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.
> {{
>
> }}

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. {{
}}

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.