptions listed in Section 5.2.1 by a license applicant have to be evaluated to understand potential impact to control room staff workload before this staffing plan can be used.

The applicants' licensed operator training programs for the plant include the following attributes and items:

- developed using a systems approach to training, as described in 10 CFR Part 55
- the math, physics, thermodynamics, and component design topics that are of specific relevance to the operation of a nuclear power plant

- training for mitigating core damage
- plant specific training, including:
  - plant systems
  - plant specific reactor technology (including core physics data)
  - plant chemistry and corrosion control
  - reactor plant materials
  - reactor plant thermal cycle
  - transient/accident analysis
  - emergency procedures

1.6 Abbreviations and Definitions

Table 1-1 Abbreviations

Term	Definition
BDBE	beyond design basis event
CFR	Code of Federal Regulations
CRS	control room supervisor
DBE	design basis event
HED	human engineering discrepancy
HFE	human factors engineering
HSI	human-system interface
IHA	important human action
ISV	integrated system validation
MCR	main control room
NRC	Nuclear Regulatory Commission
PRA	probabilistic risk assessment
RO	reactor operator
RSPV	revised staffing plan validation
SM	shift manager
SPV	staffing plan validation
SRO	senior reactor operator
STA	shift technical advisor
TA	task analysis
TLX	Task Load Index (NASA)
TMI	Three Mile Island

Table 1-2 Definitions

Term	Definition
Participant	A person who has been selected as a control room operator to perform validation exams
Scenario guide	A document that describes the initial conditions, sequence of events, and evaluation criteria used in simulator testing of participants
Simulator	A facility constructed to model as close as practical the actual NuScale design control room. NUREG-0711 uses the term “validation testbed” to describe the area in which the human-system interface (HSI) is displayed for performance evaluations. Within this document the “testbed” is referred to as the simulator.

2.0 Human Factors Engineering Program

The HFE Program for the NPP is described in Chapter 18 of the Final Safety Analysis Report. This program uses proven technology, and incorporates accepted HFE standards and guidelines, including the applicable guidance provided in Human Factors Engineering Program Review, NUREG-0711, Rev. 3 (Reference 8.2.1). The planning and analysis part of the HFE Program includes an operator TA and a staffing and qualifications analysis to establish the number and qualification of licensed operators required for safe and reliable NPP operation. This section of the topical report summarizes how these parts of the HFE Program influenced initial control room staffing assumptions.

2.1 Task Analysis Inputs to Determine Control Room Staffing

The HFE task analysis is used to determine the crew roles and responsibilities, and is used as input to the initial licensed operator staffing level. Personnel tasks, addressed in the TA, are assigned to staffing positions considering:

- task characteristics, such as the knowledge and abilities required, relationships among tasks, time available, and time required to perform the task
- the operator's ability to maintain situational awareness within the area of assigned responsibility
- teamwork and team processes, such as peer checking
- workload associated with each job within the crew

As discussed in Section 18.4 of the FSAR, task analysis provides early definition of individual roles, responsibilities, and qualifications. It also identifies the time needed to perform a task, the workload involved, and the number of personnel needed to complete each task. Further information about the HFE task analysis is documented in the Human Factors Engineering Task Analysis Results Summary Report, RP-0316-17616 (Reference 8.2.5). An audit of HFE task analysis results was conducted by NRC staff in May 2017 (ADAMS Accession No. ML17181A415.)

2.2 Using Staffing and Qualification Analysis to Determine the Number and Qualifications of Licensed Operator Personnel

The HFE staffing and qualifications analysis includes determining the number of licensed operator personnel and their qualifications. For the purposes of this analysis, licensed operator personnel include operators and senior operators as defined by 10 CFR 55.4. Licensed operator roles and qualifications considered at NPPs include those of shift manager (SM), control room supervisor (CRS), STA, and RO. Staffing and qualifications analysis define numbers and qualifications of licensed personnel for a range of conditions and tasks under normal, abnormal, and emergency conditions.

The staffing and qualification analysis uses task sequencing from the TA element as preliminary procedures, assumes specific personnel numbers, and assumes a certain level of secondary tasks such as communication. Initial staffing level goals and staffing

roles and responsibilities are evaluated and modified, as required, in an iterative fashion. The modifications are done using input from the HED process, and as information from other HFE elements, evaluations, and tests become available. Further information about the HFE staffing and qualifications analysis is documented in the Human Factors Engineering Staffing and Qualifications Results Summary Report, RP-0316-17617 (Reference 8.2.6).

2.3 Control Room Staff Level Based on Staffing and Qualification Analysis

The initial licensed operator staffing level for a 12-module NPP was assumed to be six licensed operators. Validation testing of the staffing plan was conducted to validate the initial staff assumption. The positive results of those activities led to an additional validation test with a MCR shift contingent of three licensed operators: two control board operators and a combined CRS/SM. Additional discussion on validation activities is provided in Section 5.0.

Licensed operators are selected, trained, and qualified with standards that are comparable to the approved standards of Guidelines for Initial Training and Qualification of Licensed Operators, ACAD 10-001 (Reference 8.2.4), and fully comply with the applicable license operator training programs described in 10 CFR Part 55 and 10 CFR Part 50.120.

3.0 Analysis of the Shift Technical Advisor Position

The STA was created following the Three Mile Island (TMI) accident in 1979 to ensure a nuclear control room included an individual knowledgeable in engineering principles. These recommendations were incorporated into NUREG-0737, Clarification of TMI Action Plan Requirements (Reference 8.1.6), which states that “the need for the STA position may be eliminated when the qualification of the shift supervisors and senior operators have been upgraded and the man-machine interface in the control room has been acceptably upgraded.” No further guidance has been developed to establish the required level of upgrade to the man-machine interface or what upgrades to senior operator qualifications are required.

3.1 Industry Upgrades to Qualifications of Shift Supervisors and Senior Operators

The training of the licensed operators was upgraded following the addition of the STA position. Applicable engineering principles are now an integral part of any licensed operator training program. Licensee training programs also now include specific training on transient and accident analysis, and on mitigating core damage. A requirement to complete the training is included in NUREG-1021 license requirements and specifically called out on "NRC Form 398, Personal Qualification Statement-Licensee."

3.2 NuScale Control Room Upgrades

The NuScale control room design includes safety function monitoring that is integrated into the man-machine interface. The HSI design provides 'at-a-glance' assessment of plant conditions and facilitates early detection of degrading conditions. The features of the HSI, such as design of the overview screens, safety function displays, ease of navigation, and universal display of active processes, keep the operators situationally aware of plant status. The emergency operating procedures are embedded into the interface and directly linked to the safety functions. The control room design also includes active monitoring of emergency action levels in the emergency plan. These features are upgrades to the conditions facing plant operators during the TMI accident when the need for an STA position was identified.

3.3 Validation Activities

The NuScale HSI meets NUREG-0737 criteria for an upgraded man-machine interface as follows. The two NuScale validation tests of the staffing plans and the integrated systems validation (ISV) are the HFE-related activities that NuScale has conducted to validate how the man-machine interface has been upgraded. These activities demonstrate that operators can be successful at recognizing and mitigating beyond design basis events (BDBEs) using the upgraded control room man-machine interface.

During the three-person crew validation tests, the STA was not manned, and the SM and CRS positions were combined as a dual role assigned to one SRO. Initial emergency plan duties were assigned to that role.

3.4 Shift Technical Advisor HFE Task Analysis and Conclusion

The HFE task analysis, as discussed in Section 2.1 of this report, identified 32 tasks associated with the STA position. These tasks have been reassessed utilizing insights from the results of the staff plan validation (SPV), integrated system validation, and revised staffing plan validation (RSPV) and using the more mature plant design information now available. The tasks were further evaluated such that five tasks were added, and ten tasks were deleted, resulting in twenty-seven tasks remaining. The five additional tasks were a result of doing a further breakdown of the original tasks. The ten tasks that were deleted were grouped together in three common categories. Five of the tasks duplicated tasks assigned to other crew members. Three tasks were no longer required based on updated plant information. The remaining two tasks were duplicates of existing STA tasks.

The twenty-seven tasks were grouped together into three common categories. Seventeen tasks were related to oversight functions that were assigned to both the STA and CRS roles. Removal of the STA position and assignment of these tasks solely to the CRS has no significant impact to the CRS workload since the oversight function remains the same during these conditions. Eight of the tasks are associated with emergency plan assessment and implementation. In a declared emergency, the crew will be backed up by the emergency response organization. The remaining two tasks are associated with administrative duties tied to non-emergency notifications, which are tasks that the crew could delay or disregard if needed.

Based on the low number of tasks, the high amount of time available to identify and complete the tasks, and the redundant nature of how specific HFE tasks assigned to the CRS can also be peer checked by the second senior reactor operator on the crew, NuScale has concluded that the control room staff as described in the topical report is adequate to support the task reassignment. There is adequate time for the second on-shift senior reactor operator to independently assess and provide advice to the CRS in a reasonable amount of time or to engage off-site or off-shift resources for assistance. There are HFE tasks primarily assigned to the CRS, that are also assigned to the second senior reactor operator on the crew. Both are qualified to complete the task. The second SRO on shift is available to perform independent assessment and provide advice to the CRS.

After completing the reassessment, each of the remaining HFE tasks were also verified to be covered by a companion SRO training task which supports the NuScale learning objective based knowledge, skills and ability catalog.

3.5 Conclusion

NUREG-0737 provides two conditions in which the STA position may be eliminated; an upgrade to qualification of senior operators and an upgrade to the man-machine interface. The upgrade to senior operator qualification has been accomplished by the upgrades integrated into accepted industry licensed training programs. Specifically, the addition of generic fundamentals to licensed operator training, as well as the addition of mitigating core damage and transient accident analysis training. The upgrades to the

man-machine interface have been accomplished by the HFE improvements incorporated into NuScale control room design. The NuScale validation testing of the staffing plan and ISV activities have demonstrated that operators are successful at recognizing and mitigating BDBEs using this upgraded control room man-machine interface.

For NPPs, the use of passive safety features and lower operational complexity have resulted in no required operator actions for DBEs as well as improvement in overall safety. The design only has two IHAs associated with events that have a very small probability of occurrence. Both IHAs are simple, straight-forward actions that can be completed from the MCR by a single operator. These IHAs also have large time margins to complete tasks that historically would need to be performed without delay. These design features reduce the need for additional oversight.

Satisfaction of these conditions justifies excluding the STA position from the NuScale staffing plan and technical specifications. Although the STA position addressed by NUREG-0737 is not a regulatory requirement applicable to NuScale or future licensees, 10 CFR 50.120 requires a licensee to provide a training and qualification program for the STA position. Based on the foregoing, an STA training program is not required for applicants and licensees referencing an approved NuScale design.

An exemption from the regulations is not appropriate for a standard design applicant because 10 CFR 50.54(m) and 10 CFR 50.120 are applicable only to a licensee. Therefore, NuScale is requesting approval for the design-specific MCR staffing requirements presented in this topical report, in lieu of the current requirements of 10 CFR 50.54(m) and 10 CFR 50.120(b)(2)(iii).

4.0 Additional Staffing Considerations

The three-person crew staffing complement is intended to identify the minimum crew size to support safe plant operations. An additional requirement is added for at least two of the crew members to have senior operator licenses so that the CRS could leave while the second senior license holder remained in the control room. An additional senior license holder is required to support refueling operations.

4.1 Compliance with Regulatory Guide 1.114

The requirement to have at least two of the three control room operators licensed at a senior operator license level has been added to accommodate occurrences in which one licensed operator would leave the control room area. This allows the crew to meet the methods set forth in Guidance to Operators at the Controls and to Senior Operators in the Control Room of a Nuclear Power Unit, Regulatory Guide 1.114 (Reference 8.2.3) without the need for any additional exemptions. The specific NuScale requirements for the manning of operators in the control room is provided in Table 6-1:

b. A person holding a senior reactor operator license shall be in the control room at all times when there is fuel in any reactor vessel. In addition to this senior reactor operator, a licensed reactor operator or senior reactor operator shall be present at the controls at all times when there is fuel in any reactor vessel.

4.2 Staffing Level during Refueling Operation

Table 6-1 includes a requirement for a senior license holder during refueling operations. The NuScale requirement is similar to that required in the existing fleet facilities:

d. Each licensee shall have present, during alteration or movement of the core of a nuclear power unit (including fuel loading, fuel transfer, or movement of a module that contains fuel), a person holding a senior operator license or a senior operator license limited to fuel handling to directly supervise the activity and, during this time, the licensee shall not assign other duties to this person. This person is in addition to the two senior operator license holders identified in Table 6-1.

4.3 Conclusion

Table 6-1 provides the control room staffing level for combined license applicants who meet the conditions of applicability in Section 1.5. This includes the requirement for an additional senior license holder who is dedicated to fuel handling. The staffing level also requires that at least two of the control room staff are licensed at the senior license level to allow for any crew member to leave the control room. The three-person crew size for a NPP establishes a minimum control room manning to safely operate the facility.

5.0 Staffing Plan Validation and Verification

5.1 Staffing Plan Validation Methodology Overview

The Control Room Staffing Plan Validation Methodology, RP-1215-20253 (Reference 8.2.7) has been developed following a review of numerous regulatory and research studies on staffing, situational awareness, and workload measurements. The methods selected use multiple approaches from these reviews to gather and analyze data for a holistic approach and to form conclusions. The review of multiple data collection methods to produce an evidentiary conclusion acknowledges that each analysis method taken individually has certain testing bias and uncertainty.

The validation plan consists of the following elements:

- identify challenging operating conditions
- identify primary and dependent tasks
- identify independent tasks
- construct scenarios and assign operator responsibilities
- operating staff assignments
- staffing assumptions
- scenario development input
- scenario development content goals
- creation of scenario guides
- scenario test plan
- analyze workload

This methodology has been used to conduct two validation efforts. These tests are referred to as the control room staffing plan validation (SPV) and the revised staffing plan validation (RSPV). Two improvements to the methodology were made following the SPV, the addition of an independent observer role and the elimination of applying weighting factors to the National Aeronautics and Space Administration Task Load Index (TLX). The results of these tests successfully validated the crews could safely operate an NPP of up to 12 power modules from a single control room under high-workload conditions. There is reasonable assurance that the workload during each of the scenarios was representative of the highest-workload conditions the operators might face. The testing was limited to control room licensed operator staffing positions.

Both tests were conducted using two independent crews with a basic level of training, each performing three high-workload scenarios. The crew size was changed between the SPV and the RSPV scenarios.

During the trials, data was collected using time measurements, TLX, pre-screened questionnaires related to situational awareness, performance measures developed as task attributes by subject matter experts during TA, independent operations and expert

HFE observations, and post-test critiques similar to those used in current operating plant training programs.

Further information about the methodology that NuScale used during validation testing is documented in RP-1215-20253. An audit of the staffing plan validation methodology was conducted by NRC staff in May 2016 (ADAMS Accession No. ML16137A129).

5.2 First Validation Trials

The SPV was performed in August 2016. Three scenarios were used for the trials. These scenarios focused on operator performance, high workload, and situational awareness during challenging plant operating conditions. These scenarios were performed by two independent crews for a total of six tests.

5.2.1 License Operator Staffing Assumptions Used During SPV and RSPV

- Refueling operations and module assembly and disassembly are not directed from the MCR. Refueling is a planned activity and has a dedicated staff assigned for specific performance and oversight. Because the NPM is electrically and mechanically disconnected during refueling, the control room operators have no direct interaction with the refueling team other than operating common system components (e.g., align reactor pool cooling) or to update the SM on refueling status.
- A work control center (WCC) is available to assist the control room with work management during periods of significant workload. This reduces the distractions to the control room crew and is common practice among existing nuclear plants.
- The crew staffing complement includes one non-licensed operator acting as a communicator to offsite agencies during emergencies. The crew responsibilities do not include the fire brigade, supplemental emergency plan responder, or emergency medical team responder.

5.2.2 Licensed Operator Staffing Levels, Position Descriptions, and Qualifications Used During First Validation Trials

The crew complement for the SPV consisted of six licensed operators. The following staff and license levels were used during testing as part of the on shift operating crew:

- one SM - SRO license
- one CRS - SRO license
- one STA - SRO license and having a degree in a science or applied science field
- three ROs - RO license

5.2.3 Participants in First Validation Trials

The crew participants were selected based on having prior nuclear control room operating experience and some experience with the NuScale design. The operating crew participants were considered subject matter experts in nuclear plant operations.

The definition of subject matter expert for testing purposes is a person that has completed the NuScale HFE/operations initial company training program, has previous licensed operating nuclear plant experience, and has worked at NuScale in some capacity to be familiar with the design, such as performing TA, NuScale system reviews, or operating the NuScale Integral Systems Test facility.

5.2.4 Participant Training for First Validation Trials

Participant crew training was required to ensure the same base level of knowledge existed among the crew members regarding the NPP design, plant controls, and conduct of operations. This provided a reference for anticipated operator response and provided some assurance that observations and ratings of high workload would be attributed to actual workload and not because operators were unfamiliar with how to accomplish the tasks.

The crew participants were trained in basic fundamental operation of the safety systems, selected systems used during normal operation, and applicable support systems. The participants also received basic HSI navigation, conduct of operations, and administrative task training. All participants had previous licensed operator experience at nuclear facilities, which allowed the training to be condensed and drew on the operators' experience with nuclear power plant fundamentals and control room etiquette.

5.2.5 Staffing Plan Validation Test Design Summary

The three-high workload, challenging operating conditions or themes for NuScale were determined using the methodology described in RP-1215-20253. The scenarios include:

- A scenario in which the operators are required to implement the IHA to add inventory to the containment to avoid reactor core damage or large radiological releases. These are needed in BDBEs that result from multiple safety-related system failures. In the most limiting probabilistic risk assessment (PRA) analysis, this failure requires operator action to add inventory within approximately 90 minutes from the event initiation. The probability of this event is extremely low.
- A multi-module transient is another potential high-workload condition and would present a challenge to the crew to manage and communicate. There are many possible events that may result in a multi-module transient. Some examples are a loss or malfunction in the common systems that support more than one module or a loss of offsite power or other major electrical transient.
- Failures of automation on a large scale that may produce taxing and high-workload conditions. Automation failures may occur at many levels, but from TA, the most workload intensive is a loss of nonsafety digital systems used to control the NPP. This scenario was analyzed with the instrumentation and control architecture designers and thought not to be a credible event with the multiple levels of redundancy incorporated in the design, but it is useful to encompass the many credible possibilities. A high-workload scenario should include many

variations of automation failure or failure of the nonsafety controls and indications. This condition would challenge the operator's ability to detect accident conditions and ensure the correct response of the safety systems.

The simulator scenarios were developed using the three challenging conditions listed above as the overall theme for each. Additional events were added referencing the sampling criteria described in NUREG-0711 and the high-workload tasks from the NuScale TA.

5.2.6 Summary of Staffing Plan Validation Trial Results

The SPV test results demonstrate that the initial NuScale licensed operator staffing size was sufficient to protect public health and safety while operating up to a 12-module NPP from a single MCR.

- The completion times for the required tasks were performed within the scenario acceptance criteria, with margin. Diagnostic criteria was used to identify potentially high-workload tasks using a holistic approach using convergence of measured results. For example, the TLX data collection methodology and the data analysis approach used were designed to identify potential high workload by examining deviations in data with less emphasis on absolute value. This was done so that even small deviations at low workload levels would be identified. When workload met predetermined criteria, then other tools such as direct questioning, observations, and self-critiques were used to validate or gather further evidentiary information. Actual or perceived level of workload and stress was related to the impact on performance.
- The scenarios included evaluation criteria that could have warranted additional testing if not met. However, all of the evaluation criteria were met in all trials. No additional retests were required and no additional validation was performed.
- During the tests, no discrepancies were identified that warranted being entered into the NuScale Corrective Action Program. No identified HEDs were designated as a nuclear safety concerns that would require retest (category priority 1). Some discrepancies were identified and categorized as improvements to the process, HSI, procedures, or conduct of operations (category priority 2 or 3). Identified HEDs were documented in the HFE issue tracking system.

The trial results demonstrate that the plant can be safely operated by a crew of three ROs and three SROs. The validation testing resulted in comprehensive data that supported the initial staffing plan.

Further information about the original SPV trials is documented in the Control Room Staffing Plan Validation Results, RP-0516-49116 (Reference 8.2.8). An audit of staffing plan validation testing was conducted by NRC staff in November 2016 (ADAMS Accession No. ML16137A257).

5.3 Second Validation Trials

After reviewing the HFE analysis program results, the initial validation effort, and the ISV, an additional study was conducted in May 2019 entitled the Revised Staffing Plan Validation Test Report, RP-0419-65209 (Reference 8.2.9). Three new scenarios from the ones used for SPV were used for the trials. These scenarios were performed by two independent crews, for a total of six tests. The crew participants were selected based on having previous experience as ISV crew participants. This section of the topical report provides the activities and results of the RSPV trials.

5.3.1 Licensed Operator Staffing Levels, Position Descriptions, and Qualifications used during Second Validation Trials

The crew complement for the RSPV consisted of three licensed operators. The following staff and license levels were used during testing as part of the on shift operating crew:

- Shift Manager / CRS - SRO license
- Reactor operator 1 - RO or SRO license
- Reactor operator 2 - RO or SRO license

5.3.2 Participants in Second Validation Trials

The three-person crew members were chosen based on previous experience as crew members during ISV testing.

5.3.3 Participant Training for Second Validation Trials

The participants in the RSPV were selected from the ISV crews who had previously attended the ISV program training. This training consisted of the following:

- 260 hours of classroom training that included an overview of NuScale design, system interactions, normal and abnormal conditions, technical specifications, emergency action levels, and applicable administrative processes.
- Four quizzes to assess individual comprehension.
- 120 hours of simulator familiarization of system tasks, normal and abnormal conditions, IHAs, teamwork, communications, and formality.
- Two program dynamic simulator scenario tests assess crew performance.
- One final dynamic simulator audit test.

Additional training before the start of the second validation testing consisted of four hours of classroom refresher training followed by 30 hours of simulator practice.

Classroom training consisted of the following topics:

- Purpose of RSPV testing

- Results of ISV testing
- Description of simulator differences from ISV
- Conduct of Operations refresher
- A list of assumed operator timed actions

5.3.4 Staffing Plan Validation Test Design Summary

The original SPV scenarios performed in 2016 were not used for this validation primarily because the previous scenario information was published both internally and submitted to the NRC for review. Therefore, it could not be ensured that participants would be unaware of the contents of that earlier validation test. For this reason, new scenarios were generated using the same method as used to generate the original SPV scenarios in accordance with RP-1215-20253, Control Room Staffing Validation Methodology. The scenarios were developed using the following inputs:

- Challenging operating conditions listed in Section 3.0 of RP-1215-20253
- Sampling of operational conditions Section 11.4.1 of NUREG-0711
- High-workload tasks identified by the TA

Three potentially higher-workload themes for the NuScale design were incorporated into three different scenarios:

- Performing PRA-credited IHAs to add inventory to the reactor vessel or containment vessel in beyond design basis, low-probability events
- Multi-module transients or events
- Higher levels of automation and incorporation of various automation-related failures or loss of non-safety controls

Three validation scenarios were created using a framework designed around the three potentially high-workload themes listed above. One scenario included the performance of a PRA-credited IHA. Two scenarios were designed to test varying multi-module events. Automation failures were then incorporated into these scenarios. A comprehensive sampling-of-conditions approach was then used to ensure that a representative high-workload sample was tested. A review of the current TA concluded there was no change in required workload tasks previously identified in RP-1215-20253, Control Room Staffing Plan Validation Methodology. The list of required high-workload tasks from Appendix F of the methodology document was input into a computer-generated randomizer. The randomizer was used to provide the initial population of scenario events.

The scenarios were then developed being informed by the random high-workload tasks and the high-workload themes. Details were added to support scenario tasks and acceptance criteria was applied based on timing criteria used during ISV testing. NUREG-0711 provides a list of sample conditions that were referenced with the goal of including 70 percent of the listed conditions within all three scenarios in total.

5.3.5 Workload and Situational Awareness Data for Second Validation Trials

The range of average workload for each 2019 RSPV test crew member is as follows:

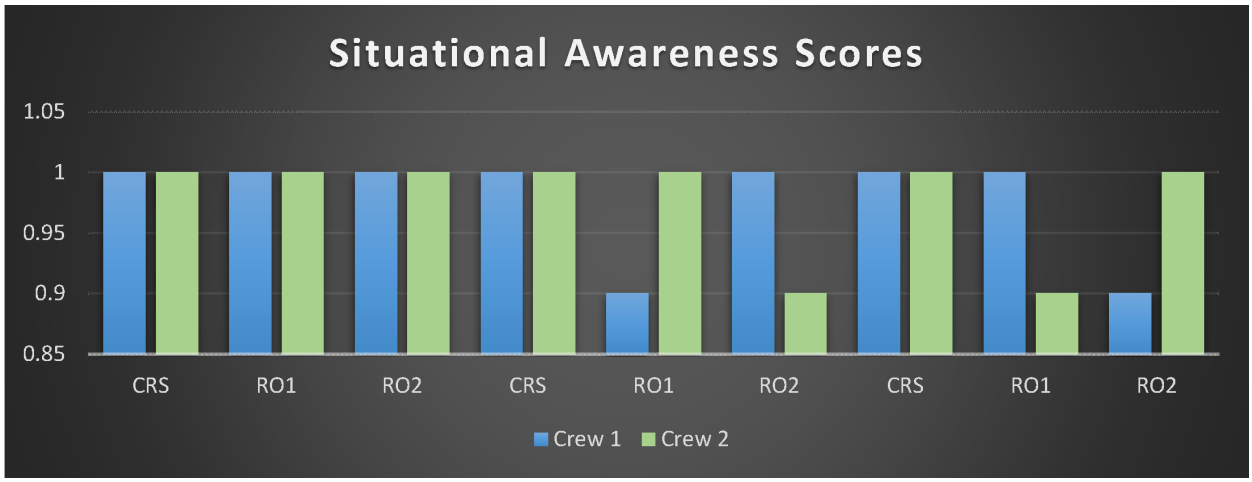
Table 5-1 RSPV Average Workload Data

Crew Member	Avg.	Lowest Avg. Workload	Highest Avg. Workload
RO1	21	15	28
RO2	13	10	15
CRS	18	11	25

The maximum workload value measured during all the trials was a raw score of 80. This score was tied to a scenario event which was designed so that the crew would not be successful. During this event reactor coolant inventory was leaking from the module and the crew had to take action to inject additional inventory. Subsequently, the crew had indications of fuel clad degradation. In this scenario their actions were not allowed be successful. Both CRSs stated that this no-win situation was very stressful which was reflected in their higher TLX scores.

Situational awareness questionnaires were used at predetermined points administered in conjunction with TLX workload measures. The figure below shows the actual scores for scenarios 1, 2, and 3 from left to right on the x-axis.

Figure 5-1 RSPV Situational Awareness Scores



The range of scores were 90%-100%. The average situational awareness score was 97%. There was no trend to indicate that one position or person had a deviation of results from any other person or position. No situational awareness comments were generated during the RSPV.

5.3.6 Summary of Revised Staffing Plan Validation Trial Results

The results of the RSPV confirmed that up to a 12-module NPP and the associated plant facilities can be operated safely and reliably by a minimum staffing contingent of three licensed operators from a single control room during high-workload conditions.

The RSPV tests demonstrate that, like the SPV test results, the minimum NuScale licensed operator staffing is sufficient to protect public health and safety, while operating up to a 12-module NPP from a single control room.

- The completion times for the required tasks were performed within the scenario acceptance criteria, with margin. Diagnostic criteria was used to identify potentially high-workload tasks using a holistic approach using convergence of measured results. For example, the TLX data collection methodology and the data analysis approach were designed to identify potential high workload by examining deviations in data with less emphasis on absolute value. This was done so that even small deviations at low workload levels would be identified. When workload met predetermined criteria then other tools such as direct questioning, observations, and self-critiques were used to validate or gather further evidentiary information. Actual or perceived level of workload and stress was related to the impact on performance.
- The trial scenarios included evaluation criteria that could have warranted additional testing if not met. However, all of the evaluation criteria were met during all scenario testing, and in all trials, so no additional retests were required and no additional validation was performed.
- During the tests, no discrepancies were identified that warranted being entered into the NuScale Corrective Action Program. No identified HEDs were designated as a nuclear safety concerns that would require retest (category priority 1). Some discrepancies were identified and categorized as improvements to the process, HSI, procedures, or conduct of operations (category priority 2 or 3). Identified HEDs were documented in the HFE issue tracking system.

Further information about the second validation trial is documented in RP-0419-65209, Revised Staffing Plan Validation Test Report.

6.0 Results

6.1 Facility Staff

The minimum licensed operator staffing for licensees referencing an NRC-approved NPP design of up to 12 modules is shown in the following table:

Table 6-1 Minimum Onsite Licensed Operator Staffing

Reactor Operator	Senior Reactor Operator
1	2

a. A person holding a senior operator license for all fueled units at the site who is assigned responsibility for overall plant operation shall be onsite at all times when there is fuel in any reactor vessel.

b. A person holding a senior reactor operator license shall be in the control room at all times when there is fuel in any reactor vessel. In addition to this senior reactor operator, a licensed reactor operator or senior reactor operator shall be present at the controls at all times when there is fuel in any reactor vessel.

c. Shift crew composition may be less than the minimum requirement for a period of time not to exceed two hours in order to accommodate unexpected absence of on-duty shift crew members provided immediate action is taken to restore the shift crew composition to within the minimum requirements.

d. Each licensee shall have present, during alteration or movement of the core of a nuclear power unit (including fuel loading, fuel transfer, or movement of a module that contains fuel), a person holding a senior operator license or a senior operator license limited to fuel handling to directly supervise the activity and, during this time, the licensee shall not assign other duties to this person. This person is in addition to the two senior operator license holders identified in Table 6-1.

The control room staff requirement excludes the STA position and excludes an STA program under 10 CFR 50.120(b)(2) from the licensee's training program.

6.2 Results Summary of Staffing Plan Validation Testing

The results of iterative validation testing of the staffing plan confirmed that up to a 12-module NPP and the associated plant facilities may be operated safely and reliably by a minimum staffing contingent of three licensed operators from a single control room during high-workload conditions.

7.0 Summary and Conclusions

The NuScale design provides passive systems that operate with no required operator actions for DBEs. The design has a small number of PRA-identified IHAs that have very remote probability for occurrence related to BDBEs. The NPP design features provide operators large time margins to complete tasks that historically would need to be performed without delay. All IHAs were tested during the staffing plan validations and met the acceptance criteria.

The HSI design provides 'at-a-glance' assessment of plant conditions and facilitates early detection of degrading conditions. The features of the HSI, such as design of the overview screens, safety function displays, ease of navigation, and universal display of active processes, promote high levels of situation awareness.

The Concept of Operations, RP-1020-72177 (Reference 8.2.10) specifies that one operator has the primary focus to monitor the NPP as demonstrated in the validation testing of the staffing plan. One person is able to monitor up to 12-modules and quickly detect changing trends and off-normal conditions. This allows other operators to be focused on specific task completion. During the second validation test the STA position was eliminated, and the test successfully validated the functionality of the upgraded HSI, the effectiveness of the embedded safety function monitoring, and the back-up validation by the crew members. This demonstrated an equivalent and effective level of plant safety monitoring.

Staffing plan validations were conducted using guidance in NUREG-0711, NUREG-1791, and NUREG/CR-6838 as well as other industry guidance. The validation testing of the staffing plan included performance-based tests using a simulator focused on operator performance, workload, and situational awareness during challenging plant operating conditions, including DBE, BDBE, and multi-module events. These events were tested in cases where they occurred in series, and other times with one or more of the events happening in parallel.

Two independent crews were trained and qualified to conduct three challenging and workload-intensive scenarios using conduct of operations guidance reflective of the current industry standards with respect to communications and use of human performance tools during the scenarios. The three scenarios were designed to be challenging and create high workload conditions. By using those tasks from TA that were high workload and could not be ignored, operators were required to confront and manage issues affecting multiple modules, BDBEs, and large scale loss of controls and indications. As was expected because of the scenario design, the testing tools such as TLX showed at certain points in the scenarios, operators experienced higher levels of workload. However, when examining all of the tools used to measure workload, a preponderance of evidence shows that individuals, and the crew as a whole, experienced acceptable levels of workload.

A team of trained and qualified observers consisting of operations, management, and HFE personnel observed and analyzed the tests using multiple methods of monitoring crew performance, workload, and situation awareness.

The results of the validation testing confirm that up to a 12-module NPP and the associated plant facilities can be operated safely and reliably by a minimum staffing contingent of three licensed operators from a single control room during high-workload conditions. The staffing level requires that at least two of the control room staff are licensed at the senior license level to allow for any crew member to leave the control room.

8.0 References

8.1 Source Documents

8.1.1 U.S. Nuclear Regulatory Commission SECY-11-0098, "Operator Staffing for Small or Multi-Module Nuclear Power Plant Facilities," Commission Paper SECY-11-0098, July 22, 2011.

8.1.2 U.S. Nuclear Regulatory Commission, "A Study of Control Room Staffing Levels for Advanced Reactors," NUREG/IA-0137, November 2000.

8.1.3 U.S. Nuclear Regulatory Commission, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," NUREG-1791, July 2005.

8.1.4 Brookhaven National Laboratory Technical Report No. 20918-1-2005, "Methodology to Assess the Workload of Challenging Operational Conditions In Support of Minimum Staffing Level Reviews," March 9, 2015.

8.1.5 U.S. Nuclear Regulatory Commission, "Technical Basis for Regulatory Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," NUREG/CR- 6838, February 2004.

8.1.6 U.S. Nuclear Regulatory Commission, "Clarification of TMI Action Plan Requirements: Requirements for Emergency Response Capability" NUREG- 0737 Supplement No.1, January 1983.

8.1.7 NuScale Standard Plant Design Certification Application.

8.1.8 U.S. Nuclear Regulatory Commission, "Operator Licensing Examination Standards for Power Reactors" NUREG-1021, Revision 11, February 2017.

8.2 Referenced Documents

8.2.1 U.S. Nuclear Regulatory Commission, "Human Factors Engineering Program Review Model," NUREG-0711, Rev. 3, November 2012.

8.2.2 U.S. Nuclear Regulatory Commission, "Standard Review Plan, Human Factors Engineering," NUREG-0800, Chapter 18.0, Table 1, Rev. 3, December 2016.

8.2.3 U.S. Nuclear Regulatory Commission, "Guidance to Operators at the Controls and Senior Operators in the Control Room of a Nuclear Power Unit," Regulatory Guide 1.114, Rev. 3, October 2008.

8.2.4 National Academy for Nuclear Training, "Guidelines for Initial Training and Qualification of Licensed Operators," ACAD 10-001, Rev. 1, November 2016.

8.2.5 NuScale Power, LLC, "Human Factors Engineering Task Analysis Results Summary Report," RP-0316-17616, Revision 2, April 2019.

8.2.6 NuScale Power, LLC, "Human Factors Engineering Staffing and Qualifications Results Summary Report," RP-0316-17617, Revision 0, December 2016.

8.2.7 NuScale Power, LLC, "Control Room Staffing Plan Validation Methodology," RP-1215-20253, Revision 3, December 2016.

8.2.8 NuScale Power, LLC, "Control Room Staffing Plan Validation Results," RP-0516-49116, Revision 1, December 2016.

8.2.9 NuScale Power, LLC, "Revised Staffing Plan Validation Test Report," RP-0419-65209, Revision 2, November 2020.

8.2.10 NuScale Power, LLC, "Concept of Operations," RP-1020-72177, Revision 1, December 2020.

8.3 Forms

8.3.1 U.S. Nuclear Regulatory Commission, "Personal Qualification Statement - Licensee," Form 398, October 2019.

Section C

RAI Number	eRAI Number	NuScale Letter Number
001	9789	RAIO-1220-73475

December 17, 2020

Docket: 99902078
RAIO-1220-73475

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 (RAI No. 9789) on the NuScale Standard Design Approval Application

REFERENCES:
1. NRC Letter eRAI 9789 - Control Room Staffing TR, dated October 21, 2020, RAI# 9789
2. NuScale Topical Report, NuScale Control Room Staffing Plan, dated December 2020, TR-0420-69456

The purpose of this letter is to provide NuScale's response to NRC Requests for Additional Information (RAI), RAI# 9789, noted in the References above. The responses to the individual RAI questions are provided in the attached Enclosure.

This letter contains NuScale's response to the following RAI Questions from NRC RAI# 9789:

- NTR-01 through NTR-15

This letter makes no new regulatory commitments and no revisions to any existing regulatory commitments.

Please contact Jim Osborn at 541-360-0693 or at JOsborn@nuscalepower.com if you have any questions.

Sincerely,

Carrie Fosaaen
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Bruce Bavol, NRC
Getachew Tesfaye, NRC
Michael Dudek, NRC

Enclosure 1: NuScale Response to NRC Request for Additional Information RAI# 9789

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9789, nonproprietary

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-01

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

The proposed revised minimum staffing level for a 12-module NuScale plant is shown in the topical report, Table 6- 1, "Minimum Licensed Operator Staffing," as one licensed reactor

operator and two licensed senior reactor operators. During the audit, the NRC staff discussed revisions that need to be made to the table and its notes in the topical report, Section 6.1, "Facility Staff," to improve clarity and ensure the plan can be implemented by a licensee.

1. Please revise Table 6-1 to specify the number of units for which the staffing level applies (e.g., 1-12 units operated from one control room).

2. Please revise Table 6-1 (e.g., in the title) to state that the staffing is onsite staffing.

NuScale Response:

TR-0420-69456, NuScale Control Room Staffing Plan, Section 6.1 "Facility Staff," has been revised as shown below:

6.1 Facility Staff

The minimum licensed operating staffing for licensees referencing an NRC-approved NPP design of up to 12 modules is shown in the following table:

Table 6-1 Minimum Onsite License Operator Staffing

Reactor Operator	Senior Reactor Operator
1	2

a. A person holding a senior operator license for all fueled units at the site who is assigned responsibility for overall plant operation shall be onsite at all times when there is fuel in any reactor vessel.

b. A person holding a senior reactor operator license shall be in the control room at all times when there is fuel in any module. In addition to this senior reactor operator, a licensed reactor operator or senior reactor operator shall be present at the controls at all times.

Impact on Topical Report:

Topical Report TR-0420-69456, NuScale Control Room Staffing Plan has been revised as described in the response above and as shown in the revision provided in LO-1220-73414.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-02

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.
Request for Additional Information:

1. Topical Report, Section 4.0, "Additional Staffing Considerations," states, "[t]he three-person crew staffing complement is intended to identify the minimum crew size to support

safe plant operations. An additional requirement is added for at least two of the crew members to have senior operator licenses so that the CRS could leave while the second senior license holder remained in the control room." However, Table 6- 1, Note b says, in part (underline added for emphasis), "A person holding a senior reactor operator license shall be in the control room complex at all times." Absent a definition of "control room complex," it is not clear whether Note b is consistent with the topical report, Section 4.0. Please either (1) revise Note b to delete "complex," or (2) provide a definition of "control room complex" and, if the complex includes area outside the control room, explain how control room supervisors at a NuScale plant could adhere to the guidance of Regulatory Guide (RG) 1.114 or why an alternative to RG 1.114 would be acceptable for a NuScale plant.

2. Please clarify when the licensee is required to establish the staffing discussed in Note b (e.g., when any unit is fueled, a licensed reactor operator or senior operator shall be present at the controls at all times).

NuScale Response:

TR-0420-69456, NuScale Control Room Staffing Plan, Notes a and b of Table 6-1 "Minimum Licensed Operator Staffing," have been revised as shown below:

a. A person holding a senior operator license for all fueled units at the site who is assigned responsibility for overall plant operation shall be onsite at all times when there is fuel in any reactor vessel.

b. A person holding a senior reactor operator license shall be in the control room at all times when there is fuel in any reactor vessel. In addition to this senior reactor operator, a licensed reactor operator or senior reactor operator shall be present at the controls at all times when there is fuel in any reactor vessel.

Impact on Topical Report:

Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, has been revised as described in the response above and as shown in the revision provided in LO-1220-73414.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-03

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.
Request for Additional Information:

The topical report, Section 4.0 Additional Staffing Considerations, states in part, "An additional senior license holder is required to support refueling operations." Table 6-1, Note d, states, "Each licensee shall have present, during alteration or movement of the core of a nuclear power

unit (including fuel loading, fuel transfer, or movement of a module that contains fuel), a person holding a senior operator license or a senior operator license limited to fuel handling to directly supervise the activity and, during this time, the licensee shall not assign other duties to this person." Please revise Note d to clarify that the senior operator assigned to supervise alteration or movement of the core of a nuclear power unit is in addition to the two senior operators identified in Table 6-1.

NuScale Response:

TR-0420-69456, NuScale Control Room Staffing Plan, Note d of Table 6-1 "Minimum Licensed Operator Staffing," has been revised as shown below;

d. Each licensee shall have present, during alteration or movement of the core of a nuclear power unit (including fuel loading, fuel transfer, or movement of a module that contains fuel), a person holding a senior operator license or a senior operator license limited to fuel handling to directly supervise the activity and, during this time, the licensee shall not assign other duties to this person. This person is in addition to the two senior operator license holders identified in Table 6-1.

Impact on Topical Report:

Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, has been revised as described in the response above and as shown in the revision provided in LO-1220-73414.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-04

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

NUREG-1791, Section 2.0, lists the type of information that is considered part of the concept of operations. In addition to the number of personnel who will have plant monitoring and

operational control responsibilities on each shift, it also includes their individual roles and responsibilities; the interaction of control personnel with automated systems; other mechanisms that enable or support control personnel responsibilities for monitoring, disturbance detection, situation assessment, response planning, response execution, and the management of transitions between automatic and manual control; the interactions of control personnel with each other and with people not directly responsible for the control and safe operation of the plant; and multi-unit operations. Although a major goal of a staffing plan validation test is to confirm that the proposed minimum number of licensed operators on each shift is acceptable, the other elements of the concept of operations are also validated and assessed during a staffing plan test since they govern the ways in which the operators perform their function to operate the plant safely. As such, the staff considers the other elements of the concept of operations to be an important element of the staffing plan.

Reference 8.2.10 in the references section of the topical report is, "Concept of Operations," RP-0215-10815, Revision 3. Revision 3 is for a crew of at least six licensed operators, and it is incorporated by reference in Tier 2 of the NuScale standard design certification document for the 600 MWe, 12 small modular reactor plant design. The information in Revision 3 about the roles and responsibilities of the six-person crew is not applicable to the revised staffing plan. During the August 2020 audit, the staff reviewed draft Revision 4 of the "Concept of Operations," which NuScale revised to account for changes to the concept of operations for the revised staffing plan.

Please either submit Revision 4 of the "Concept of Operations" document or revise the topical report to include the changes to the concept of operations for the revised staffing plan.

NuScale Response:

RP-1020-72177 "Concept of Operation," Revision 1 reflects the changes to the concept of operations for the revised staffing plan that the NRC Staff reviewed during the August 2020 audit. RP-1020-72177, Revision 1 is included with this response for NRC review. Additionally, reference 8.2.10 in the topical report has been revised to show the updated report number and revision number.

Impact on Topical Report:

Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, and RP-1020-72177, Concept of Operations have been revised as described in the response above and are shown

in the revisions provided in submittals LO-1220-73414, Control Room Staffing Plan and LO-1220-73431, Concept of Operations.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-05

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

NuScale measured workload of the test participants during the revised staffing plan validation test using the NASA TLX methodology. When using NASA TLX method, it is acceptable to

either apply weighting factors to the measurements or to not apply them. The topical report, Section 5.1, "Staffing Plan Validation Methodology Overview," refers to the "streamlined use" of workload weighting factors. Please clarify what is meant by "streamlined use" of weighting factors.

NuScale Response:

The discussion contained in TR-0420-69456, Section 5.1 "Staffing Plan Validation Methodology Overview," was intended to reflect the elimination of applying weighing factors to the staffing plan validation and verification methodology based on good practices learned during iterative applications of this methodology. NuScale has revised TR-0420-69456, Section 5.1 "Staffing Plan Validation Methodology Overview," as shown below:

This methodology has been used to conduct two validation efforts. These tests are referred to as the control room staffing plan validation (SPV) and the revised staffing plan validation (RSPV). Two improvements to the methodology were made following the SPV, the addition of an independent observer role and the elimination of applying weighting factors to the National Aeronautics and Space Administration Task Load Index (TLX).

Impact on Topical Report:

Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, has been revised as described in the response above and as shown in the revision provided in LO-1220-73414.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-06

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

During the audit, the staff observed video recordings of the scenario trials. The staff noticed that at the beginning of all of the scenarios, all three operators were in the control room simulator. However, in accordance with Table 6-1, all three operators may not be in or near the control room at the same time. Please explain whether there is any impact on the results of the RSPV

test by not simulating that one of the three crew members could be elsewhere onsite at the start of a potentially challenging, high workload situation.

NuScale Response:

Due to the overall low operational complexity, simple passive engineered safety features actuation systems that are designed as fail-safe, no required operator actions for design basis events, and the limited number of risk important human actions for beyond design basis events, there is ample time to consider any required operation actions in response to plant transients or other events at a NuScale Power Plant.

Based on these considerations, NuScale judged that starting the scenarios with one operator outside of the main control room (MCR) at the beginning of the scenario would serve primarily as a communications exercise to recall the absent operator to the MCR. As the ability of the MCR staff to communicate with outside personnel was already tested in other parts of the validation, starting one operator outside the MCR was determined to be redundant to other elements of the plan, and therefore was not included.

During the revised staffing plan validation (RSPV) testing, the risk important human actions were completed with margin similar to the results from the integrated system validation and staffing plan validation, and earlier than the required time from the probabilistic risk assessment analysis. Since at least one reactor operator and one senior reactor operator (SRO) are required within the MCR, actions to stabilize the affected modules can begin as soon as the event is recognized. The evaluation of Emergency Action Levels and other remaining emergency planning tasks, including notifications and facility activations, could either be performed by the SRO within the MCR for lower workload events, or may be deferred until the third operator returns to the MCR for higher workload events.

Therefore, there is no impact to the conclusions of the RSPV test by not simulating that one of the three crew members were outside the control room because the required risk important human actions would still occur within the analyzed limits.

Impact on Topical Report:

There are no impacts to the Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, as a result of this response.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-07

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

NUREG-1791, Section 3, "Review the Operational Conditions," says the staff reviews the operational conditions selected for the staffing plan validation to "ensure that the operational

conditions which present the greatest potential challenges to the effective and safe performance of control personnel, under the conditions of the requested exemption, were analyzed by the applicant and support the exemption request." The topical report, Section 5.1, states, "There is reasonable assurance that the workload during each of the scenarios bounds the anticipated workload conditions." Please explain how the scenarios selected for the RSPV bound the anticipated workload conditions at a NuScale plant.

NuScale Response:

The scenarios used during the 2016 staffing plan validation were developed to test high workload-conditions using the process described in Control Room Staffing Plan Validation Methodology, RP-1215-20253. The same proven methodology was used to develop the high workload-condition scenarios of the revised staffing plan validation. The methodology provides reasonable assurance that the workload was representative of the highest-workload conditions the operators might face. TR-0420-69456 has been revised to replace the term “bounds” with the phrase “representative of the highest-workload conditions the operators might face”, which better reflects the goals of the revised staffing plan validation.

Impact on Topical Report:

Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, has been revised as described in the response above and as shown in the revision provided in LO-1220-73414.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-08

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

During the audit, the staff reviewed a list of scenario assumptions in the RSPV Test Report, Section 3.3. In some cases, these scenario assumptions provide limitations and constraints on

the activities that may be assigned to the control room crew. The staff recognizes that it was necessary for NuScale to make staffing assumptions in the absence of a facility licensee, who will be responsible for finalizing the decisions addressed by the staffing assumptions, in order to perform the RSPV test.

The NRC staff also observed that the Conduct of Operations document, Revision 1, Section 3.11, includes a staffing assumption about availability of additional personnel. During the audit, the staff observed during some scenario trials that the control room supervisor/shift manager was heavily involved in phone communications, and the reactor operators were engaged in operations. During situations where multiple units are in a transient, and the reactor operators are engaged in tasks as directed by the plant procedures, the CRS will need to limit the amount of time he or she spends engaged in external communications to ensure he or she maintains the role of providing effective command and control of the shift activities. The staffing assumption in Section 3.11 of the Conduct of Operations document addresses a way for the CRS to manage external communications to ensure he or she can maintain the command and control function in the control room. Additionally, Section 4.0 of the Conduct of Operations document states an expectation for how long it will take the third operator to return to the control room if he or she is outside of the control room (and is still onsite).

Given the topical report is to be used by facility licensee applicants, the facility licensee should confirm that these assumptions remain accurate for its facility, and if not, it should describe the deviations and any impacts to the staffing plan.

1. Please revise the topical report to include a summary of the scenario and staffing assumptions in Section 3.3 of the RSPV Test Report, Bullets 4 and 5, and Sections 3.11 and 4.0 of the Conduct of Operations document.

2. Additionally, in the conditions of applicability section, add that a COL applicant will either verify these assumptions remain valid for its facility or identify and address impacts of any deviations.

NuScale Response:

The assumptions in the revised staffing plan validation (RSPV) test report section 3.3 bullets 4 and 5, section 3.11, and section 4.0 of conduct of operations, were provided to ensure that testing was repeatable and consistent. Performing a representative dynamic simulator validation in the absence of site-specific combined operating license (COL) actions being

completed requires assumptions to be made. For example, a completed Emergency Action Level (EAL) scheme, non-licensed operator (NLO) staffing, and work control procedures are items that are left to the COL applicant to determine in accordance with NUREG-0800, Chapter 13. A COL will develop a comprehensive emergency plan and non-licensed operator staffing requirements to ensure that the plant can be operated safely and reliably. The COL will develop non-licensed operator staffing requirements with a more detailed understanding of the final plant design, programs, processes and procedures that are developed during the COL phase of the plant licensing process.

NuScale has revised the topical report to document relevant staffing assumptions used during staffing plan validation (SPV) and RSPV, in the following new section;

Section 5.2.1 License Operator Staffing Assumptions used during SPV and RSPV:

- Refueling operations and module assembly and disassembly are not directed from the MCR. Refueling is a planned activity and has a dedicated staff assigned for specific performance and oversight. Because the NPM is electrically and mechanically disconnected during refueling, the control room operators have no direct interaction with the refueling team other than operating common system components (e.g., align reactor pool cooling) or to update the SM on refueling status.
- A work control center (WCC) is available to assist the control room with work management during periods of significant workload. This reduces the distractions to the control room crew and is common practice among existing nuclear plants.
- The crew staffing complement includes one non-licensed operator acting as a communicator to offsite agencies during emergencies. The crew responsibilities do not include the fire brigade, supplemental emergency plan responder, or emergency medical team responder.

Additionally, a requirement has been added to Section 1.5, Conditions of Applicability, for an applicant using this topical report to evaluate any deviations from the control room staffing assumptions listed in section 5.2.1 prior to using this alternative staffing plan.

Impact on Topical Report:

Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, has been revised as described in the response above and as shown in the revision provided in LO-1220-73414.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-09

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

NUREG-0711, Section 11.4.3.3(2) states that "[t]he testbed's HSIs and procedures should be represented with high physical fidelity to the reference design, including the presentation of

alarms, displays, controls, job aids, procedures, communications equipment, interface management tools, layout, and spatial relationships." The staff previously assessed the simulator used for ISV and determined it had sufficient fidelity to the plant design for validation testing. The topical report, Section 5.3.3, states that participant training for the RSPV included classroom training on simulator differences from the ISV. During the audit, the staff reviewed two simulator release notes that document changes to the simulator that occurred following ISV. However, neither the topical report nor the test report discuss whether simulator changes that occurred between the ISV and RSPV were based on plant design changes and, furthermore, whether they improved the fidelity of the simulator to the as-designed HSI (e.g., whether the changes to the simulator following ISV were implemented to ensure the simulator reflected changes to the as-designed control room and HSI).

Additionally, during the audit, the staff reviewed the RSPV Test Report, which describes the simulator testing NuScale conducted prior to the RSPV test to validate the fidelity of the simulator to the plant design. The staff also reviewed documentation of simulator testing that was conducted to verify the scenarios used for the RSPV would perform as planned.

1. Please revise the topical report to state that NuScale conducted simulator performance testing prior to the RSPV to verify the fidelity of the simulator to the plant design, the type of testing that was performed, and whether the results confirmed the simulator for RSPV had adequate fidelity to the as-designed MCR HSI.

2. Please explain whether simulator changes that occurred between the ISV and RSPV were based on plant design changes and whether they improved the fidelity of the simulator to the as-designed HSI.

NuScale Response:

NuScale Response to Question 1:

Detailed testing methodology and results that confirm simulator fidelity and performance are described in Sections 6.2, 6.3, and 6.4 of RP-0419-65209, "Revised Staffing Plan Validation Test Report." RP-0419-65209 is included with this response, and is docketed. TR-0420-69456 Section 5.3.5, "Summary of Revised Staffing Plan Validation Trial Results," summarizes the revised staffing plan validation (RSPV) results and points to the RSPV test report for additional details. No additional changes are needed to TR-0420-69456.

NuScale Response to Question 2:

The simulator was updated with two releases between the integrated system validation (ISV) and the version of the simulator used for the RSPV. The changes were made to address human engineering discrepancies that were generated as a result of the ISV, improvements to the human-system interface (HSI), and procedures based on ISV operator feedback. The second release was to support scenario administration and to complete additional minor improvements to the HSI and procedures based on ISV operator feedback. The changes that support scenario adminstration were the creation of three new scenario controllers to administer the RSPV test, and an update to the data historian to produce records. These are limited to simulator tools and not part of the MCR design. The additional minor HSI and procedure improvements improve simulator fidelity to the plant design.

Impact Statement:

RP-0419-65205, Revised Staffing Plan Validation Test Report has been revised as described in the response above and as shown in the revisions provided in submittal LO-1220-73411.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-10

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.
Request for Additional Information:

The topical report, Section 1.5, contains the conditions of applicability that are associated with the topical report. This section of the topical report lists several features and states that "an applicant can show the proposed design complies with the conditions of applicability by

performing an evaluation or demonstration of their design to these attributes." The staff understands NuScale intends to submit a standard design approval application for the NuScale 720MWe plant design. During the audit, NuScale explained that the simulator used for the RSPV test was based on the NuScale plant design as described in the design certification application (i.e., the 600MWe plant).

1. Please provide the rationale for the conditions and limitations contained in the topical report and explain why additional conditions and limitations are not needed for COL applicants referencing the NuScale 720 standard design.

2. Given the level of automation in the plant design helps minimize operator workload by performing more tasks, please explain why it was not listed with the other HSI design features listed in the topical report, Section 1.5, "Conditions of Applicability."

NuScale Response:

NuScale Response to Question 1:

The rationale for the conditions contained in Section 1.5, "Conditions of Applicability," of the topical report functionally represent the minimum set of features required to allow the operators to perform tasks important to safe plant operation during challenging, high workload events, so the three person crew can be effective. The conditions of applicability limits the use of this staffing plan to a combined operating license applicant referencing the NuScale small modular reactor design, therefore no further conditions or limitations are required. It is inherent in these conditions that the NuScale small modular reactor plant has a higher margin of safety and low operational complexity as compared to plant designs using the existing staffing regulations.

No operator actions credited during DBEs: The plant design tested during the staffing plan validation exercises cited in this topical report does not have operator actions credited during DBEs. If essential safety-related operator actions are required during DBEs in future design updates, further analysis would be required to verify procedures in place provided sufficient prioritization to direct the sequence of actions on any affected units, and all actions could be accomplished within the required time frame. This element is required as no such analysis is contained within this topical report.

Two important human actions (IHAs) which are easily recognizable and can be completed from the main control room (MCR) by a single licensed operator: The plant

design tested during the staffing plan validation exercises cited in this topical report has only two IHAs, and those can be completed from the MCR by a single licensed operator. Maintaining the limit of two IHAs to future plant design updates is provided to limit the number of conditions that must be monitored by the operators during BDBEs. In the tested design, both IHAs are the result of failure to meet a critical safety function. Direct links with subsequent procedures are provided for both of these conditions by the HSI to alert the operator of the need to take these actions, and provide the procedures to allow timely and proper execution.

The two IHAs are not specifically identified because the IHAs are irrelevant to the staffing plan. The characteristics of the responses to the IHAs are the important factors and potentially impactful. The important considerations are, in order of importance: the IHA actions can be accomplished by a single licensed operator, they can be accomplished from the main control room, and there are only a small number of IHAs (e.g.; two) that are easily recognized by straightforward cues from the HSI. As long as the plant design retains these characteristics as they pertain to IHAs, then adding more operators to the control room staff does not improve the chances of successfully completing the task(s).

The specific time available for completing the IHAs actions are not listed because they do not affect the staffing plan. The important considerations are still that the IHA actions can be accomplished by a single licensed operator from the main control room, without reliance on actions performed in the field by non-licensed operators. The performance data from SPV and RSPV confirmed that the crews were able to complete the IHA actions with significant margin, so the addition of a very long time limit for events having such low probability of occurrence and where analysis of validation test data does not show a vulnerability, does not add value to this parameter. Regardless of the time allowed to complete the IHA, adding more operators to the control room staff does not improve the chances of successfully completing the task within the allowed time.

A human-system interface (HSI) design that retains the following features:

Critical safety function and defense-in-depth monitoring and display, which provide direct links to response procedures: This feature allows operators to assess critical safety status at a glance, efficiently identify actions to mitigate challenges to the safety functions and ensure that defense in depth capabilities are maintained. Directly identifying the procedures assists the operator to take the correct action on the correct unit, and is a key component of the lower operational complexity of the NuScale plant design.

Tiered alarm scheme: This feature assists with prioritization and ensures operators are aware of important alarm conditions that are less challenging than what is identified by critical safety function and defense in depth monitoring.

Computer-based alarm response procedures that are directly linked assist the operator in efficiently locating the correct information: This feature provides the operator with direct access to the actions that address the annunciated condition in a format that is simple to use. It also helps ensure the operator takes actions on the intended unit.

Twelve-module trend monitoring: This feature allows the operator to efficiently identify trends to allow for early mitigation to minimize the severity of transients for up to 12 units using one central operator interface. This reduces the need to look through multiple interfaces and locations to obtain key operational parameters about the plant.

Any changes that occur to the IHA attributes stated in Section 1.5, Conditions of Applicability, can be addressed by the conditional statement included in the section; “An applicant can show the proposed design complies with the conditions of applicability by performing an evaluation or demonstration of their designs to these attributes.”

NuScale Response to Question 2:

The NuScale plant design reduces operator work load due to its lower operational complexity - the design eliminates large complex components (i.e., Reactor Coolant Pumps), and is simpler in the number of systems and number of transient response procedures.

Automations within the control system primarily exist to assist operators in efficient management of the plant to produce electricity. These automations do not, much like the operators, have a substantial impact on safety. This is demonstrated in both deterministic and probabilistic analysis.

The HSI features listed in the topical report are those necessary to ensure the operator maintains situational awareness and can easily and correctly identify the appropriate action to take, to stop, or mitigate a transient or accident condition. During a DBE or BDBE, “normal operations” on unaffected units will not be the focus of the crew, regardless of the level of automation, and therefore automation to minimize operator workload was not listed with the other HSI design features listed in the topical report, Section 1.5, “Conditions of Applicability.”

Impact on Topical Report:

There are no impacts to the Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, as a result of this response.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-11

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

The topical report, Section 5.3.2, "Participants in Second Validation Trials," states that RSPV test participants were chosen based on previous experience as crew members during the ISV.

NUREG-0711, Section 11.4.3.4, "Plant Personnel," says there should be variation in age, skill/experience, and qualifications among test personnel, and test participants should not be selected for specific characteristics, such as good performers. Also, test participants should not have access to the test scenarios prior to testing in order to avoid biasing the test results.

1. Please explain the other criteria NuScale used to select the RSPV test participants in order to avoid selecting for specific characteristics such as good performance.

2. Please state whether the test participants had access to the scenario contents prior to the RSPV test.

NuScale Response:

NuScale Response to Question 1:

Selecting participants who had successfully completed the integrated system validation (ISV) training program was a primary consideration to be a revised staffing plan validation (RSPV) crew member, since completing the ISV training program was required to ensure crew members had sufficient knowledge of the NuScale plant design, plant controls, and conduct of operations in order to interact with the HFE design in the same manner as experienced plant personnel. This avoided the need to conduct an additional comprehensive training program, which takes more time, more expense, and is impactful to NuScale resources who would conduct the training. This would have increased the RSPV duration by up to five months, with associated costs. The next criteria used for RSPV candidate selection was logistical and did not include consideration for prior performance during ISV. Candidates were chosen based on availability and geographic location. The three candidates that were employed by NuScale, and were available to participate, were selected first. The two non-employee candidates that lived locally and were available were selected next. The final participant was selected from a small pool of remaining candidates. That candidate was chosen based on availability, as well as contributing to the diversity in age, skills and qualifications among the crews. The resulting crews included individuals with varying ISV performance levels and varying experience, which included commercial operating experience (OE), previous Navy nuclear power OE, and direct input operators that may have a technical or engineering degree, but no nuclear plant operating experience. The overall profile of the participants' background was validated to ensure it included a mix of experience expected of operators of a NuScale power plant and would meet the requirements of NUREG-0711, Section 11.4.3.4.

NuScale Response to Question 2:

Exam security protocol was maintained as described in Section 4.3 of the RSPV Test Report (RP-0419-65209). RSPV participants did not have access to the scenario contents prior to the RSPV test. None of the participants were involved in any aspect of the HFE review elements, as described by NUREG-0711. None of the participants performed activities associated with test development or pilot testing. None of the three participants who worked at NuScale worked in any capacity that would have allowed them access to the contents of the scenarios.

Impact on Topical Report:

There are no impacts to the Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, as a result of this response.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-12

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

The topical report, Section 7.0, "Summary and Conclusions," states in part that "a preponderance of evidence shows that individuals, and the crew as a whole, experienced

acceptable levels of workload." During the August 2020 audit, the staff reviewed the NASA TLX workload data for each crew member in each of the scenario trials. The staff also reviewed the results of the situation awareness questionnaires administered to each test participant.

Please revise the topical report to include the following:

1. the range of the average workload for each crew member (i.e., lowest average workload and the highest average workload),

2. the maximum workload measured during all trials and the reason(s) why the workload was high in the specific scenario(s),

3. a statement about the situation awareness results as described in the RSPV Test Report, Section 10.2.2, "Situation Awareness."

NuScale Response:

TR-0420-69456, "NuScale Control Room Staffing Plan," has been revised to include the following information in Section 5.3.5, Workload and Situational Awareness Data for Second Validation Trials:

The range of average workload for each 2019 revised staffing plan validation (RSPV) test crew member is as follows:

Crew Member	Avg.	Lowest Avg. Workload	Highest Avg. Workload
RO1	21	15	28
RO2	13	10	15
CRS	18	11	25

Table 5-1 RSPV Average Workload Data

The maximum workload value measured during all the trials was a raw score of 80. This score was tied to a scenario event that was designed so that the crew would not be successful. During this event, reactor coolant inventory was leaking from the module and the crew had to take action to inject additional inventory. Subsequently, the crew had indications of fuel clad

degradation. In this scenario, their actions were not allowed be successful. Both control room supervisors stated that this no-win situation was very stressful, which was reflected in their higher TLX scores.

Situational awareness questionnaires were used at predetermined points administered in conjunction with TLX workload measures. The figure below shows the actual scores for scenarios 1, 2, and 3 from left to right on the x-axis.

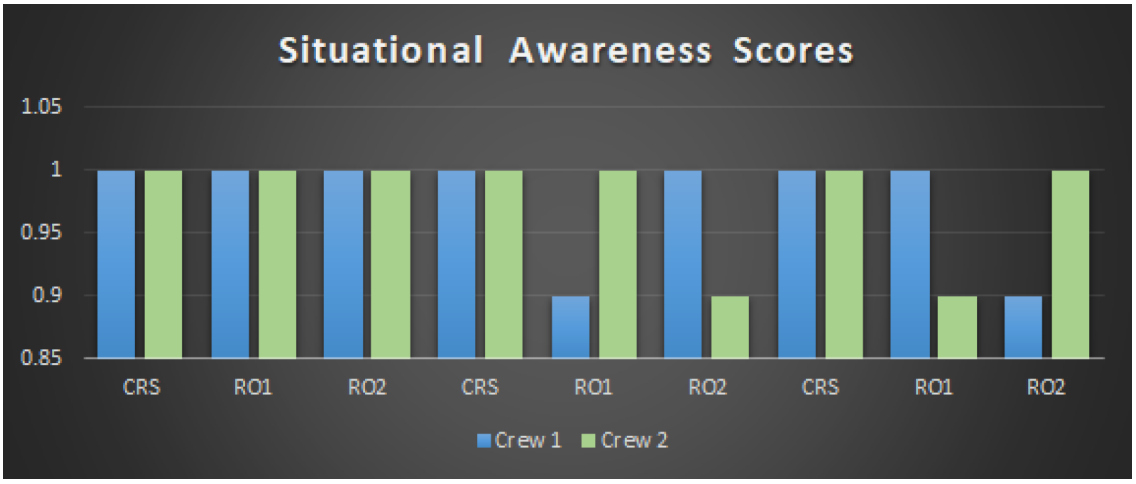


Figure 5-1 RSPV Situational Awareness Scores

The range of scores were 90%-100%. The average situational awareness score was 97%. There was no trend to indicate that one position or person had a deviation of results from any other person or position. No situational awareness comments were generated during the RSPV.

Impact on Topical Report:

Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, has been revised as described in the response above and as shown in the revision provided in LO-1220-73414.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-13

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.
Request for Additional Information:

The RSPV Test Report, Appendix D, says that a readiness assessment was performed prior to RSPV, which used the same scenarios from the 2016 SPV test and the RSPV test participants. It also says all acceptance criteria were met; these included criteria for successful task

performance. During the August 2020 audit, NuScale explained that the readiness assessment used the same test protocol and data collection methods as the RSPV test. The scenario events are included in the SPV Results Technical Report, which is a document that can be accessed by NuScale employees. Thus, NuScale stated it could not guarantee that the RSPV test participants had not reviewed the scenarios prior to the readiness assessment. However, NuScale said it had a high level of confidence that the RSPV participants had not reviewed the scenarios. Although the reviewed documentation indicates that access to the readiness assessment scenarios were not controlled as strictly as the RSPV test scenarios prior to the readiness assessment, the NRC staff believe that there is some confidence that the participants did not have prior knowledge of the readiness assessment scenarios prior to the assessment. As such, reviewing this data provides the staff a reasonable "apples-to-apples" comparison between the SPV and the RSPV that provides support for NuScale's staffing plan.

Please include a description of the RSPV readiness assessment, including a summary of the task performance, workload and situation awareness results and how they compare to the results from the initial SPV test, and why it is unlikely that the test participants reviewed the scenario contents prior to the readiness assessment.

NuScale Response:

A description of the revised staffing plan validation (RSPV) readiness assessment is provided below:

The original staffing plan validation (SPV) scenarios performed in 2016 were not used as the scenarios for the RSPV primarily because the scenario information was not maintained under exam security following the SPV. Therefore, however unlikely, it could not be assured that participants would be unaware of the SPV scenarios. For this reason, new scenarios were generated using the same methodology, Control Room Staffing Plan Validation Methodology, RP-1215-20253, that was used to generate the original SPV scenarios.

The three SPV scenarios were used as the RSPV readiness assessment performed prior to the start of the RSPV testing.The purpose of the readiness assessment was to ensure data collection methods were rehearsed and to ensure participants were ready for the validation test. Additionally, most of the lower tier performance measure data on task timing was collected during the readiness assessment. Using the original SPV scenarios for the readiness assessment allowed benchmarking of the results against the SPV results. Also, because the purpose of the readiness assessment was only to ensure that data collection methods were rehearsed and to ensure participants were ready for the validation test, most, but not all, of the

data on task timing was collected. The three original SPV scenarios were administered in the same manner as they were in 2016 with the exception that no crew observers were present. Workload and situational awareness data are available as well as some crew task performance times, however, no human factors engineering or operations observer comments were generated beyond those of the test lead. The only modification to the scenario guides were to update the handouts used for the crew participants. For example, the format of turnover sheets and work orders had been changed since the SPV, but the content remained the same.

Summary of the crew task performance observed during RSPV readiness assessment:

The acceptance criteria which was also included in the 2016 SPV, was the performance of the important human action (IHA) to inject water into a module. The data showed that the completion times were similar in both the SPV and the RSPV readiness assessment resulting in all crews meeting the acceptance criterion. Table A-1 provides the measured time information for comparison.

	Measured Performance Time (min)	PRA Assumed Maximum Time Allowed (min)	Ratio of measured to PRA Maximum Time Allowed (not to exceed 0.75)
2016 SPV Crew 1	12	56	0.2
2016 SPV Crew 2	14		0.3
2019 Assessment Crew 1	10		0.2
2019 Assessment Crew 2	15		0.3

Table A-1 Acceptance Criterion Comparison

Overall, the data collected showed that measured tasks were completed within the allowed time for both crews. In some instances one, and sometimes both, of the crews in the readiness assessment had better time performance than the SPV crews.

The following figures show a ratio of task time measured as compared to task time available to complete. A threshold of 50% was used during SPV and the same threshold was applied during the readiness assessment. Using a ratio view accentuates results to aid in determining if there is a task or set of tasks that challenges the time available for that task. The following figures show the measured task times from the RSPV readiness assessment (in shades of blue and listed as Pilot Crew 1 and 2) as compared to the measured task times from the 2016 SPV (in shades of green).

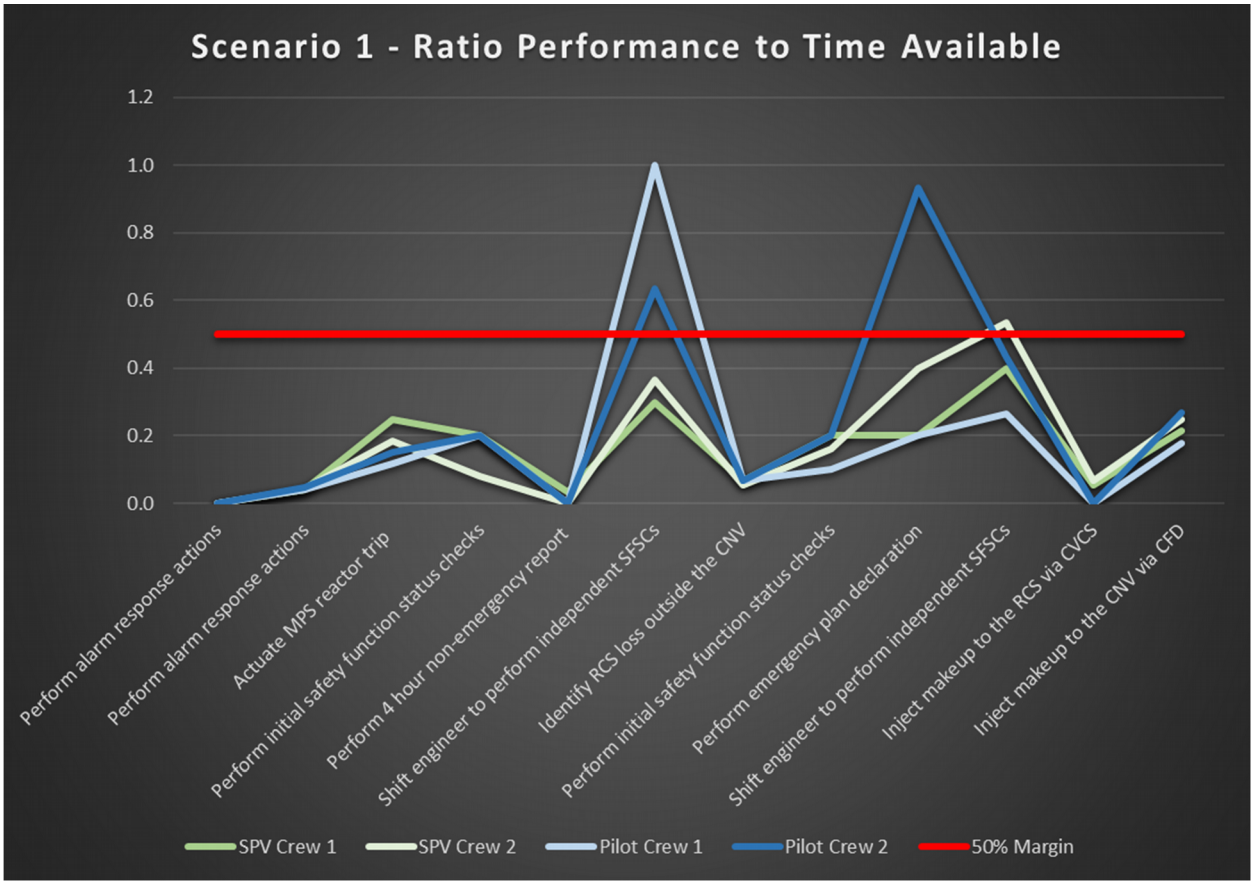


Figure A-2.4 Scenario 1 Task Time Ratios

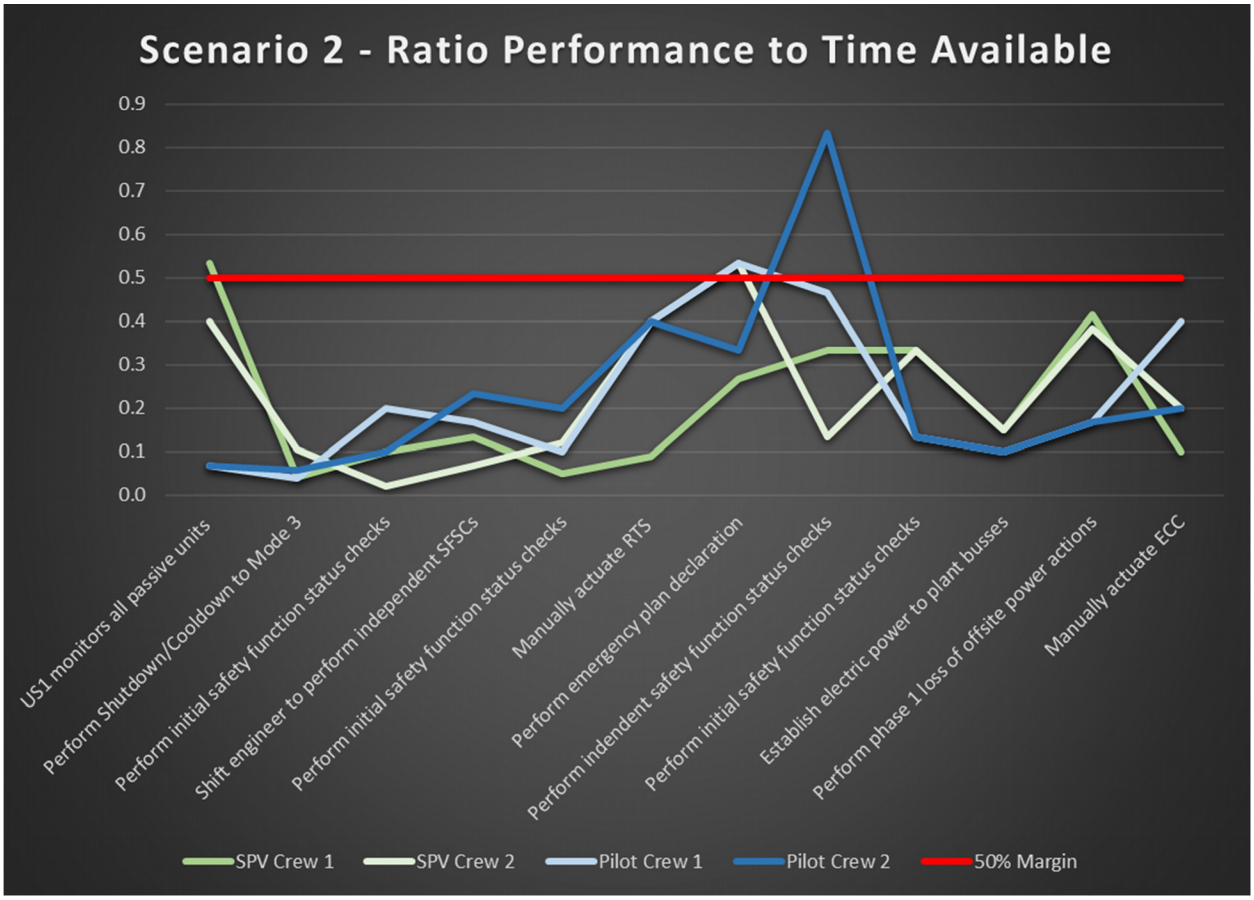


Figure A-2.5 Scenario 2 Task Time Ratios

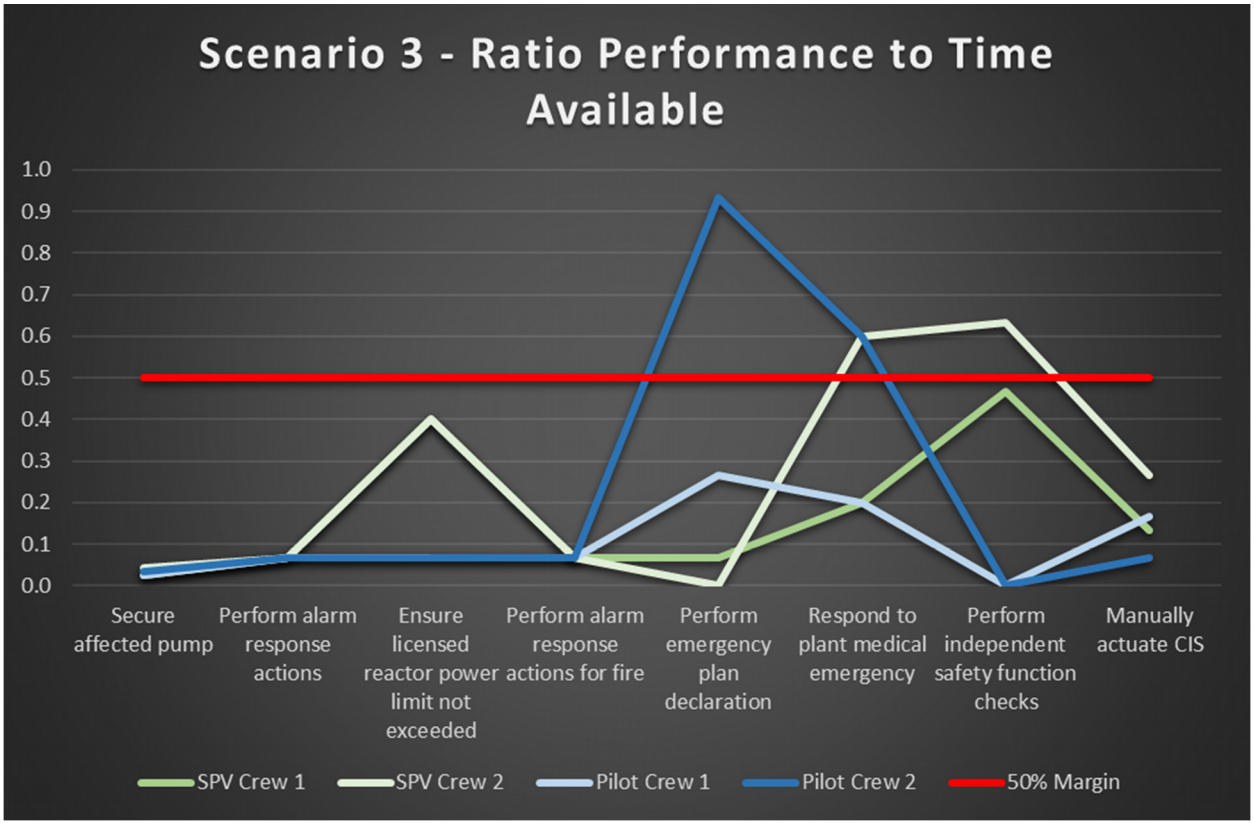


Figure A-2.6 Scenario 3 Task Time Ratios

The task timing ratios for the three scenarios shows, generally, that the RSPV crew data was consistent with the SPV data with all the tasks were performed within the allowed time by all crews.

Summary of workload observed during RSPV readiness assessment:

The average of TLX workload index scores gathered during the RSPV readiness assessment were similar to the 2016 SPV results.

Figure A-2.1 shows a comparison of the average workload measures on a scale of 0-100.

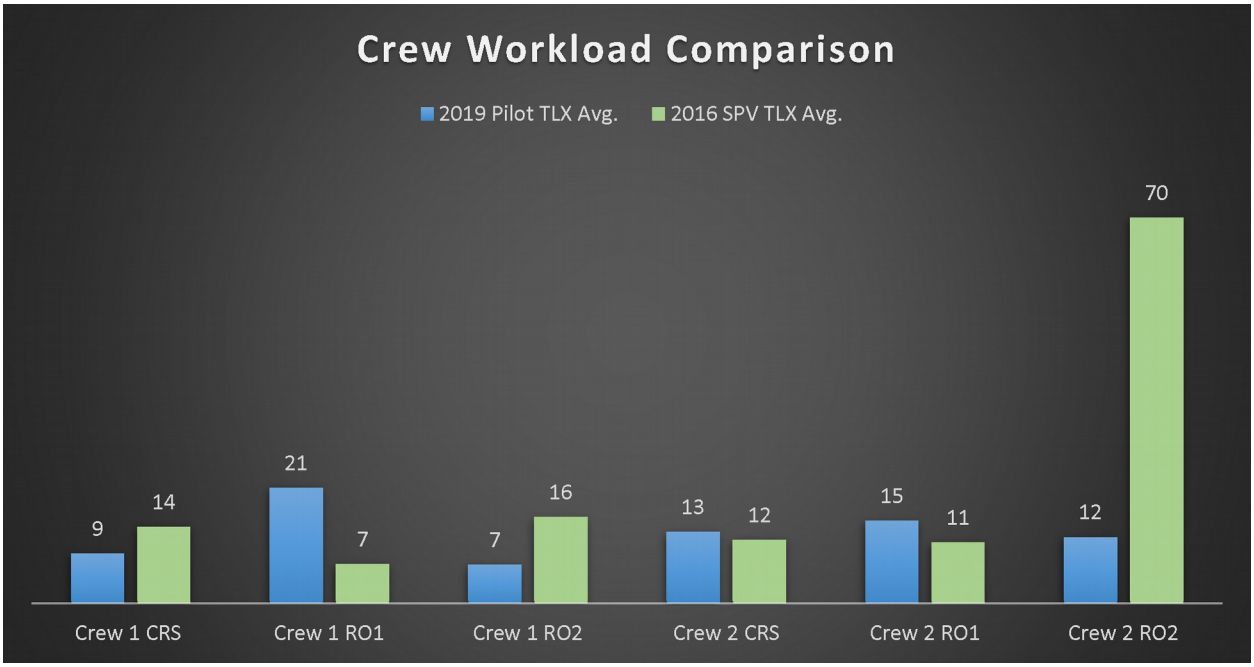


Figure A-2.1 Crew Workload Comparison

In general, the measured workload is consistent between the two tests with the exception of RO2 for crew 2. The 2016 SPV results document this self-observed high level on one of the individuals. That individual had a consistently higher scoring baseline in comparison to others.

Summary of situational awareness question data during RSPV readiness assessment:

The situational awareness question scores gathered during the RSPV readiness assessment were similar to the SPV results. The average situational awareness scores for both the readiness assessment and the SPV were 93%. There was no discernable trend to indicate that one position or person had a significant deviation of results from any other person or position.

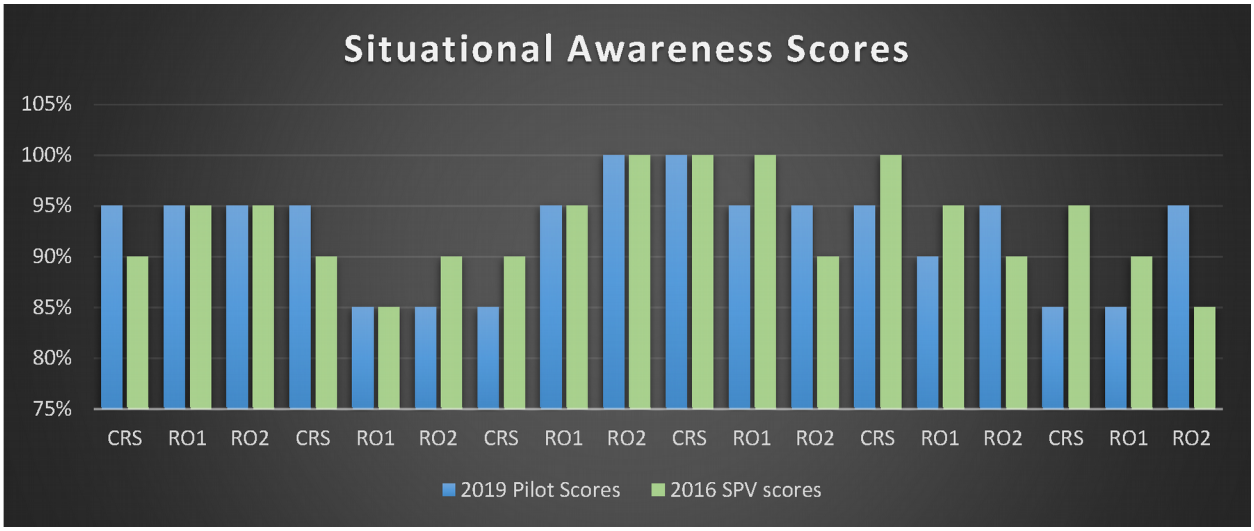


Figure A-2.3 Situational Awareness Scores

Test participant access to the scenarios prior to the RSPV readiness assessment:

Although there were no safeguards in place to ensure participants had not seen the original 2016 SPV scenarios, it was clear through observation of the crew performances that the scenarios were not reviewed by the crews prior to the assessment. The scenario files were maintained on a corporate drive and would only be accessible for someone actively searching for those files. Although not used for official validation purposes, they do provide an opportunity for comparison.

Impact Statement:

RP-0419-65209, Revised Staffing Plan Validation Test Report has been revised as described in the response above and as shown in the revisions provided in submittal LO-1220-73411, Revised Staffing Plan Validation Test Report.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-14

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

The topical report, Section 3.1, "Industry Upgrades to Qualifications of Shift Supervisors and Senior Operators," states, "Applicable engineering principles are now an integral part of any

licensed operator training program." The topical report, Section 2.3, "Control Room Staff Level Based on Staffing and Qualification Analysis," also states, "Licensed operators are selected, trained, and qualified consistent with 'Guidelines for Initial Training and Qualification of Licensed Operators,' ACAD 10-001 (Reference 8.2.4)."

ACAD 10-001 is a proprietary document maintained by the Institute of Nuclear Power Operations (INPO) National Academy for Nuclear Training (NANT). Reference 8.2.4 is Revision 0, which has been superseded, and is expired. It is the facility licensee's responsibility to establish the training programs (i.e., training is an operational program and the development of the training program is a COL item). A facility licensee may not seek INPO/NANT accreditation, and therefore, may not have access to ACAD 10-001. Therefore, in addition to using a SAT-based process to develop the operator initial training program based on the tasks operators perform at the plant, the COL applicant should confirm that its initial training program does include the operator generic fundamentals that are relevant to operation of a NuScale power plant.

1. Please revise the topical report to account for a facility licensee that may not use ACAD 10-001 and that the revision listed in Reference 8.2.4 is expired.

2. Please revise the topical report to include a condition for the COL applicant's initial operator training program to be SAT-based and contain relevant generic fundamentals, including the math, physics, thermodynamics, and component design topics that are of specific relevance to the operation of a nuclear power plant.

NuScale Response:

NuScale Response to Question 1:

TR-0420-69456, "NuScale Control Room Staffing Plan," Section 2.3 Control Room Staff Level Based on Staffing and Qualification Analysis has been revised to account for a facility licensee that may not use ACAD 10-001. Reference 8.2.4 has also been updated to reflect the latest revision. The changes are shown below.

2.3 Control Room Staff Level Based on Staffing and Qualification Analysis

Licensed operators are selected, trained, and qualified with standards that are comparable to the approved standards of Guidelines for Initial Training and Qualification of Licensed

Operators, ACAD 10-001 (Reference 8.2.4), and fully comply with the applicable licensed operator training programs described in 10 CFR Part 55 and 10 CFR Part 50.120.

Reference 8.2.4

8.2.4 National Academy for Nuclear Training, "Guidelines for Initial Training and Qualification of Licensed Operators", ACAD 10-001, Rev. 1, November 2016.

NuScale Response to Question 2

The amount and style of mathematical training provided by various academic bodies varies widely from institute to institute. NuScale staff has concluded that the mathematics needed for achieving mastery of an initial operator training program is that engineering mathematics needed to complete the standard industry generic fundamentals training as described in NUREG-0737, TMI Action Plan Requirements.

The incorporation of GFE back into the site specific written examination will not impact this requirement, because it states training program requirement, not an NRC exam requirement.

TR-0420-69456, "NuScale Control Room Staffing Plan," Section 1.5 Conditions of Applicability has been revised to include the attributes to be included in a systematic approach to training based licensed operator training program, and to include the math, physics, thermodynamics, and component design topics that are of specific relevance to the operation of a nuclear power plant. It is important to note that, from the list included in Section 1.5, only a site specific commercial nuclear power plant training program would be guaranteed to include all of these elements. The mitigating core damage, plant systems, plant specific reactor technology (including core physics data), transient and accident analysis, and emergency operating procedure training could only be acquired at a plant specific training program.

There is no impact to not having at least one person on shift who has a technical degree. The initial license operator training programs changes that were put in place by the industry as a whole to comply with NUREG-0737, TMI Action Plan Requirements, provide a specific list of the elements of the engineering expertise that are germane to operating a commercial nuclear power facility. These would already be required training elements for any COL holder, and are repeated as part of the conditions of applicability for use of this alternate staffing plan. They are:

The applicants' licensed operator training programs for the plant include the following attributes and items:

- developed using a systems approach to training, as described in 10 CFR Part 55

- the math, physics, thermodynamics, and component design topics that are of specific relevance to the operation of a nuclear power plant
- training for mitigating core damage
- plant specific training, including:
    - plant systems
    - plant specific reactor technology (including core physics data)
    - plant chemistry and corrosion control
    - reactor plant materials
    - reactor plant thermal cycle
    - transient/accident analysis
    - emergency procedures

It is important to note that, from this list, only a site specific commercial nuclear power plant training program would be guaranteed to include all of these elements. The mitigating core damage, plant systems, plant specific reactor technology (including core physics data), transient and accident analysis, and emergency operating procedure training could ONLY be acquired at a plant specific training program.

Impact on Topical Report:

Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, has been revised as described in the response above and as shown in the revision provided in LO-1220-73414.

Response to Request for Additional Information
Docket: 99902078

RAI No.: 9789
Date of RAI Issue: 10/21/2020

NRC Question No.: NTR-15

Background and Regulatory basis:

By letter dated June 11, 2020, NuScale Power, LLC (NuScale) submitted licensing topical report TR-0420-69456, Revision 0, "NuScale Control Room Staffing Plan" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20163A556), for NRC review and approval. The topical report is designed to be used by a NuScale licensee to support exemption requests from the staffing requirements in 10 CFR 50.54(m) or other alternative control room staffing regulations, such as those included in the NuScale design certification rule, and from the requirement in 10 CFR 50.120(b)(2)(iii) to provide training and qualifications for the STA.

The NRC staff reviews such exemption requests and must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to that afforded by compliance with the current regulations. NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," provides a process for systematically reviewing and assessing alternatives to licensed operator staffing requirements. NUREG-0711, "Human Factors Engineering Program Review Model," contains guidance the staff uses to evaluate the methodology and results of human factors and staffing plan validation testing.

On August 17-27, 2020, the staff conducted a regulatory audit (audit plan ADAMS Accession No. ML20210M065) in support of the staff's review of the topical report. During the audit, the staff identified information that will require docketing to allow the staff to make conclusion on the whether the staffing proposal will adequately protect the public health and safety. Therefore, the NRC staff requests that NuScale provide additional information regarding the following topics.

Request for Additional Information:

The topical report, Executive Summary, states, "NUREG-0737 (Reference 8.1.6) states 'the need for the STA position may be eliminated when the qualification of the shift supervisors and

senior operators have been upgraded and the man-machine interface in the control room has been acceptably upgraded.' These conditions have been met in the NuScale Power Plant, and the minimum operating crew of three operators does not include the STA role…" Although the STA was initially intended to be an interim or short-term measure implemented following the accident at Three Mile Island, the Commission's Policy Statement on Engineering Expertise on Shift (50 FR 43621), which was issued in October 1985 after NUREG-0737, states, "The STA has proven to be a worthwhile addition to the operating staff by providing an independent engineering and accident assessment capability, and we support continuation of this position."

NUREG-1791, Section 6.2, states that "[t]he task analysis data submitted in support of the exemption request should include the following, as applicable… identification of tasks that may affect the roles, responsibilities, or qualifications for licensed control personnel." During the August 2020 audit, the staff reviewed the results of a task analysis that NuScale performed as part of assessment of eliminating the STA position. The task analysis listed all tasks that were previously assigned to the STA and how they have been dispositioned with the elimination of the STA.

During the audit, the staff observed that some tasks previously assigned to the STA that involve assisting and making recommendations to the CRS and/or SM about whether an emergency action level (EAL) has been exceeded and whether plant equipment included in Technical Specifications is operable were listed as having been consolidated with tasks assigned to the CRS position. In the revised staffing plan, the CRS and SM roles can be combined, and so the individual in the combined CRS/SM position cannot assist or make recommendations to him or herself. Additionally, the staff did not observe any HSI design features that provide recommendations to the CRS/SM that are comparable to an additional operator who has been trained on EALs and Technical Specifications. Ensuring equipment included in technical specifications is operable helps ensure important plant equipment will be available if needed in an emergency, and proper implementation of the emergency plan, including identification of the correct the correct EAL during an abnormal event, helps to protect public health and safety.

1. In support of the proposal to eliminate the STA role, please revise the topical report to include a description of the task analysis NuScale conducted, including a summary of how NuScale dispositioned the tasks that were assigned to the STA, and NuScale's conclusions from the task analysis.

2. Please explain why, when the CRS/SM position is combined, there is not a need for an additional individual who is trained on operability determinations and emergency action

levels to provide independent assessment and advice to the CRS/SM.

NuScale Response:

NuScale Response to Question 1:

TR-0420-69456, "NuScale Control Room Staffing Plan," has been revised to add Section 3.4 "Shift Technical Advisor HFE Task Analysis and Conclusion" to explain how NuScale dispositioned the tasks assigned to the shift technical advisor and the conclusions from the task analysis.

This section discusses eight emergency plan tasks and 2 administrative tasks that were reassigned when the STA position was removed. These tasks were reassigned to the control room supervisor (CRS) when functioning in the dual role shift manager (SM)/CRS capacity, or the SM when the roles are split apart. There are also 25 tasks that are assigned to the SM/CRS that have now been identified that can be delegated to the RO 2/3, who also holds an SRO license.

The conclusion of the STA HFE task analysis has been revised as follows:

"Based on the low number of tasks, the high amount of time available to identify and complete the tasks, and the redundant nature of how specific HFE tasks assigned to the CRS can also be peer checked by the second senior reactor operator on the crew, NuScale has concluded that the control room staff as described in the topical report is adequate to support the task reassignment. There is adequate time for the second on-shift senior reactor operator to independently assess and provide advice to the CRS in a reasonable amount of time to engage off-site or off-shift resources for assistance."

NuScale Response to Question 2:

As part of the combined operating license (COL) applicant’s responsibilities, a conduct of operations manual will be developed to establish licensee expectations for use of peer checks, and practices to use independent assessment and additional advice and input when making decisions. It will be the COL holder’s responsibility to determine expectations for peer checks of emergency action level (EAL) classification and operability determinations. The human factors engineering task analysis identified that the responsibility for EAL classifications and operability determinations resides with the CRS. The event progression is slower at a NuScale Power Plant with less reliance on operator actions than at a typical large light water nuclear power plant.

There is adequate time for the second on-shift senior reactor operator to independently assess and provide advice to the CRS in a reasonable amount of time or to engage off-site or off-shift resources for assistance.

Initial License Operator Training programs that comply with standards comparable to ACAD 10-001, "Guidelines for Initial Training and Qualification of Licensed Operators," include specific training on the use of human performance tools, and on crew teamwork and dynamics.

Impact on Topical Report:

Topical Report TR-0420-69456, NuScale Control Room Staffing Plan, has been revised as described in the response above and as shown in the revision provided in LO-1220-73414.

Enclosure 3:

Affidavit of Mark Shaver, AF-103282

NuScale Power, LLC
1100 NE Circle Blvd., Suite 200 Corvallis, Oregon 97330 Office 541.360-0500 Fax 541.207.3928
www.nuscalepower.com

NuScale Power, LLC

AFFIDAVIT of Mark Shaver

I, Mark Shaver, state as follows:

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

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

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

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

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

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

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

(3) Public disclosure of the information sought to be withheld is likely to cause substantial harm to NuScale's competitive position and foreclose or reduce the availability of profit-making opportunities. The accompanying topical report reveals distinguishing aspects about the process by which NuScale develops its control room staffing plan.

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

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

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

(4) The information sought to be withheld is in Enclosure 1 titled "NuScale Safety Evaluation for NuScale Topical Report, TR-0420-69456, 'NuScale Control Room Staffing Plan'" The enclosure contains the designation "Proprietary" at the top of each page containing proprietary information. The information considered by NuScale to be proprietary is identified within double braces, "{{ }}" in the document.

(5) The basis for proposing that the information be withheld is that NuScale treats the information as a trade secret, privileged, or as confidential commercial or financial information. NuScale relies upon

the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC § 552(b)(4), as well as exemptions applicable to the NRC under 10 CFR §§ 2.390(a)(4) and 9.17(a)(4).

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

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

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

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

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

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

I declare under penalty of perjury that the foregoing is true and correct. Executed on June 2, 2021

Mark Shaver