Enclosure 2:

"Human Factors Engineering Treatment of Important Human Actions Implementation Plan," RP-0914-8539-NP, Revision 0, nonproprietary version

Human Factors Engineering Treatment of Important Human Actions Implementation Plan

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Revision 0

NuScale Nonproprietary

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N/A

1.0 Introduction

1.1 Purpose

This implementation plan (IP) for treatment of important human actions (TIHA) describes an element of the NuScale Power human factors engineering (HFE) program.

The objective of the TIHA program element is to provide an overview of the processes for

- identifying important human actions (IHA), which collectively include risk-important human actions (RIHA) contained in the probabilistic risk assessment (PRA) and deterministically-important human actions (DIHAs) from the transient and accident analysis (TAA) and diversity and defense-in-depth coping analysis (D3CA)
- addressing IHAs in the NuScale Power HFE program, specifically the function allocation (FRA/FA), task analysis (TA), and human-system interface (HSI) design as described in the IPs for those elements (References 6.2.3, 6.2.4, and 6.2.6 respectively).

1.2 Scope

The scope of the TIHA program element is the identification and treatment of IHAs in the overall HFE program. Specific treatment of IHAs is described in the FRA/FA IP (Reference 6.2.3), the TA IP (Reference 6.2.4), and the HSI design IP (Reference 6.2.6). A human engineering discrepancy (HED) is initiated for any IHA which cannot be sufficiently treated during the specific phase of the HFE program element in process. IHA-related HEDs are resolved during human factors verification and validation as described in Section 3.1.7.

1.3 Abbreviations and Definitions

Table 1-1 Abbreviations

Term	Definition
DCD	design control document
DIHA	deterministically-important human actions
D3CA	diversity and defense-in-depth coping analysis
FRA/FA	functional requirements analysis / function allocation
FS	functional specification
HED	human engineering discrepancy
HEP	Human error probability
HFE	human factors engineering
HFEITS	human factors engineering issue tracking system
HRA	human reliability analysis
HSI	human-system interface
HPM	human performance monitoring
I&C	instrumentation & control
IP	implementation plan
LCS	local control station
MCR	main control room
NPP	nuclear power plant
NRC	Nuclear Regulatory Commission

Term	Definition
NUREG	NRC technical report designation (Nuclear Regulatory Commission)
OER	operating experience review
PRA	probabilistic risk assessment
RIHA	risk-important human action
RSS	remote shutdown station
SA	situation awareness
SME	subject matter expert
SRO	senior reactor operator
TA	task analysis
TAA	transient accident analysis
T&E	testing & evaluation
TIHA	treatment of important human actions
V&V	verification & validation
VDU	visual display unit

Table 1-2 Definitions

N/A

2.0 Determining Important Human Actions

Important human actions are determined during probabilistic risk assessment (PRA) and in the diversity and defense-in-depth coping analysis (D3CA) and the transient accident analysis (TAA). For the purposes of the HFE program and treatment of IHAs, no distinction is made between risk-important human actions (RIHA) from the PRA and deterministically-important human actions (DIHA) from the D3CA and TAA.

2.1 Risk-Important Human Action Identification

The methodology for identifying risk-important systems, structures, and components is described in the Risk Significance Determination Topical Report (Reference 6.2.8). RIHAs are those human actions to operate systems or components which are above the risk-significance thresholds described in Reference 6.2.8.

The methodology for identifying RIHAs is in conformance with NUREG/CR-1278, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications," (Reference 6.1.5) in that RIHAs have the following characteristics

- Developed from the Level 1 (core damage) PRA and Level 2 (release from containment) PRA, for power operation, low power and shutdown, including both internal and external events
- Developed using selected importance measures and PRA sensitivity analyses to provide reasonable assurance that an important action (or multiple actions in the same scenario) is not overlooked because of the selection of the measure or the use of a particular assumption in the analysis

RIHAs are listed in the TIHA results summary report (RSR) (see Section 4.0). HFE characteristics assumed in the PRA that contribute to human error probability (HEP) are included. These HFE characteristics are confirmed in subsequent HFE program elements, as described in Section 3.1. Design features initiated to minimize associated risks are described in the HSI Design IP (Reference 6.2.6).

The methodology for identifying RIHAs includes the following considerations (Reference 6.1.5)

- identify interactions of people with systems and components
- analyze interfaces to see if performance shaping factors are adequate to support the tasks that people have to perform
- identify potential problem areas in equipment design, written procedures, plant policy and practice, people skills, and other factors likely to result in human error
- decide which problems have sufficient potential impact on the system to warrant changes
- develop candidate solutions for problems
- evaluate estimated consequences of changes to ensure that they improve system reliability and availability of safety systems and that no additional serious problems will result from them

2.2 Deterministically-Important Human Action Identification

DIHAs are identified in the TAA or D3CA.

DIHAs are operator actions directly credited to mitigate an abnormal event and achieve plant stabilization when the applicable automatic actions (such as reactor trip or engineered safety feature actuation) are not triggered.

Operator actions 1) to confirm automatic actions, 2) required for long-term decay heat removal or reactivity control, or 3) needed to maintain a stable plant condition for the long term, are not DIHAs even though they may be identified in the TAA or D3CA.

HFE team subject matter experts (SMEs) review each event scenario described in the TAA and D3CA to extract DIHAs.

DIHAs are listed in the TIHA RSR (see Section 4.0). HFE characteristics and the time available to execute these actions are included in the RSR. These HFE characteristics are confirmed by HFE program elements that are performed subsequent to TIHA as described in Section 3.1, below. These subsequent HFE program elements also confirm that there is adequate margin between the time available and time required to execute each DIHA.

3.0 Integration of Important Human Actions

3.1 Addressing Important Human Actions in Other Human Factors Engineering Program Elements

IHAs are considered during operating experience review (OER), FRA/FA, TA, HSI design, procedure development, and training program development. The following sections explain how IHAs are addressed.

The HFE program itself is iterative in that elements of the program are input to other elements and some design issues are only resolved by changing assumptions or re-analyzing based on new data. IHAs discovered during HFE analyses (i.e., OER, FRA/FA, and TA) are tracked as HEDs, resolved during HFE design activities (HSI design, procedure development, and training program development), and verified during human factors verification and validation and/or design implementation activities. Resolution of IHA-related HEDs may result in changes to or re-work of HFE analyses.

HFE program activities, including TIHA, fall within the design control process as described in Reference 6.2.1, which includes provisions for design changes and revision control for all NuScale plant systems. Proposed design changes are screened for acceptability and processed in accordance with department and project procedures. The design change request process includes an evaluation of the impact on the HFE analyses and directs modification as appropriate.

3.1.1 Addressing Important Human Actions during Operating Experience Review

Potential IHAs are determined early in the NuScale plant design process as described in Section 2.0. These potential IHAs are recorded in the OER database (Reference 6.2.2) so that the information is available during the issue analysis and review portion of OER. Each operating experience item analyzed and entered into the OER database is evaluated against the list of NuScale potential IHAs to determine if the operating experience had either a positive or negative impact on the human action. OER issues that indicate potential IHAs are tracked in the human factors engineering issues tracking database for resolution during appropriate HFE program elements. HEDs are generated for OER issues related to identified NuScale plant IHAs (Reference 6.2.2).

3.1.2 Addressing Important Human Actions during Functional Requirements Analysis and Function Allocation

FRA identifies functions to be performed to satisfy plant safety objectives. FRA is a top-down analysis starting with plant goals and high-level functions that are then broken down into success paths addressing operating modes and conditions. FA is the allocation of the control associated with each high-level function to human, machine, or shared control. FA is performed to ensure that plant design and allocation of control support operator vigilance and maintain acceptable workload levels. FRA/FA verifies that the IHAs identified in human reliability analysis (HRA) are appropriately allocated. HEDs are generated for IHAs for which evaluation criteria such as workload and time margin are not met (Reference 6.2.3).

3.1.3 Addressing Important Human Actions during Task Analysis

As described in the TA IP (Reference 6.2.4), tasks involving IHAs receive detailed TA including time validation of the assumptions. The TA confirms the assumptions about HFE characteristics used in the PRA to determine HEPs and the assumptions used in

the TAA and D3CA to conclude that operators can execute DIHAs within the time available. The final TA results in a complete inventory of alarms, controls, and indications to be implemented on the HSIs. The availability of HSIs to conduct IHAs, the associated situation and performance-shaping factors, the action complexity, and any times when adverse synergistic effects are created by combination of primary and secondary tasks are also confirmed during TA. The TA also assesses the operator workload when conducting the IHA (for individual or overall operating crew as appropriate) and confirms that the IHA can be carried out within the time available. The TA generates HEDs for any IHA that result in excessive workload conditions or any IHA that cannot be executed with adequate margin between the time available and the time required.

3.1.4 Addressing Important Human Actions during Human-System Interface Design

During HSI design (Reference 6.2.6), assumptions regarding HSI characteristics for IHAs are verified (e.g., reduction of time required for human actions via simplified or reduced navigation or by development of spatially dedicated continuously visible (SDCV) HSI or by establishing that alarms associated with IHAs are high-priority alarms).

The following HSI design considerations are included to reduce the probability of human errors for IHAs

- {{

}}[3(a)-(c)]

3.1.5 Addressing Important Human Actions during Procedure Development

System design specifications include basic operation sequences and/or guidance, which comply with task performance requirements for IHAs as design assumptions. The operating procedures are developed to meet the operation sequences and guidance in the system design specifications.

{{

}}[3(a)-(c)]

3.1.6 Addressing Important Human Actions during Training Program Development

Basic operational guidance and special annotations for conducting operations for plant systems are addressed and described in system design specifications. Training materials and the training program include guidance and special annotations for IHAs, {{

}}$^{3(a)-(c)}$

3.1.7 Addressing Important Human Actions during Human Factors Engineering Verification and Validation

The adequacy of the HSI design to support operator performance of IHAs is confirmed in the integrated system validation (ISV) process (Reference 6.2.7). Consideration of IHAs during ISV involves defining simulator scenario initiating events with system and component failures which challenge the operators to bring the plant to a safe state while following procedures. The scenarios addressed in the ISV address the IHAs, dominant sequences, systems, and events.

The ISV assesses whether all needed task-support HSIs are present and whether the HSIs comply with the governing HFE guidelines to support successful performance of IHAs. The ISV assesses the successful performance of the integrated crew and the HSI for IHAs. HEDs are processed when discrepancies are found for any IHA.

The ability of operators to execute IHAs associated with a set of scenarios within the time available as defined in the analyses that identified the IHA is an ISV acceptance criterion. The V&V program element (Reference 6.2.7) is not considered complete until the ISV acceptance criteria are met. Other issues identified during the V&V related to IHAs are documented as HEDs and are resolved after V&V.

3.2 Additional Considerations for Reviewing the Human Factors Engineering Aspects of Plant Modifications

After completion of start-up testing and provisional turn over, 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 design change proposal evaluation considers HEDs in the human factors engineering issues tracking system (HFEITS) regardless of which stage of the design in which they were initiated. IHAs and their integration in other aspects of the HFE program which are invalidated by design changes are re-evaluated to support plant modification without reducing human performance.

A licensee's design change process is governed by regulatory requirements such as 10 CFR 50.59, "Changes, Tests, and Experiments".

4.0 Treatment of Important Human Actions Results Summary Report

IHAs are documented in the TIHA RSR.

Documentation of IHAs includes

- the source of the IHA (event for which an IHA is identified – multiple events may be associated with a single IHA)
- amount of time required for operation (most limiting in the case of multiple events for a single IHA)
- HFE characteristics of the IHA
- what alarms, controls, indications, and procedures are used to perform the IHA
- who performs the IHA, e.g., reactor operator, equipment operator
- cognitive, physical, and emotional stresses anticipated on the operator at the time IHA is performed
- type of task associated with the IHA, i.e., step-by-step or dynamic
- assumptions associated with the IHA to be confirmed in subsequent program HFE program elements, e.g., procedural guidance is assumed to be symptom-based (operators maintain parameters rather than trying to troubleshoot the cause)

When IHAs are identified and integrated with the design, a TIHA RSR is compiled.

The TIHA RSR includes

- a TIHA results overview, including the principal findings
- the TIHA execution results, including details demonstrating compliance with the methodology described in Sections 2.0 and 3.0 above
- identified RIHAs, the source of those RIHAs, and the assumed HFE characteristics
- identified DIHAs, the source of those DIHAs, the assumed HFE characteristics
- HAs identified to be not DIHAs, and the basis for that conclusion
- a summary of how any identified IHAs are integrated in the other HFE program elements.

5.0 NUREG-0711 Conformance EVALUATION

Table 5-1 indicates where each NUREG-0711, Revision 3 criterion is met in this IP.

Table 5-1. Conformance with NUREG-0711

Review Criteria Stated in NUREG-0711, Rev. 3	TIHA IP Section No. and paragraph
7.4 Review Criteria (1) The applicant should identify risk-important HAs from the PRA/HRA. *Additional Information*: The NRC's technical branch responsible for PRA reviews the acceptability of the applicant's methodology for identifying risk-important human actions. The human factors engineering staff is responsible for ensuring that risk-important HAs included in the HFE design process are the same as those identified in Chapter 19. NRC reviewers should be aware that risk- important HAs may be distributed throughout multiple Chapter 19 tables, a practice that has caused delays in completing reviews.	Section 2.1, all paragraphs
(2) Applicants should identify deterministically-important HAs from the following licensing analyses: • operator actions credited in the DCD/FSAR Chapter 15 accident and transient analyses • operator actions identified in the D3 coping analyses performed for DCD/FSAR Chapter 7, as specified in Section 1 and 2 of Interim Staff Guidance DI&C-ISG-02, *Diversity and Defense in Depth (D3) Issues* (NRC, 2009) *Additional Information*: The HFE reviewer should coordinate with the appropriate NRC technical staff to ensure that the operator actions credited in the Chapter 15 accident and transient analysis and D3 coping analyses are correctly identified.	Section 2.2, all paragraphs

Review Criteria Stated in NUREG-0711, Rev. 3	TIHA IP Section No. and paragraph
(3) The applicant should specify how important HAs are addressed by the HFE program, in Function Allocation, Task Analysis, HSI design, Procedural Development, and Training Program Development, in order to minimize the likelihood of human error and facilitate error-detection and recovery capability. *Additional Information:* The applicant's treatment of important HAs will help ensure that the design supports these actions, and that they are within acceptable human performance capabilities (e.g., within time and workload requirements).	Section 3.1, all paragraphs
(4) Additional Considerations for Reviewing the HFE Aspects of Plant Modifications – In addition to any of the criteria above that relate to the modification being reviewed, the applicant should address the following considerations: • Whether the modification changes any of the important HAs. If so, the necessary analyses of this element should be performed to ensure that the design of the plant still addresses them appropriately. • Whether there are new important HAs based on the modification. If so, they should be considered using the methods of this element. *Additional Information*: NRC IN 97-78 and NUREG-1764 contain valuable information and guidance on modifications and important human actions.	N/A, Section 3.2

6.0 References

6.1 Source Documents

6.1.1 NUREG-0700, Rev. 2. Human-System Interface Design Review Guidelines, May 2002.

6.1.2 NUREG-0711, Rev. 3. Human Factors Engineering Program Review Model, November 2012.

6.1.3 NUREG-1764, Guidance for the Review of Changes to Human Actions, September 2007.

6.1.4 NUREG/CR-4772, Accident Sequence Evaluation Program Human Reliability Analysis Procedure, February 1987.

6.1.5 NUREG/CR-1278, Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications, August 1983.

6.2 Referenced Documents

6.2.1 NuScale Human Factors Engineering Program Management Plan, NP-RP-0914-8534.

6.2.2 NuScale Human Factors Engineering Operating Experience Review Implementation Plan, NP-RP-0914-8535.

6.2.3 NuScale Human Factors Engineering Functional Requirements Analysis and Function Allocation Implementation Plan, NP-RP-0914-8536.

6.2.4 NuScale Human Factors Engineering Task Analysis Implementation Plan, NP-RP-0914-8537.

6.2.5 NuScale Human Factors Engineering Staffing and Qualifications Implementation Plan, NP-RP-0914-8538.

6.2.6 NuScale Human Factors Engineering Human-System Interface Design Implementation Plan, NP-RP-0914-8540.

6.2.7 NuScale Human Factors Engineering Verification and Validation Implementation Plan, NP-RP-0914-8543.

6.2.8 NuScale Risk Significance Determination Topical Report, TP-0515-13952.