April 29, 2019 Docket No. 52-048

U.S. Nuclear Regulatory Commission
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SUBJECT: NuScale Power, LLC Submittal of "Human Factors Engineering Design Implementation Implementation Plan," RP-0914-8544, Revision 2

REFERENCE: Letter from NuScale Power, LLC to U.S. Nuclear Regulatory Commission, “NuScale Power, LLC Submittal of Third Set of Human Factors Engineering Documentation for Design Certification Application”, Dated December 29, 2016 (ML16364A348)

NuScale Power, LLC (NuScale) hereby submits Revision 2 of the “Human Factors Engineering Design Implementation Implementation Plan,” RP-0914-8544.

Enclosure 1 contains the report entitled “Human Factors Engineering Design Implementation Implementation Plan,” RP-0914-8544, Revision 2.

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

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

Sincerely,

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Enclosure: "Human Factors Engineering Design Implementation Implementation Plan," RP-0914-8544, Revision 2

Enclosure:

"Human Factors Engineering Design Implementation Implementation Plan," RP-0914-8544, Revision 2

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Human Factors Engineering Design Implementation Implementation Plan

April 2019
Revision 2
Docket: 52-048
NuScale Nonproprietary

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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 9.2.3).

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, facility configuration, procedures, and training program 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 (QA) policy related programs and processes. Any changes to the human-system interfaces are addressed by the licensee.

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 NuScale HFE program. DI demonstrates that the HFE program "as-built" design of the human-system interface (HSI), facility configuration, procedures, and training program 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 post V&V HFE design. 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 post V&V HFE design.
- 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 post V&V HFE design.

The HSIs, procedures, and training program 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).

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 post V&V 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 QA policy is approved by the NRC.

Approval of the QA policy 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. The procedures and training documentation used to support the ISV.
3. NuScale Generic Technical Guidelines (GTGs) for emergency procedures.
4. HFE design changes and testing results demonstrating design change acceptability for all priority 1 HEDs identified after submittal of the V&V RSR.

5. HFE design changes and testing results demonstrating design change acceptability for all priority 2 HEDs that were not addressed in the V&V RSR.

6. 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 QA policy related programs and processes.

3.0 Design Implementation Assessments

Design implementation uses the following methods to verify that the final HSIs, facility configuration, procedures, and training program conform to the post V&V HFE design:

- 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 post V&V HFE design
- 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 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 amended HFE design is properly integrated with the post V&V HFE design.

To accomplish this integration the licensee performs the following actions:

- the as-built design is compared to the post V&V design. 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.

3.3 Procedures and Training Material Assessment

The DI assessment of procedures and training material compares the final HSIs, procedures, and training material with the post V&V HFE design and the procedures and training material supporting the development of that design. Any identified discrepancies should be corrected, or justified.

Emergency operating procedures should be evaluated against the GTGs. The GTGs provide the design basis for these procedures and are a more authoritative source than the emergency procedures used for the ISV.

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 the licensee's QA policy programs and processes. 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, procedure, or training design is equivalent to the V&V HFE design. If equivalent, the basis for the equivalency shall be documented and design, procedure and training documentation revised as necessary.
- if a design change is needed to correct the as-built configuration so it conforms to the post V&V HFE design.
- If the current design is different from the post V&V design but potentially acceptable. If potentially acceptable, a design change review is conducted to determine the significance of the differences between planned and as-built. 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.
- if procedure changes are necessary, procedural changes are validated in accordance with the licensee's procedure change process.
- if training changes are necessary. Training changes are validated in accordance with the licensee's program for Systematic Approach to Training.

5.0 Addressing Important Human Actions

Important human actions (IHA) are determined, 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 each IHA 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 QA policy is approved. Approval of the QA policy 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 verified and validated design 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 9.2.3) 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
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 5.0, 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.
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.	Section 6.0
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

Review Criteria Stated in NUREG-0711, Rev. 3	DI IP Section No. and paragraph
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
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

Review Criteria Stated in NUREG-0711, Rev. 3	DI IP Section No. and paragraph
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
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.