RAIO-0519-64198

May 23, 2019

Docket No. 52-048

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 432 (eRAI No. 9415) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 432 (eRAI No. 9415)," dated April 23, 2018
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 432 (eRAI No.9415)," dated June 21, 2018

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

The Enclosure to this letter contains NuScale's supplemental response to the following RAI Question from NRC eRAI No. 9415:

- 18-46

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Carrie Fosaaen at 541-452-7126 or at cfosaaen@nuscalepower.com.

Sincerely,

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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9415

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9415

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

eRAI No.: 9415
Date of RAI Issue: 04/23/2018

NRC Question No.: 18-46

Regulatory Basis

10 CFR 52.47(b)(1) requires a design certification application to contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and should operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

The NRC uses 10 CFR 50.34(f)(2)(iii) as the basis to regulate the human factors aspects of a main control room design. This regulation indicates that designers of plants must apply state-of-the-art human factors principles when designing the main control room. Chapter 18 of the standard review plan (NUREG-0800) and NUREG-0711 direct NRC staff regarding the review of human factors considerations in the design of nuclear power plant control rooms. NUREG-0711 identifies design implementation as one of the twelve elements of an acceptable human factors program and provides acceptance criteria that staff use to review an applicant's design implementation (DI) implementation plan (IP).

Background Information

Design Implementation Objectives

The human factors design process described in NUREG-0711 considers design implementation to be one of the 12 elements necessary in a state-of-the-art human factors program. The design implementation element objectives found in Section 12.2 of NUREG-0711 are paraphrased below:

1. Verify that the as-built design conforms to the verified and validated design resulting from the human factors engineering (HFE) design process

2. Verify that the implementation of changes to the design consider the effects on human performance.

NuScale provided Revision 1 of "Human Factors Engineering Design Implementation Implementation Plan" for review with the design certification application.

Draft Standard ITAAC

A letter from NRC to NuScale dated April 8, 2016 (ML16096A121) contains a set of draft standard ITAAC that could be used in the design certification application. However, NRC staff note that the draft standard ITAAC specific to Human Factors (H01 and H02 in this document) may have been intended for a design certification application utilizing design acceptance criteria (DAC) for the human factors design. Revisions may be necessary to achieve ITAAC appropriate for the NuScale application. NuScale is not using DAC, and the design certification will include the NuScale standard plant MCR design, which is configured for the operation of 12 modules from one control room. NuScale committed to revising DCD Tier 1, Table 3.15-1, "Human Factors Engineering Inspections, Tests, Analyses, and Acceptance Criteria", in response to RAI No. 8781 (ML17172A712) resulting in one ITAAC for human factors engineering (HFE).

Description of the Issues

For the sake of clarity, staff will use the following terminology:

- **As-designed**: Refers to the HSI design described in the HSI RSR which will be the input to the HFE V&V process
- **As-designed, as modified by the V&V**: refers to the HSI design that includes all design changes necessary to resolve human engineering deficiencies (HEDs) that came out of the V&V process. The as-designed, as modified design is the output of the V&V, which includes the HED resolution processes. NuScale has committed to submitting the V&V results summary report prior to Phase 4 of the design certification review (ADAMS Accession No. ML16099A270).
- **As-designed, as modified by the DI**: refers to the design that incorporates the resolution of ultimately resolves any HEDs identified during the DI activities. This is the design that should match the "as-built" main control room design. The "as-designed, as modified by the V&V" design is the input to this process.

1. The wording in the ITAAC currently requires verifying the as-built HSI design to the as-designed HSI, as modified by the integrated system validation (ISV) report, which means comparing the as-built design to the design specifications for the standard, generic, 12-unit control room design validated during ISV (one part of the V&V process). However, after V&V, and prior to construction of the control room, a COL holder may make changes to the HSI design, control room configuration, and plant system design. The evaluation of those changes is one of the DI activities discussed in NUREG-0711, Section 12.4.1. The as-built control room HSI and configuration should therefore be verified to be consistent with the design that was validated, as modified by the DI activities.

If the wording in the ITAAC is not clarified, there could be confusion while implementing important changes to the design that occur during DI activities, and there may also be delays in closing the ITAAC. This confusion may inhibit necessary changes to the design caused by updates to the PRA (which may cause changes to important human actions and may affect procedures and training), site specific design features, and any other changes to the design that occur after the V&V is complete but before plant startup.

2. Section 4, "Addressing Important Human actions," of the DI IP is written as though important human actions will be entirely addressed during V&V for the standard plant. However, it is possible that as the COL's PRA evolves, additional risk-important human actions (RIHAs) may be identified that should be evaluated. Also, Section 2.0, "Design Implementation Assessments," says the as-built configuration is compared to the design documents used for ISV; however, as-built configuration should also be compared to the design documents modified during DI.

3. The DI IP describes a method for resolving and closing out HEDs. It appears that in some cases, unresolved design issues may no longer be tracked and the mechanism for communicating them with a COL holder is unclear.

An appropriate process is necessary to ensure that the COL holder will appropriately consider and implement the correct scope of activities during the design implementation process. Staff have reviewed the process described in the related documents and additional information is necessary to clarify and possibly modify the processes to ensure adequate outcomes. Please provide additional information responding to the questions below.

Question 1 – Revisions to the ITAAC: Clarification of Scope

Please explain how the acceptance criteria of the HFE ITAAC in DCD Tier 1, Table 3.15-1, Revision 1, is sufficient to address design changes that may result following V&V and prior to

construction. If it is not sufficient, please revise the ITAAC in DCD Tier 1, Table 3.15-1 to ensure that the as-built HSIs are consistent with the as-designed configuration of the MCR HSI as modified by design implementation activities.

Question 2 – Clarification of COL Applicant Role with DI IP & ITAAC

NUREG-0711, section 12.3 "Applicant Products and Submittals" states:

NUREG-0711 indicates that an RSR should be provided when the activities described in an implementation plan are complete. Given the nature of DI activities, staff expects that it is the responsibility of the COL holder to provide the RSR or make it available for review. However, this is not made explicit in the application.

Please clarify the strategy used to ensure that the full scope of the design implementation activities will be properly conducted and documented by the COL, and that the final results will ultimately be documented in a manner consistent with NUREG-0711, Sections 12.3 and 12.4. Clarify how the role of the COL applicant will be communicated to them using just the ITAAC or revise the application to provide appropriate COL action item(s) or additional ITAAC.

Please revise the DI IP, Sections 2 and 4 to account for changes that may occur after V&V and before plant startup.

Question 3 – Closure of HEDs that are not resolved

NUREG-0711 Criterion 12.4.1(3) states "*The applicant should verify that all HFE-related issues in the issue-tracking system are adequately addressed."*

Section 3.0 of "Human Factors Engineering Design Implementation Implementation Plan," Rev. 1, addresses the use of the Human Factors Engineering Issues Tracking System (HFEITS) for documenting and tracking Human Engineering Discrepancies (HEDs) that were generated in the human factors process and will be resolved during DI. Section 3.0 indicates that some HEDs "may be on-going due to anticipated technology or other advancements; however, all HEDs are closed prior to DI completion."

It is clear from Section 3.0 that the intent is to close all HEDs by the time that the DI RSR is complete. However, it also indicates that in some cases, it may not be advantageous to resolve HEDs by the end of DI. It is unclear how any remaining issues will ultimately be tracked and resolved by an eventual COL applicant based on Section 3.0 because all HEDs will be closed, regardless whether the issue is "on-going" or not.

Please clarify how on-going issues (which may include validation of site specific differences, scalability of the design, unit differences, modifications to the design that occurred after the V&V, operating experience from other operating NuScale plants, etc.) will be corrected by COL applicants if they are no longer documented or tracked. Also describe how it is determined which on-going issues can be closed without resolution.

NuScale Response:

This response supplements NuScale's previous response to eRAI 9415, Question 18-46 (ML18204A190). During an August 21, 2018 teleconference call, NRC Staff asked NuScale to provide additional information on the following staff concerns.

NRC Question 1: ITAAC 3.15-1 No. 1, as currently written in Rev 1 of the Tier 1 submittal, does not cover the appropriate scope to include the design implementation activities described in the design implementation (DI) implementation plan (IP).

NuScale Response to Question 1:

NuScale has revised the ITAAC and the DI IP. The DI IP revision provides clarity on HFE design turnover to the licensee and their responsibilities within the HFE design process following that turnover, including a clear description of the method by which the DI process will ensure the HFE ITAAC is properly evaluated.

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1	The configuration of the main control room HSI is consistent with the design verified and validation by the integrated system validation as reconciled by the Design Implementation Implementation Plan.	An inspection will be performed of the as-built configuration of MCR HSI.	A report exists and concludes the as-built configuration of main control room HSI is consistent with the design verified and validated by the integrated system validation as reconciled by the Design Implementation Implementation Plan.

NRC Question 2: Draft DI IP, Page 3 suggests that there is no need for a design implementation results summary report (RSR). Staff need the information in this report to adequately determine

that design changes made post-ISV have been analyzed to ensure that they will [not] introduce new human performance issues.

NuScale Response to Question 2:

Once the NuScale Design Certification is approved the HFE design cannot be changed unless the change meets the applicable design certification change control requirements (Section VIII of the NuScale Design Certification Rule or 10 CFR 52.63, as applicable. NUREG-0711 supports the change control process by providing a method to review design changes. The DI IP describes the method by which the HFE design will be turned over to a COL applicant and how the applicant will complete the DI activities including documenting design changes, maintaining the post V&V HFE design, and the method to compare the as-built configuration of the main control room to the final as-designed HSI configuration.

NRC Question 3:

The current plan indicates that all important human actions (IHAs) will be addressed by the V&V IP. Staff agree that this is an important part of NuScale's HFE program. This strategy adequately captures the results up to and through the integrated system validation (ISV) process; however, it does not capture any changes that may occur post ISV. Refinements to the PRA either due to design changes or improvements in the PRA fidelity may change IHAs (such as, by reducing or increasing the time available to perform the action). Staff will need to verify that any supporting analysis and/or validation activities are adequate to support the conclusions in the DI RSR. It's not clear how the staff will do this given the current plan.

NuScale Response to Question 3:

Once the NuScale Design Certification is approved the HFE design cannot be changed unless the change meets the applicable design certification change control requirements (Section VIII of the NuScale Design Certification Rule or 10 CFR 52.63, as applicable. NUREG-0711 supports the change control process by providing a method to review design changes. Following NRC approval of the V&V results summary report, the HFE design described in the HSI Design RSR will be the design that must be replicated by COL applicants referencing the design certification.

NRC Question 4:

Draft DI IP, Page 4 has the RSS stricken out. It is unclear why this change was made in this revision. It looks like it might be a deletion error because several initialism were also stricken. The staff would like to confirm that though.

NuScale Response to Question 4:

The deletion was intentional. The DI implementation plan, Section 1.2, "scope" identified activities to which the plan does not apply. Parts of the plan may be applicable to the remote shutdown station as it is treated as a local control station. Because the title does not occur again in the procedure it was deleted from the list of abbreviations in section 1.3.

NRC Question 5:

Draft DI IP, Page 8 changes HFE review to subject matter expert (SME) review - it's unclear why this change was made. Staff do not object to the use of SME, but HFE staff should be involved in the assessment to ensure that any changes do not introduce new human performance concerns.

NuScale Response to Question 5:

SME was used to reflect the inclusion of both HFE and Operations experts. Revision 2 of the Implementation plan has been revised to say "HFE and Operations subject matter expert (SME) review."

Impact on DCA:

Tier 1 Section 3.15, Tier 2 Section 14.3, and RP-0914-8544 "Human Factors Engineering Design Implementation Implementation Plan" have been revised as described in the response above and as shown in the markup provided in this response.

Human Factors Engineering Design Implementation Implementation Plan

May 2019
Revision 3
Docket: 52-048
NuScale Nonproprietary

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TABLES

Abstract

This implementation plan describes the methodology for conducting the design implementation element of the human factors engineering (HFE) program. Design implementation is an element of the HFE program that verifies conformance of the as-built design to the planned design. The Design Implementation element is complete once the HFE inspections, tests, analyses, and acceptance criteria (ITAAC) item is closed.

The methodology described is consistent with the applicable provisions of Section 12 of U.S. Nuclear Regulatory Commission, “Human Factors Engineering Program Review Model,” NUREG-0711, Rev. 3 (Reference 9.1.1).

Executive Summary

The methodology for design implementation ensures that the as-built HFE design of the NuScale Power plant accurately reflects the verified and validated design resulting from the human factors engineering design process. This implementation plan describes how ownership of the HFE program is transferred from NuScale to a licensee and the actions a licensee completes in order to close the HFE ITAAC. Design implementation activities include evaluation of those aspects of the design that were not addressed during human factors verification and validation. The methods used to verify that the final human-system interfaces and facility configuration, conform to the planned design include subject matter expert reviews and plant walkdowns. The HFE issues identified during these activities are documented, evaluated, and resolved in the licensee's quality assurance program description (QAPD).

1.0 Introduction

1.1 Purpose

This document is designed to be implemented by a licensee and ensures actions needed to address the HFE ITAAC are completed. Because a transition in ownership of HFE design, configuration control, and corrective action resolution must occur, specific transition criteria are provided. Prior to meeting these criteria NuScale maintains responsibility for HFE program and process controls. When transition criteria are met, NuScale will provide a turnover package as described in Section 2.0 and the licensee assumes responsibility for the HFE program and process controls.

This document provides the implementation plan (IP) for design implementation (DI) within the HFE program. DI demonstrates that the HFE program "as-built" design of the human-system interface (HSI) and facility configuration accurately reflects the verified and validated design resulting from the HFE design process. DI activities also include an evaluation of those aspects of the design that were not addressed during the human factors verification and validation (V&V) including new human error deficiencies (HEDs) identified after completion of the V&V.

Features evaluated during DI generally include those that cannot be accurately simulated:

- ergonomic considerations such as lighting and background noise
- HSIs outside of the main control room (MCR) but within the NuScale plant HFE program scope

Priority 3 HEDs identified during V&V and HEDs identified after completion of the V&V are tracked and resolved in accordance with Section 3.0 of this document.

Completion of DI activities ensures that the as-built HFE design conforms to the verified and validated design resulting from the HFE design process hereafter called the final as-designed HSI configuration. The HFE ITAAC tracks completion of DI activities and therefore, a results summary report (RSR) is not prepared for the DI element of the HFE program.

1.2 Scope

For the MCR and each local control station (LCS), the DI element confirms that:

- the as-built design matches the final as-designed HSI configuration.
- other aspects of the facility that were not simulated but are relevant to the overall HFE program are evaluated using an appropriate V&V method.
- HFE design changes made subsequent to completion of the V&V have been properly integrated into the final as-designed HSI configuration.

The HSIs, evaluated for conformance apply to the MCR and certain LCSs during normal, abnormal, and emergency operating conditions. This IP does not apply to maintenance or refueling activities, activities completed by craft/technical personnel (i.e., mechanical, electrical, or instrumentation and control (I&C), health physics, chemistry, engineering, or information technology), or activities associated with the technical support center, emergency operations facility, operations support center, or any other emergency response facilities (see Reference 9.2.1). This IP does not specifically review procedures as they are subject to the licensee's QA program and that includes verification and validation of new and changed procedures. It also does not specifically review training as the licensee has its own program that is required to use the systematic approach to training. New or changed training would be controlled and evaluated by the licensee's program.

1.3 Abbreviations and Definitions

Table 1-1. Abbreviations

Term	Definition
DC	design certification
DI	design implementation
HED	human engineering discrepancy
HFE	human factors engineering
HPM	human performance monitoring
HSI	human-system interface
IHA	important human action
IP	implementation plan
ISV	integrated system validation
ITAAC	inspections, tests, analyses, and acceptance criteria
LCS	local control station
MCR	main control room
NRC	Nuclear Regulatory Commission
QA	quality assurance
RSR	results summary report
SME	subject matter expert
V&V	verification and validation

2.0 Configuration Control of HSIs

Changes to the HSI design will be controlled under the NuScale Appendix B programs and processes and the applicable 10 CFR 52 Appendix, Section VIII.B.5 (50.59-like process). NuScale is responsible for maintaining HFE design configuration control until the turnover requirements are met.

NuScale design activities supporting Chapter 18 of the Design Certification (DC) are complete when the DC is approved by the NRC. Chapter 18 is supported by completion of the following:

- all priority 1 HEDs are closed
- retesting required for priority 1 HED closure is completed satisfactorily
- the V&V results summary report is submitted
- all NRC Requests for Additional Information are satisfactorily addressed

NuScale will be prepared to turnover responsibility for HFE program implementation to the licensee when:

- 10 CFR 52 Appendix specific to the NuScale DC is issued.
- the licensee's QAPD is approved by the NRC.

Approval of the QAPD establishes programs and processes comparable to those used in the NuScale HFE program. Turnover of the HFE program implementation responsibilities to the licensee is supported by the following:

- all priority 2 HEDs are closed
- retesting required for priority 2 HED closure is completed satisfactorily

Turnover of HFE responsibilities to the licensee marks the end of NuScale engineering activities associated with the DC Chapter 18 implementation.

When turnover requirements are met NuScale will provide the following material:

1. The HFE design configuration validated by the ISV.
2. HFE design changes and testing results demonstrating design change acceptability for all priority 1 HEDs identified after submittal of the V&V RSR.
3. HFE design changes and testing results demonstrating design change acceptability for all priority 2 HEDs that were not addressed in the V&V RSR.
4. HFE design changes made as a result of addressing priority 3 HEDs.

When the licensee assumes responsibility for the HFE program, they will track and resolve HEDs under their QAPD related programs and processes.

3.0 Design Implementation Assessments

Design implementation uses the following methods to verify that the as-built HSIs and facility configuration conform to the final as-designed HSI configuration:

- HFE and Operations subject matter expert (SME) review
- plant walkdowns

The licensee is responsible for completing assessments of the following elements:

- conditions that could not be accurately simulated in the ISV
- negative findings in the comparison of the as-built configuration to the final as-designed HSI configuration
- open priority 3 HEDs
- new HEDs identified as the design matures

Each of these elements could potentially identify the need for an HFE design change. The licensee's programs and processes determine when such changes are implemented. It is expected that some HFE design changes will not have sufficient priority to be implemented prior to the ITAAC closure. For those that do, the design change amends the as-designed HSI configuration post V&V HFE design. The amended design is used as the standard for verifying that the as-built configuration is consistent with the design. ITAAC closure is designed to verify the verified and validated HFE design is properly integrated with the final as-designed HSI configuration.

To accomplish this integration the licensee performs the following actions:

- the as-built design is compared to the final as-designed HSI configuration. Deviations are documented.
- each deviation is justified. If the deviation is caused by implementing an approved modification then the deviation is considered justified.
- deviations that cannot be justified are resolved in accordance with Section 4.0.
- when all deviations are justified, the deviations as a group are evaluated to determine if there is any collective significance that would invalidate the ISV conclusions.

3.1 Human System Interface Assessment

The DI assessments for software and hardware configurations confirm clear configuration-controlled design traceability for HSI components (alarms, controls, and indications) and peripheral equipment.

The DI assessment for HSI configuration is conducted by plant walkdown and SME reviews and includes:

- Conformance with HFE design documents such as the HFE style guide, display schematics, drawings and specifications
- Screen navigation

- Control functionality
- Automation functionality
- Alarm and notification functionality
- Procedure interface functionality

3.2 Facility Configuration Assessment

The DI assessment for facility configuration is conducted by performing plant walkdowns that include the:

- physical configuration of workstations, panels, and displays
- visibility and sight lines
- accommodations for communication
- inclusion of emergency plan and personal protection equipment
- lighting
- background noise
- environmental controls/conditions (e.g., temperature and humidity)

The evaluation of aspects of the facility not simulated (e.g., LCSs) but relevant to the overall HFE program include:

- a walkdown to confirm conformance to the latest approved HFE design documentation including the HFE style guide.
- a SME review of:
  - the suitability of the LCS for executing the operating procedures where operating procedures direct use of that LCS (i.e., typically not computer-based procedures).
  - the suitability of those procedures.

4.0 Human Factors Engineering Issue Resolution

The following milestones are associated with HED resolution:

- all priority 1 HEDs will be resolved prior to issuing the V&V RSR.

- all priority 2 HEDs generated during V&V activities and those identified after completion of the V&V are resolved by NuScale prior to turning over configuration HFE program control to the licensee.

- all priority 3 HEDs generated during V&V and those identified after completion of the V&V are either resolved by NuScale prior to turning over HFE program responsibilities to the licensee or transferred to the licensee.

The transferred HEDs and HEDs identified during the DI activities described in Section 3.0 are tracked and resolved in accordance with the licensee's QAPD. Some HEDs may be on-going due to anticipated technology or other advancements.

For each HED, an evaluation is conducted to determine:

- if the configuration is equivalent to the V&V HFE design. If equivalent, the basis for the equivalency shall be documented and design documentation revised as necessary.

- if a design change is needed to correct the as-built configuration so it conforms to the final as-designed HSI configuration.

- If the as-built configuration is different from the final as-designed HSI configuration but potentially acceptable. If potentially acceptable, a design change review is conducted to determine the significance of the differences between final as built HSI configuration and as-built configuration. If the design change review concludes that the design change is acceptable and has no impact on the completed ISV results, then a specific validation method (e.g., tabletop walkthrough, mockup, part-task simulator, or plant walkdown) is determined. If the ISV results are impacted by the design changes, the applicable portion(s) of ISV are repeated.

5.0 Addressing Important Human Actions

Important human actions (IHA) are identified, addressed, and tracked by the Treatment of Important Human Actions element of the HFE program. Features that provide for reliable implementation of the IHAs are incorporated into the HSI design (e.g., alarms, controls, indications, and procedures).

As described in the human factors V&V IP (Reference 9.2.2), IHAs are considered among the significant conditions, personnel tasks, and situational factors sampled during V&V activities as the ISV scenarios are developed. The ISV assesses the successful performance of the integrated crew and the HSI for IHAs. During V&V, HEDs are processed when discrepancies are found for any IHA. HEDs found during V&V are resolved as described in Section 4.0. A description of how the HFE program addressed IHAs is submitted as part of the V&V RSR.

6.0 Additional Considerations for Human Factors Engineering Aspects of Control Room Modifications

The licensee's responsibilities for HFE program implementation begin when the 10 CFR 52 Appendix specific to the NuScale DC is issued and the licensee's QAPD is approved. Approval of the QAPD establishes programs and processes comparable to those used in the NuScale HFE program. After assuming HFE program responsibility, a licensee institutes a human performance monitoring (HPM) program to evaluate impacts on human performance going forward. The HPM program evaluates design change proposals for HSI design, procedures, or training against the design bases established for the as-built design.

The licensee's HFE program should implement the guidance of NUREG-0711, Human Factors Engineering Program Review Model, Revision 3.

7.0 Results Summary Report

Completion of DI activities is tracked and confirmed by an ITAAC item. This ensures that the as-built design conforms to the final as-designed HSI configuration resulting from the HFE design process. Therefore, an RSR is not prepared for the DI element of the HFE program as part of design certification.

8.0 NUREG-0711 Conformance Evaluation

Table 8-1 indicates where each NUREG-0711, Rev. 3 (Reference 9.1.1) criterion is met in this IP.

Table 8-1. Conformance with NUREG-0711

Review Criteria Stated in NUREG-0711, Rev. 3	DI IP Section No. and paragraph
12.4 Review Criteria 12.4.1 Final HFE Design Verification for New Plants and Control Room Modifications 1. The applicant should evaluate aspects of the design that were not addressed in V&V by an appropriate V&V method. *Additional Information: Aspects of the design addressed by this criterion may include design characteristics, such as new or modified displays for plant-specific design features.*	Section 1.2, all paragraphs Section 3.0
2. The applicant should compare the final HSIs, procedures, and training with the detailed description of the design to verify that they conform to the planned design resulting from the HFE design process and V&V activities. This verification should compare the actual HSI, procedures, and training materials to design descriptions and documents. Any identified discrepancies should be corrected, or justified. *Additional Information: Final design means the design existing in the actual plant.*	Section 4.0, all paragraphs The human factors engineering process does not review procedures as they are subject to the licensee's QA program and that includes verification and validation of new and changed procedures. The human factors engineering process does not review training as the licensee has its own program that is required to use the systematic approach to training. New or changed training would be controlled and evaluated by the licensee's program.
3. The applicant should verify that all HFE-related issues in the issue-tracking system (Section 2.4.4) are adequately addressed.	Section 2.0, all paragraphs Section 4.0, all paragraphs
4. The applicant should provide a description of how the HFE program addressed each important HA.	Section 6.0, all paragraphs
12.4.2 Additional Considerations for Reviewing the HFE Aspects of Control Room Modifications In addition to any of the criteria above that are relevant to the modification being reviewed, the following should be addressed. 12.4.2.1 General Criteria for Plant Modifications 1. The applicant should provide reasonable assurance that the reactor fuel is safely monitored during the shutdown period while physical modifications to the control room are being made.	The remaining criteria are not applicable to the NuScale HFE program. They are to be addressed as part of the licensee HFE program in Section 6.0.

Review Criteria Stated in NUREG-0711, Rev. 3	DI IP Section No. and paragraph
2. The applicant should verify that modifications in the plant's procedures and training reflect changes in plant systems, personnel roles and responsibilities, and in HSIs resulting from the new systems.	The human factors engineering process does not review procedures as they are subject to the licensee's QA program and that includes verification and validation of new and changed procedures. The human factors engineering process does not review training as the licensee has its own program that is required to use the systematic approach to training. New or changed training would be controlled and evaluated by the licensee's program.
3. Installation should be planned to minimize disruptions to work of plant personnel.	Section 6.0
4. The applicant should verify that operations and maintenance personnel are fully trained and qualified to operate and maintain all modifications made to the plant before starting up with the new systems and HSIs in place.	Section 6.0
5. The applicant should have a plan to monitor start-up and initial operations after the modification to reasonably assure that: • operational and maintenance problems arising from personnel's interactions with the new systems, HSIs, and procedures are identified and addressed • personnel are sufficiently familiar with the new systems, HSIs, and procedures to support safe operations and maintenance • any negative transfer of training from the old removed HSIs to the corresponding new ones was identified and corrected • no new problems are created by coordinating tasks between the remaining old HSIs and new HSIs • no unanticipated negative effects on personnel interaction and teamwork have surfaced	Section 6.0
12.4.2.2 Modernization Programs Consisting of Many Small Modifications 1. The applicant should assure that each modification follows an HFE program that provides standardization and consistency (1) between old and new equipment, and (2) across the new systems being implemented.	Section 6.0
2. The applicant should verify that new modifications fulfill a clear operational need, and do not interfere with existing systems. *Additional Information: For example, the auditory alerts in a new HSI should not distract operators from addressing more important alarms.*	Section 6.0

Review Criteria Stated in NUREG-0711, Rev. 3	DI IP Section No. and paragraph
12.4.2.3 Modernization Programs Consisting of Large Modifications during Multiple Outages 1. Interim configurations may exist for long times (e. g., a refueling cycle), and therefore, applicants should verify that they are acceptable from both engineering and operations perspectives and that they meet regulatory requirements. The applicant's evaluations should include: • PRA evaluations to ensure minimizing high-risk situations • FSAR evaluations to assure defense against design basis accidents • technical-specifications evaluations to determine if changes are needed • defense in depth evaluations to ensure meeting the criteria in RG 1.174	Section 6.0
2. The applicant should perform task analysis for each interim configuration to verify that any task demands are known and do not degrade personnel performance.	Section 6.0
3. The applicant should update the HRA to address any unique tasks that may impact risk, as well as any changes to existing tasks due to the interim configuration.	Section 6.0
4. The applicant should verify that the HSIs needed to perform important tasks (as defined in Section 6) are consistent and standardized. Personnel should not have to use both old and new HSIs for different aspects of the same task.	Section 6.0
5. The applicant should develop procedures for temporary configurations of systems and HSIs that personnel use when the plant is not shutdown.	Section 6.0
6. The applicant should develop training for temporary configurations of systems, HSIs, and procedures that personnel can use when the plant is not shutdown.	Section 6.0
7. The applicant should consider the following aspects of V&V: • HFE Design Verification – Temporary configurations of the systems, HSIs, and procedures that operations and maintenance personnel employ when the plant is not shutdown should be reviewed to verify that their design is consistent with the principles of good HFE design (e.g., conforms to a plant-specific style guide or NUREG-0700). • HSI Task-Support Verification – Temporary configurations of the systems, HSIs, and procedures, which operations and maintenance personnel may use when the plant is not shutdown, should be reviewed to verify that their design supports the intended tasks. – Additional Information: For example, if a temporary configuration of plant systems introduces special monitoring requirements, then the HSIs should give the necessary information. • ISV - Interim configurations should be validated if so warranted by the risk significance of the personnel tasks affected by them.	Section 6.0
12.4.2.4 Modernization Programs Where both Old and New Equipment are Left in Place 1. The applicant should identify and address negative effects on personnel performance due to control room or HSI clutter resulting from using old and new HSIs in parallel.	Section 6.0
2. The applicant should identify and address negative effects on personnel performance resulting from the simultaneous presence of parallel alarms.	Section 6.0
3. The applicant should identify and address negative effects on personnel performance resulting from differences in information from old and new systems on the same parameter or equipment.	Section 6.0

Review Criteria Stated in NUREG-0711, Rev. 3	DI IP Section No. and paragraph
4. The applicant should identify and address any safety concerns from providing controls that operators can access from two different HSIs. Additional Information: For example, a switch may be installed to select which HSI will control the equipment, thus preventing simultaneous control inputs.	Section 6.0
12.4.2.5 Modernization Programs Where New Non-functional HSIs are in Place in Parallel with Old Functional HSIs 1. The applicant should evaluate the potential for negative effects on personnel performance due to control room or HSI clutter resulting from having old and new HSIs available in parallel. Where safety concerns are identified, the applicant should take measures to improve the HSIs.	Section 6.0
2. The applicant should ensure that the non-functional state of HSIs is clearly indicated.	Section 6.0

9.0 References

9.1 Source Documents

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

9.2 Referenced Documents

9.2.1 Human Factors Engineering Program Management Plan, RP-0914-8534.

9.2.2 Human Factors Verification and Validation Implementation Plan, RP-0914-8543.

3.15 Human Factors Engineering

3.15.1 Design Description

System Description

The human factors engineering (HFE) program design process is employed to design the control rooms and the human-system interfaces (HSIs) and associated equipment while relating the high-level goal of plant safety into individual, discrete focus areas for the design.

The HFE and control room design team establish design guidelines, define program-specific design processes, and verify that the guidelines and processes are followed. The scope of the HFE program includes the following:

- location and accessibility requirements for the control rooms and other control stations
- layout requirements of the control rooms, including requirements regarding the locations and design of individual displays and panels
- basic concepts and detailed design requirements for the information displays, controls, and alarms for HSI control stations
- coding and labeling conventions for control room components and plant displays
- HFE design requirements and guidelines for the screen-based HSI, including the actual screen layout and the standard dialogues for accessing information and controls
- requirements for the physical environment of the control rooms (e.g., lighting, acoustics, heating, ventilation, and air conditioning)
- HFE requirements and guidelines regarding the layout of operator workstations and work spaces
- corporate policies and procedures regarding the verification and validation of the design of HSI

RAI 18-43

The HFE program applies to the design of the main control room (MCR) and the remote shutdown station. The HSI of the technical support center, the emergency operations facility, and local control stations (LCS) are derivatives of the main control room (MCR) HSI. The design of local control station is accomplished concurrently with the applicable system design and follows guidelines established by the HFE and control room design team.

Design Commitments

- The MCR design incorporates HFE principles that reduce the potential for operator error.

RAI 18-46S1

- The ~~as-built~~configuration of the MCR HSI is consistent with the ~~final~~ design ~~specifications~~verified and validated by the integrated system validation ~~test~~as reconciled by the Design Implementation Implementation Plan.

3.15.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 3.15-1 contains the inspections, tests, and analyses for the HFE.

RAI 14.03.09-1, RAI, 14.03.09-2, RAI 14.03.09-3, RAI 18-46S1

Table 3.15-1: Human Factors Engineering Inspections, Tests, Analyses, and Acceptance Criteria

No.	Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1.	The configuration of the ~~as-built~~ main control room HSI is consistent with the ~~final~~ design verified and ~~specifications~~ validated by the integrated system validation as reconciled by the Design Implementation Implementation Plan.~~test.~~	An inspection will be performed of the as-built configuration of MCR HSI.	~~The~~A report exists and concludes the as-built configuration of main control room HSI is consistent with the design verified and validated by the integrated system validation as reconciled by the Design Implementation Implementation Plan.~~ as-designed configuration of main control room HSI as modified by the Integrated System Validation Report.~~

RAI 09.01.04-1, RAI 09.05.01-6, RAI 14.03.02-1, RAI 14.03.02-2, RAI 14.03.03-1, RAI 14.03.03-6, RAI 14.03.03-7, RAI 14.03.03-8, RAI 14.03.07-1, RAI 14.03.08-1S1, RAI 14.03.09-1, RAI 14.03.09-2, RAI 14.03.09-3, RAI 14.03.12-2, RAI 14.03.12-3, RAI 18-46S1

Table 14.3-2: Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference(1)

ITAAC No.	System	Discussion	DBA	Internal/External Hazard	Radiological	PRA & Severe Accident	FP
03.01.01	CRH	Testing is performed on the CRE in accordance with RG 1.197, "Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors," Revision 0, to demonstrate that air exfiltration from the CRE is controlled. RG 1.197 allows two options for CRE testing; either integrated testing (tracer gas testing) or component testing. Section 6.4 Control Room Habitability, describes the testing requirements for the CRE habitability program. Section 6.4 provides the maximum air exfiltration allowed from the CRE. In accordance with Table 14.2-18, a preoperational test using the tracer gas test method demonstrates that the air exfiltration from the CRE does not exceed the assumed unfiltered leakage rate provided in Table 6.4-1: Control Room Habitability System Design Parameters for the dose analysis. Tracer gas testing in accordance with ASTM E741 will be performed to measure the unfiltered in-leakage into the CRE with the control room habitability system (CRHS) operating.			X		
03.01.02	CRH	The CRHS valves are tested by remote operation to demonstrate the capability to perform their function to transfer open and transfer closed under preoperational temperature, differential pressure, and flow conditions. In accordance with Table 14.2-18, a preoperational test demonstrates that each CRHS valve listed in Tier 1 Table 3.1-1 strokes fully open and fully closed by remote operation under preoperational test conditions. Preoperational test conditions are established that approximate design-basis temperature, differential pressure, and flow conditions to the extent practicable, consistent with preoperational test limitations.			X		

Table 14.3-2: Shared/Common Structures, Systems, and Components and Non-Structures, Systems, and components Based Design Features and Inspections, Tests, Analyses, and Acceptance Criteria Cross Reference[(1)] (Continued)

ITAAC No.	System	Discussion	DBA	Internal/External Hazard	Radiological	PRA & Severe Accident	FP
03.15.01	HFE	Section 18.11, Design Implementation, describes the implementation of HFE aspects of the plant design. The Design Implementation activities verify that the final MCR is consistent with the verified and validated design resulting from the HFE design process. An ITAAC inspection is performed to verify that the as-built configuration of main control room HSI is consistent with the final as-designed HSI configuration. As used here, the final as-designed HSI configuration is the COL holder's configuration-controlled design, which includes changes made subsequent to integrated system validation under a licensees configuration control process and includes resolution of human engineering discrepancies.~~An ITAAC inspection is performed to verify that the as-built configuration of main control room HSI is consistent with the as-designed configuration of main control room HSI as modified by the Integrated System Validation Report.~~					
03.16.01	SEC	Section 13.6 discusses that the physical security system design provides the capabilities to detect, assess, impede, and delay threats up to and including the design basis threat, and to provide for defense-in-depth through the integration of systems, technologies, and equipment. Technical Report TR-0416-48929, "NuScale Design of Physical Security Systems," provides safeguards and security-related information that describes security design bases and requirements for security SSC. Vital equipment and vital area are discussed in the report. An ITAAC inspection is performed of the as built vital equipment to verify that the equipment is located in a vital area.					