Enclosure 3:

"Human Factors Engineering Task Analysis Implementation Plan," RP-0914-8537-NP, Revision 0, Nonproprietary version

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Human Factors Engineering Task Analysis Implementation Plan

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NuScale Nonproprietary

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1.0 Introduction

1.1 Purpose

This implementation plan (IP) describes the methodology for conducting the NuScale Power, LLC (NuScale) task analysis (TA) as part of the human factors engineering (HFE) program.

For the purposes of this IP, human actions (HA) are determined from the functional allocation (FA) process. Related HAs are combined into groups to form a task. HAs include manual controls, supervision of automated functions, manual back up of automated functions, and in some cases communications. Inputs to task analysis also include HAs found to be risk significant during human reliability analysis (HRA) and HAs or tasks found during the operating experience review (OER) to cause errors in other operating nuclear plants or systems with similar human-system interface (HSI) technology. HAs are used in succeeding HFE program elements (staffing and qualifications, HSI design) to define the roles and responsibilities of plant personnel.

The purpose of TA is to systematically determine the requirements for information, control, and task support. The TA results establish HSI inventory requirements, including alarms, controls, displays, procedures, and training programs to support accomplishment of tasks. TA encompasses a range of plant operating conditions, including startup, normal operations, low-power and shutdown conditions, transient conditions, abnormal conditions, emergency conditions, and severe accident conditions.

1.2 Abbreviations and Definitions

Table 1-1. Abbreviations

Term	Definition
D3CA	diversity and defense-in-depth coping analysis
DIF	difficulty, importance, and frequency
EOF	emergency operations facility
FRA & FA	functional requirements analysis & function allocation
HA	human action
HED	human engineering discrepancy
HFE	human factors engineering
HFEITS	human factors engineering issue tracking system
HRA	human reliability analysis
HSI	human-system interface
I&C	instrumentation and control
IHA	important human action
IP	implementation plan
K&A	knowledge and abilities
LCS	local control station
MCR	main control room
OER	operating experience review
OSD	operational sequence diagram

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Term	Definition
P&ID	process and instrumentation diagram
PRA	probabilistic risk assessment
RSS	remote shutdown station
S&Q	staffing and qualifications (analysis)
SME	subject matter expert
TA	task analysis
TAA	transient accident analysis
TSC	technical support center

Table 1-2. Definitions

Term	Definition
task	A well-defined unit of work having an identifiable beginning and end which is a measurable component of a specific job.
subtask	A discrete human action executed to support a task. Multiple subtasks are often required to complete a task. A subtask may be cognitive or physical.
element	Is the smallest logically and reasonably definable unit of behavior required in completing a task or subtask.

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2.0 Scope

2.1 Applicable Facilities

Tasks to be analyzed are those performed by licensed and non-licensed operators in the following locations:

- main control room (MCR)
- technical support center (TSC) - limited to tasks that directly support event mitigation and plant stabilization by the operating crew
- remote shutdown station (RSS)
- emergency operations facility (EOF) - limited to defining the plant safety information requirements (i.e., safety parameter display system) and requirements for voice communication with plant operators in the MCR, RSS, and TSC
- local control stations (LCS) - for LCSs specific to use by maintenance and support personnel (e.g., chemistry, radiological control, instrumentation and controls), the tasks analyzed include only those related to communication between the operators in the MCR and RSS and the personnel using these LCSs

2.2 Types of Tasks

Tasks to be analyzed include important human actions (IHA) determined through probabilistic and deterministic means. The human reliability analysis (HRA) portion of the probabilistic risk assessment (PRA) provides a list of IHAs determined by probabilistic means. IHAs found through deterministic means are derived from sources such as the transient accident analyses (TAA) and diversity and defense-in-depth coping analyses (D3CA). See Reference 10.2.4 for descriptions of the methodologies for determining IHAs. Tasks including IHAs are analyzed in detail.

Tasks to be analyzed also represent the full range of plant operating modes, including startup, normal operations, low-power and shutdown conditions, transient conditions, abnormal conditions, emergency conditions, and severe accident conditions.

- Tasks not identified as IHAs (i.e., those that do not meet the IHA threshold) as described in Reference 10.2.4, but which have negative consequences if performed incorrectly are included in the TA selection process – these tasks are typically identified through HRA, TAA, and D3CA.
- Tasks that are new compared to those in current commercial nuclear power plants, such as ones related to new systems or procedures, are included in the TA selection process. As described in Reference 10.2.2, the NuScale plant does not have a direct predecessor and several NuScale systems differ from those at current commercial U.S. operating nuclear plants; there are numerous tasks considered to be new.
- Tasks that, while not new, are performed significantly differently from current commercial nuclear power plants are included in the TA selection process. Many

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NuScale systems are operated with more automation than current commercial U.S. operating nuclear plants.

- Tasks related to monitoring and control of automated systems that are safety-related or risk-significant, and the use of automated support aids for personnel, such as computer-based procedures are included in the TA selection process – again, more tasks are automated.
- Tasks related to identifying the failure or degradation of automation, and implementing backup responses are included in the TA selection process. With the use of more automation in the NuScale plant, many tasks are related to monitoring, control, and providing backup to automated functions.
- Tasks anticipated to impose high demands on personnel, e.g., little time or high workload (such as administrative tasks that contribute to work load and challenge ability to monitor the plant) are included in the TA selection process. The NuScale plant design is such that as many as twelve units are operated from a single control room. Administrative and high-work load tasks are analyzed and modified to minimize operator demand.
- Safety-related or risk-significant tasks that are undertaken during maintenance, tests, inspections, and surveillances are included in the TA selection process.
- Tasks with potential concerns for personnel safety are included in the TA selection process.

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3.0 Methodology

3.1 Task Analysis Inputs

Inputs to TA from previous HFE program elements include the following:

- Tasks identified in the OER as human performance issues are evaluated for similarity with tasks identified for the NuScale plant. The TA confirms that the human performance issues are resolved by the plant or HSI. The TA also resolves any task-related human engineering discrepancies (HED) identified during OER.
- HAs, as determined in FRA/FA (Reference 10.2.3), are decomposed during TA to identify control tasks and related monitoring tasks. Actions allocated to a machine (automation) are decomposed to identify tasks for monitoring and control and for backing up automation. TA confirms the allocations. Functions related to nuclear safety and power production receive more detailed attention during TA.
- IHAs identified by the PRA, TAA, and D3CA are analyzed for feasibility and reliability in the TA. Time constraints on IHAs are analyzed to allow for performance shaping factors and necessary added time margins for completion of the task.
- HSI design generally receives input from TA in the form of a list of alarms, controls, indications, and procedures needed to support all tasks. However, staffing assumptions related to roles and responsibilities of operators and crew size are developed for the concept of operations portion of HSI design (an activity conducted early in the overall HFE program). TA supports the staffing design constraints.

HEDs from previous HFE program elements applicable to the completion of TA (see Section 3.13) are closed as appropriate.

The unique NuScale modular design includes an additional OER focus to provide documented lessons learned for the following plant operations:

- monitoring and control of multiple units in one control room
- construction and construction testing of one or more units coincident with operating units
- initial plant testing (preoperational and startup testing) coincident with operating units
- refueling of a unit coincident with operating units
- incident and accident management of a unit coincident with operating units

3.2 Methodology Summary

Figure 3-1 shows the general flowchart for TA.

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Figure 3-1. General flow chart for TA steps

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Note that not all steps are conducted for each task. TA is iterative and higher levels of analysis are conducted as the NuScale plant design progresses. Also, as noted below, more complex tasks result in more detailed task narratives and involve more aspects of the overall TA. TA steps may be omitted or conducted out of sequence during some iterations.

3.3 Screening Methodology

3.3.1 Normal, Abnormal, Emergency, and Alarm Response Procedure Tasks

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}}3(a)-(c) Tasks based on use of operating procedures are analyzed in greater detail in later iterations as the plant design progresses. Completely approved operating procedures are generally not available during early TA; therefore TA personnel include former operators of commercial U.S. nuclear power plants and other subject matter experts. Where procedures are not available for initial TA, the tasks to be analyzed are based on procedures from similar systems and processes.

3.3.2 Surveillance, Test, Inspection, and Maintenance Procedure Tasks

Tasks related to surveillance, test, inspection, and maintenance procedures are screened for applicability of TA. Human errors during the performance of surveillance, test, inspection, and maintenance procedures may result in components being in a state that induces a plant transient or can trigger a precursor to a plant transient. In both cases, the surveillance, test, inspection, and maintenance actions are selected for task analysis to identify defenses against these errors.

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The following selection processes are employed to determine which additional tasks are to be analyzed. Tasks are evaluated by plant operations subject matter experts (SME) based on their experience at current commercial U.S. operating nuclear plants including the SME's assessment of similarities (or differences) with the NuScale plant.

Safety-related surveillance, test, inspection, and maintenance tasks are screened in. {{

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3.3.3 Tasks Not Identified as Important Human Actions but with Potentially Negative Consequences

For selecting human actions that are not identified as IHAs but, if not performed correctly, potentially have negative consequences (such as precursors to plant transients), {{

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Negative consequences are defined as any action, task, or condition that places personnel, equipment, or the plant in jeopardy. Examples include

- a condition requiring an unplanned down power
- a condition requiring a reactor trip or initiation of emergency equipment
- a personnel injury that is reportable
- an emergency action level declaration
- a condition that places the plant in an unplanned limiting condition for operation
- a condition that places the plant at an unplanned safety level

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3.4 Detailed Task Narratives

For tasks that are screened-in for TA, a detailed task narrative is written. The purpose of the narrative is to

- describe the objectives of a specific system's operator tasks
- provide an overview of the activities personnel are expected to accomplish to complete the task
- define the alarms, controls, indications, and task support needed to accomplish the task

Narrative descriptions of operator activities contain requisite detail for a reviewer to correlate the described task objectives to the results of the completed task analysis. The length of the narrative is commensurate with the complexity of the task it describes. {{

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Task narratives are revised as relationships between tasks are better defined. Order and sequence of all tasks selected for TA are crucial to understanding workload and communication needs.

3.5 Task Sequencing Development and Decomposition into Task Elements

An operational sequence diagram (OSD) is created and used to aid in evaluating the flow of information from the point where the operator first becomes involved with the system to the completion of the task. Information flow includes operator decisions, operator control activities, and the transmission of data. Operator actions are identified in a top-down sequential format. The objective is to show how the information flows between the operators and the HSI from the beginning to the end of the task. The sequencing of the tasks provides input for the plant operating procedures and defines the activities that plant personnel are trained to execute.

The functional allocation and task description provide the objective and operating parameters for operator tasks. In order to identify the stimulus/response relationship for each lowest level task, each task is decomposed by identifying the parent task, subtasks, and task elements. A task is a well-defined unit of work that has an identifiable beginning and end. The lowest level task (element) is a discrete human action executed to support a task. Multiple subtasks and elements are often required to complete a task. A lowest level task may be cognitive or physical. The detailed task analysis includes a short descriptive statement of each of the lowest level tasks (elements) arranged in sequence within the parent task.

Figure 3-2 is a simplified (it does not include details such as valve numbers) example OSD for the decay heat removal (DHR) system showing how the task "manually initiate DHR" is decomposed into its elements. The figure demonstrates how an OSD is used to reveal tasks that are then decomposed into task elements.

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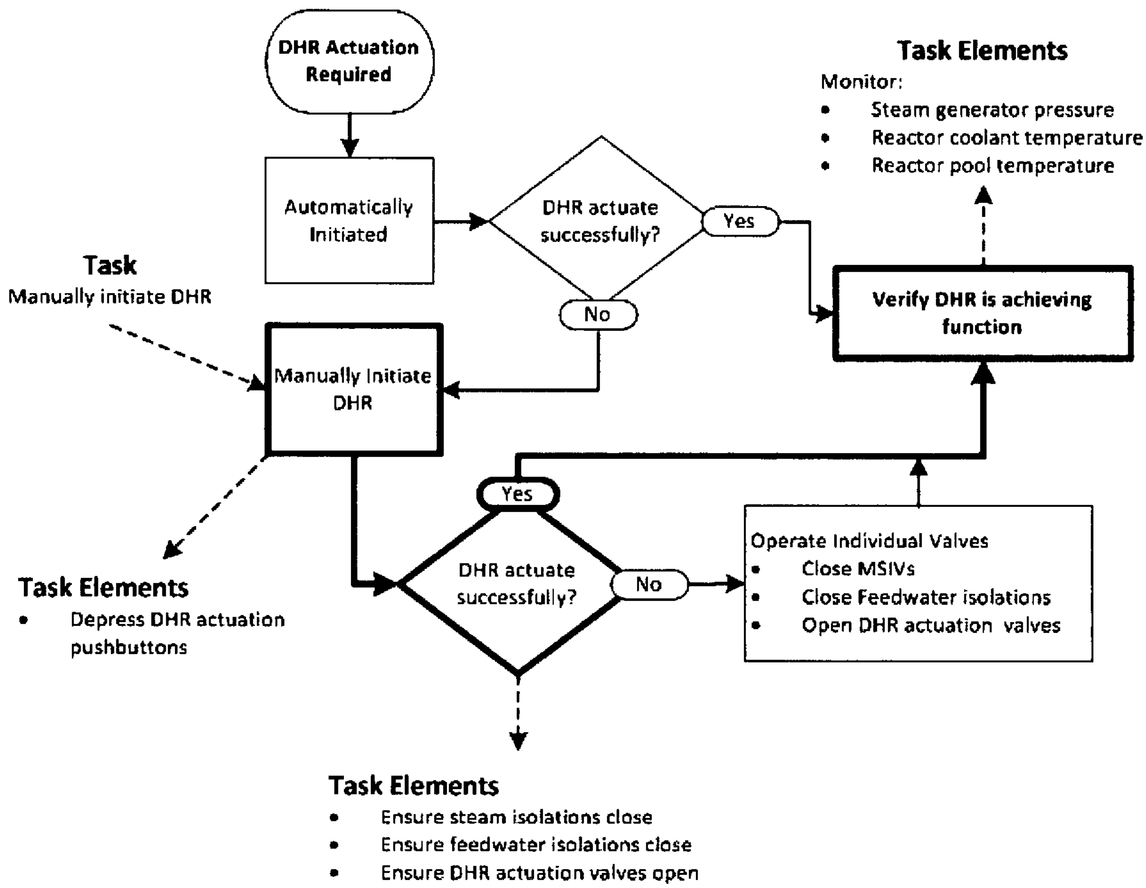

Figure 3-2. Example of visual OSD task-to-element decomposition

For example, the OSD shows that some of the tasks associated with the DHR function include

- recognize DHR actuation is required
- respond to automatic initiation of DHR
- recognize that DHR has failed to actuate
- respond to failure of DHR to actuate
- manually initiate DHR
- monitor the performance of DHR

In the example, a decomposition of the task "manually initiate DHR" produces the following elements (note: numbers indicate order, bullets imply any order)

1. Depress DHR actuation pushbuttons

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2. Ensure steam isolations close
3. Ensure feedwater isolations close
4. Ensure DHR actuation valves open
5. monitor:
- steam generator pressure
- reactor coolant temperature
- reactor pool temperature
6. report status to the control room

As the design matures, more subtasks are added as some steps imply subtasks; in the example above, implied subtasks include monitoring or interacting with the automation and HSI.

3.6 Determining Feasibility and Reliability for Important Human Actions

T_{avail} is the length of time from the initiation of the event to when the task needs to be completed as defined in applicable plant analysis. T_{avail} for each IHA is defined in the analysis that identifies the IHA (i.e., HRA, D3CA, or TAA). Applicable regulatory guidance is considered for the analyses that determine each IHA and for any task that industry experience identifies as a potential IHA. Within the HRA, D3CA, or TAA, a basis for T_{avail} is documented. The basis for T_{avail} is based on plant response to the anticipated operational occurrence or accident.

Time required to complete a task considers cognitive processing time, physical movement time, and HSI response time. The time required calculation is based on an understanding of the sequence of operator actions and takes into account secondary tasks. The time required calculation for any task, particularly IHAs, is revised as details of the design emerge.

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HEDs are generated for any previous IHA assumptions that conflict with the TA results. In addition, TA defines the methodology for selecting additional tasks for analysis that are related to human actions not identified as IHAs, but if not performed correctly, potentially have negative consequences (such as precursors to plant transients).

3.7 Time Required for Tasks

3.7.1 Workload Assessment

Balancing the physical and cognitive workload of the operators is a key design goal for an HSI design. Operator workload affects human reliability. Workload refers to the capacity of an operator to perform assigned tasks; insufficient or excessive workload leads to operator errors. Excessive workload is classified as either quantitative or qualitative.

- Quantitative - the amount of work to be done is beyond the time available and/or the task load (the number of tasks that have to be carried out) is greater than or is overlapping with others
- Qualitative - the difficulty, complexity, criticality and required effort of the work is beyond the immediate ability of the operator

The effects of excessive workload on an operator result in

- having difficulty maintaining situation awareness
- overlooking a developing unsafe situation
- making errors of judgment (mental and/or physical)
- confusion
- inability to cope with a sudden increase in workload

During TA, workload is assessed to determine the amount of time operators have available to carry out a task, T_{avail} and the amount of time operators are engaged in that task, T_{eng}. T_{avail} is the length of time from the initiation of the event to when the task needs to be completed as defined in applicable plant analysis. Sources of T_{avail} include HRA, TAA, D3CA, and plant technical specifications. T_{eng} is the time an operator is actually engaged in conducting the task and includes execution of the primary task and any increase in that time due to expected secondary task factors.

Thus, the workload is calculated as follows:

$$Workload = T_{eng} \times 100\% \div T_{avail}$$

Workload measurements determine how much physical and cognitive capacity operators expend on a task to determine remaining capacity for parallel or secondary tasks. A workload overload is defined as workload greater than 75% as high workloads are known to deleteriously affect operator performance (Reference 10.1.4). If during TA a task is found to produce workload greater than 75% alone or in combination with parallel

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or secondary tasks, an HED is generated in the human factors engineering issues tracking system (HFEITS) (Reference 10.2.1). HEDs are not generated for low workload at this stage because TA analyzes workload on a task-by-task basis; the sum of the workload associated with all tasks assigned to an operator is evaluated during staffing and qualifications (S&Q) analysis (Reference 10.2.5).

A risk-assessment based workload analysis is often used in place of a conservative go-no-go decision early in TA before the sum of the workload is evaluated. Tasks may be redefined if evaluated as high risk for workload. High-risk workload tasks include

- task activities that, when encountered, could affect safety (including IHAs)
- tasks that involve high stress on the operator or could cause unexpected results
- tasks that are performed under uncertain, degraded, or unstable plant conditions such as abnormal, transient or severe conditions
- tasks that have high consequences if performed inaccurately
- tasks that require high cognitive workload (complex)
- task activities that require a significant degree of coordination between operations team members
- tasks that have multiple concurrent activities (place high time pressure on operator)
- tasks that lack much feedback such as unavailable instrumentation or equipment status

3.7.2 Time Margin Assessment

Time required to complete a task is a conglomerate of cognitive processing time, physical movement time, and HSI response time (i.e., screen navigation, control operation, I&C platform processing, plant system response).

Time required calculations consider decision-making (which may or may not be part of cognitive processing depending on task complexity), communications with the operations team, task support requirements, situational and performance-shaping factors, and workplace factors and hazards for each sub-step of a task.

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TA confirms that the time required to complete a task is ≤90% of T_{avail}. If there is <10% time margin for a task, an HED is generated.

3.8 Number of People Required for Tasks

The task narrative developed for basic TA includes such information as

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Where detailed TA determines that workload for any individual task or analyzed sequence of tasks is excessive, an HED is generated. Designers then have options such as re-allocation of functions, changes to operator roles and responsibilities, changes to the number of operators, and changes to the HSI design to address the issue.

The S&Q analysis (Reference 10.2.5) also considers the conglomerate of all tasks and the effect on the entire operating crew workload to determine if further design changes are necessary.

3.9 Knowledge and Abilities Identification

In addition to the attributes included in the detailed task narrative, each task is analyzed to determine the knowledge and abilities (K&A) needed for success of the task. The K&A is used to complete other HFE activities such as the training program content and S&Q. {{

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3.10 Task Support Requirements

Typically, task support requirements are defined during the early TA. However, if not known, a later TA iteration captures such things as

- written job aids
- reference material
- calculation sheets
- tools
- equipment
- protective clothing

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3.11 Situational and Performance Shaping Factors

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Table 3-1. Criteria and rating factors for situational and performance-shaping factors

Situation and Performance Shaping Factors	Attributes (examples, not all-inclusive)	Stress rating
Complexity (C)	• involves abnormal, transient, or severe conditions • teamwork within crew • communications with internal or external groups	0-5
Difficulty (D)	• extreme environmental conditions • cognitive workload • physical workload • work path • work space • physical position • reduced staffing	0-5
Frequency (F)	• very often - daily • often – about once a week • occasionally – about once a month • seldom – one to several times per year • rarely - once a year or less	0-5
Accuracy (A)	• severity of consequences for error • ease of recovery from error	0-5

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Table 3-2. Total stress ratings and performance-shaping factors

Total Stress Rating	Performance Shaping Factor (PSF)
≥15	0.25
12 to 14	0.15
7 to 11	0.1
4 to 6	0.05

Workplace hazards are also identified for tasks performed at locations or in scenarios where hazards exist. Applicable workplace hazards include

- transit time to the worksite
- presence of hazardous materials, atmospheres or radiation
- slip/fall hazards
- ambient temperature
- lighting
- noise

The task analysis captures workplace hazards. Additional time margin may or may not be applicable for tasks that involve workplace hazards as determined by SMEs.

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DIF analyses consider

- difficulty – task attributes have time pressure, stress, cognitive work load, physical work load, time constraints; element attributes have time duration
- importance – task attributes have task type, task relationship, communication with other groups – internal and external; element attributes have consequences of inaccurate performance
- frequency – task attributes have frequency, task time

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3.12 Inventory of Alarms, Controls, and Indications

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3.13 Human Engineering Discrepancies

After design freeze (see Reference 10.2.1) or for design issues or problems that cannot be solved immediately, SMEs generate HEDs when the TA identifies a need for further evaluation to achieve an acceptable HSI design or plant design. HEDs are entered into the HFEITS, as described in Reference 10.2.1, to identify the deficiency or discrepancy and track its resolution. HEDs are generated if any of the following are true

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3.14 Iterative Nature of Task Analysis

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. For example, applicable HEDs initiated during OER and FRA/FA are resolved in TA, while TA output includes

- early definition of roles and responsibilities for individuals that are analyzed in S&Q for an overall operations team view
- a list of HSI inventory and characteristics for HSI design
- information and controls needed for task support that are used for procedure development
- determination of required K&A, which leads to learning objectives for training program development

When problems arise during HFE program activities after TA, HEDs are initiated; resolution of those HEDs may result in changes to or re-work of the TA.

In addition, since TA is conducted for some NuScale plant systems before other system designs have commenced, system and component design changes may result in changes to systems previously designed. In these cases, TA input assumptions are likely to change. TA SMEs revise the TA as details of the plant, system, or component designs emerge.

Further, HFE program activities, including TA, fall within the design control process as described in Reference 10.2.1, 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 TA and directs modification of the TA as appropriate.

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4.0 Additional Considerations for Plant Modifications

After completion of start-up testing and provisional turnover, 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, procedures, or training against the TA and design bases established for the as-built design. The design change proposal evaluation considers HEDs in HFEITS regardless of which stage of the design they were initiated. HFE analyses, including TA, for the NuScale plant are provided to licensees so that the assumptions made and the HSI inventory derived from TA can be maintained or 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".

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5.0 Task Analysis Outputs

The output of TA is input to the following HFE program elements:

- S&Q — TA results are used to {{

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- HSI design — TA generates the complete HSI inventory and the characteristics of that inventory needed to monitor plant critical functions and to monitor and control their success paths. The HSI inventory includes the specific alarms, controls, indications, and procedures needed for the in-scope portions of the NuScale plant. HSI design uses the detailed task analysis results and inventory of alarms, controls, indications to {{

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- procedure development — TA defines the information and control needs for each operator instruction or action in the procedures.
- training program development — {{

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- HFE verification & validation — The complete inventory of alarms, controls, and indications defined by the TA is compared to the actual HSI design during the HFE verification and validation activities "inventory and characterization" and "task support verification". Task complexity, conditions, and assumptions are used for developing scenarios for the integrated system validation.

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6.0 Task Analysis Tools

A relational database (VISION by Focus Learning is used to capture and organize the data from the TA process. The database organizes this highly interrelated set of data into a format that allows electronic linkage across the various elements of design. VISION is widely used by the nuclear industry to store and organize task analysis results and provide the foundation to develop the systematic approach to training as required by 10 CFR 50.120 (Reference 10.2.7). {{

}}3(a)-(c) VISION uses three main work areas: Analysis, Objective, and Program. The database also makes use of cross reference tables, the ability to share or link information throughout the program, and provides for extensive reporting functions.

Figure 6-1 provides a visual display of the electronic linkages from TA to other activities the analysis supports.

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Figure 6-1. TA linkages using VISION

Analysis Phase

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Objective Design Phase

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Program Design Phase

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Cross Reference Tables

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7.0 Task Analysis Support

7.1 Human Factors Engineering Design Team Organization and Qualification

The NuScale TA team is responsible for conducting task analysis. The qualifications of the HFE design team members supporting this HFE program are stipulated in NuScale Human Factors Engineering Program Management Plan, RP-0914-8534 (Reference 10.2.1).

7.2 Human Factors Engineering Issue Tracking

HFE issues, including those associated with TA, are captured and tracked throughout the life cycle of the HFE program for the NuScale design using the HFEITS database. The HFEITS database is described in Reference 10.2.1.

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8.0 Task Analysis Results Summary Report

When the TA is complete, NuScale provides a results summary report to the NRC containing the following information

- TA results overview, which includes the principal findings
- TA execution results including demonstration of compliance with the methodology
- tasks selected for analysis from surveillance, test, inspection, and maintenance procedures
- tasks not identified as IHAs but with potentially negative consequences
- output results, especially for each task that requires a detailed TA
- documented TA results review
- documented confirmation of IHAs
- a description of each HED
- a summary of the results of the independent task analysis review
- conclusions
- demonstration that tasks conducted by plant operators are analyzed to establish HSI inventory requirements
- confirmation that tasks can be conducted with acceptable workload and time margin considering the staffing plan

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9.0 NUREG-0711 Conformance Evaluation

Table 9-1 indicates where each NUREG-0711, Revision 3 criterion is met in this IP.

Table 9-1. Conformance with NUREG-0711

Review Criteria	**TA IP Section No. and paragraph**
5.4 (1) Scope The scope of the applicant's task analysis should include: • All important HAs as determined by probabilistic and deterministic means (see Section 7, Treatment of Important Human Actions, of this report) • The applicant should select tasks for analysis that represent the full range of plant operating modes, including startup, normal operations, low-power and shutdown conditions, transient conditions, abnormal conditions, emergency conditions, and severe accident conditions. The chosen tasks should cover: – tasks that were not identified as "important HAs" but have negative consequences if performed incorrectly – tasks that are new compared to those in predecessor plants, such as ones related to new systems or procedures – tasks that, while not new, are performed significantly differently from predecessor plants – tasks related to monitoring of automated systems that are important to plant safety, and the use of automated support aids for personnel, such as computer based procedures – tasks related to identifying the failure or degradation of automation, and implementing backup responses – tasks anticipated to impose high demands on personnel, e.g., little time or high workload (such as administrative tasks that contribute to work load and challenge ability to monitor the plant) – tasks important to plant safety that are undertaken during maintenance, tests, inspections, and surveillances – tasks with potential concerns for personnel safety (such as maintenance tasks performed in the containment)	Section 2.2, All paragraphs

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Review Criteria	TA IP Section No. and paragraph
5.4 (2) The applicant should describe the screening methodology used to select the tasks for analysis, based on criteria specifically established to determine whether analyzing a particular task is necessary.	Section 3.3, All
5.4 (3) The applicant should begin task analysis with detailed narratives of what personnel have to do. The analysis should be sufficiently detailed to define the alarms, information, controls, and task support needed to accomplish the task. The detailed task descriptions should address (as applicable to the task) the topics listed in Table 5-1 (table not shown).	Section 3.4, All
5.4 (4) The applicant should identify the relationships among tasks. *Additional Information*: For example, some tasks can be carried out in any order or in parallel, some tasks have to be performed in a linear sequence, while for others the relationship is conditional (if such a condition exists, perform task A). Some tasks may involve coordinated actions among crew members or control room crew members and local personnel.	Section 3.5, All
5.4 (5) The applicant should estimate the time required to perform each task.	Section 3.7, All
5.4 (6) The applicant should identify the number of people required to perform each task.	Section 3.8, All
5.4 (7) The applicant should identify the knowledge and abilities required to perform each task.	Section 3.9, All
5.4 (8) The applicant's task analysis should be iterative, and updated as the design is better defined.	Section 3.14, All
5.4 (9) Applicants should provide an analyses of the feasibility and reliability for important HAs that address the following: • The analysis establishes the time available using an analysis method and acceptance criteria consistent with the regulatory guidance associated with the actions. The basis for the time available is documented. *Additional information:* The time available to perform the actions should be based on analysis of the plant response to the anticipated operational occurrence or accident. This analysis should reflect the guidance associated with the event.	Section 3.6, All

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Review Criteria	**TA IP Section No. and paragraph**
• The analysis of the time required is based on a documented sequence of operator actions (based on task analysis, vendor-provided generic technical guidelines for emergency operating procedure development, or plant-specific EOPs, depending on the maturity of the design).	Section 3.6, All
• Techniques to minimize bias are used when estimates of time required are derived using methods that are dependent on expert judgment. Uncertainties in the analysis of time required are identified and assessed.	Section 3.6, All
• The sequence of actions uses only alarms, controls, and displays that would be available and operable during the assumed scenario(s).	Section 3.6, All
• The estimated time for operators to complete the credited action is sufficient to allow successful execution of applicable steps in the EOPs. *Additional Information:* Acceptable methods for deriving analysis time estimates for individual task components include, but are not limited to: • Operator interviews and surveys • Operating experience reviews • Software models of human behavior, such as task network modeling • Use of control/display mockups • Expert panel elicitation (e. g., Kolaczkowski et al., 2007)	Section 3.6, All
• Staffing for analysis is justified, and if credited manual actions require additional operators beyond the assumed staffing, the justification for timely availability of the additional staffing is provided and the estimate of time required includes any time needed for calling in additional personnel.	Section 3.6, All

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Review Criteria	TA IP Section No. and paragraph
• The analysis of the action sequence is conducted at a level of detail sufficient to identify individual task components, including cognitive elements such as diagnosis and selection of appropriate response. *Additional information:* The documented sequence of operator actions should be analyzed at a level of detail necessary to identify critical elements of the actions and performance shaping factors (e.g., workload, time pressure) that affect time required and likelihood of successful completion of the action sequence. The applicant should establish time estimates for individual task components (e.g., acknowledging an alarm, selecting a procedure, verifying that a valve is open, starting a pump) and the basis for the estimates, through a method applicable to the HSI characteristics of digital computer-based I&C.	Section 3.6, All
• The analysis identifies a time margin to be added to the time required and the basis for the adequacy of the margin.	Section 3.6, All
5.4 (10) 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 and will affect HAs previously identified as important, cause existing ones to become important, or create new HAs that are important, the applicant should address the following considerations: • Existing task analysis should be revised and updated to reflect the modification. If no pertinent task analysis exists, then consideration should be given to completing a new task analysis. For maintenance, tests, inspections, and surveillances, attention should be given to new important human actions, or those supported by new technologies (e.g., new capabilities for on-line maintenance).	Section 4.0, All

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Review Criteria	TA IP Section No. and paragraph
• The task analysis should identify the design characteristics of the existing HSIs supporting the performance of experienced personnel (e.g., support high levels of performance during demanding situations) and consider them in developing new design requirements. Also, design features identified during the OER also should be carefully weighed in these analyses. *Additional Information:* The design characteristics may include the spatial arrangement of control and display devices and the ease of adjusting controls and displays to deal with special tasks. The new design should have features performing similar functions as the previous design, or should eliminate the need for the same features by performing these functions differently (e.g., by automating them). In addition, the task analysis should identify and examine any adjustments made to the previous HSIs by users, such as notes and external memory aids, suggesting that the previous design does not fully meet the users' needs. The new design requirements should adequately address all task demands.	Section 4.0, All

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10.0 References

10.1 Source Documents

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

10.1.2 Brookhaven National Laboratory, "Trends in HFE Methods and Tools and Their Applicability to Safety Reviews," BNL Tech Report No. BNL-90424-2009 & NRC Document -Human Factors of Advanced Reactors (NRC JCN Y-6529), October 2009.

10.1.3 U.S Nuclear Regulatory Commission, "Knowledge and Abilities Catalog for Nuclear Power Plant Operators, Pressurized Water Reactors," NUREG-1122, Revision 2, Supp. 1, June 5, 1998.

10.1.4 MIL-HDBK-46855A, "Department of Defense Handbook, Human Engineering Program Process and Procedures".

10.2 Referenced Documents

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

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

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

10.2.4 NuScale Human Factors Engineering Treatment of Important Human Actions Implementation Plan, RP-0914-8539.

10.2.5 NuScale Human Factors Engineering Staffing and Qualifications Analysis Implementation Plan, RP-0914-8538.

10.2.6 U.S Nuclear Regulatory Commission, "Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Westinghouse AP1000 Pressurized-Water Reactors," NUREG-2103, Revision 0, October 2011.

10.2.7 U.S. Code of Federal Regulations, "Training and Qualifications of Nuclear Power Plant Personnel," Section 50.120, Part 50, Chapter 1, Title 10 "Energy," (10 CFR 50.120).

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