Licensing Technical Report

Human Factors Engineering Task Analysis Implementation Plan

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Licensing Technical Report

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Abstract

The task analysis is a significant element of the Human Factors Engineering Program. The purpose of the task analysis is to analyze human actions that are allocated to personnel during the function allocation process.

The functions allocated to plant personnel define the roles and responsibilities that can be accomplished via human actions or tasks. The results of the task analysis provide inputs to the following Human Factors Engineering activities: staffing and qualifications, human-system interface design, procedure development, training program development, treatment of important human actions, and task support verification (human factors verification and validation).

This implementation plan documents the methodology used in the task analysis process. The process used is consistent with the applicable provisions of Section 5 of NUREG-0711 (Reference 4.1.1).

Executive Summary

Consistent with the guidance of NUREG-0711 (Reference 4.1.1) Section 5, the scope of the task analysis (TA) performed by NuScale includes a method to identify: the specific tasks, the personnel required to perform the tasks, and the alarms, displays, controls, and task support needed to perform those tasks.

Functions allocated to human and system resources are determined during the function allocation process and made into tasks. The tasks are arranged into specific job categories and assigned to staff positions (e.g., licensed and non-licensed operators). The alarms, displays, controls and task support needed are design inputs for developing staffing and qualifications, human-system interface design, procedure development, training program development, treatment of important human actions, and task support verification (human factors verification and validation).

This implementation plan is organized into four major sections and appendices. Section 1.0 describes the purpose and scope of the TA. Section 2.0 provides an overview of the TA implementation process and a description of the TA team composition and responsibilities. Section 3.0 describes the methodology and specifies the criteria for performing the task analysis. The source and referenced documents applicable to and used in the TA effort are listed in Section 4.0.

1.0 Introduction

1.1 Purpose

This implementation plan (IP) describes a methodology for the task analysis (TA) for the NuScale Power Plant as part of the Human Factors Engineering (HFE) Program. This IP also includes the methodology used to achieve the results. The inputs from the HFE Program elements are described and the outputs from the TA elements are identified.

1.2 Scope

This IP is focused on TA for activities performed by licensed operators in the main control room during normal, abnormal, and emergency operating conditions. Maintenance or refueling activities, activities completed by craft and technical personnel (e.g., mechanical, electrical, or instrumentation and control (I&C) maintenance; health physics; chemistry; engineering; or information technology), or activities associated with the Technical Support Center, Emergency Operations Facility, or other Emergency Response facilities are not included in the TA focus unless those activities are determined to impact licensed operator workload.

The tasks selected for analysis represent a 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 methodology for selection of the tasks is described in Section 3.2.

1.3 Abbreviations

Table 1-1 Abbreviations

Term	Definition
D3CA	diversity and defense-in-depth coping analysis
DHRS	decay heat removal system
FA	function allocation
FRA/FA	functional requirements analysis and function allocation
HFE	Human Factors Engineering
HSI	human-system interface
I&C	instrumentation and controls
IHA	important human action
IP	implementation plan
KA	knowledge and abilities
MSIV	main steam isolation valve
OER	operating experience review
OSD	operational sequence diagram
PRA	Probabilistic Risk Assessment
RSR	results summary report
SME	subject matter expert
S&Q	staffing and qualifications
TA	task analysis
TIHA	treatment of important human actions

Table 1-2 Definitions

Term	Definition
Element	A discrete human action executed to support a task.
FRA/FA	The identification of functions that must be performed to satisfy the nuclear power plant's overall goals. Function allocation determines which tasks are manual, automatic, or a combination of the two.
FRA/FA & TA database	The VISION® Developer application is a relational database that is used to store the FRA/FA, task analysis, staffing and qualifications analysis, development of human-system interfaces (HSI), procedures, and training data. In this document it is also referred to as the "FRA/FA & TA database" or "database."
Module	A NuScale module consists of the containment vessel, reactor pressure vessel, and all components internal and external to each vessel, up to the disconnect flanges.
Plant functions	The plant functions describe how the plant meets NuScale's mission statement of "safe, scalable, affordable, electrical generation using nuclear power."
SME	An individual with appropriate knowledge in a specific area or discipline that has sufficient experience and education to competently develop or review a licensing topical report in that discipline.
Task	A group of activities with a common purpose, often undertaken in close temporal proximity.

Table 1-2 Definitions (Continued)

Term	Definition
Unit	A NuScale unit consists of the components necessary to generate electricity. This includes a primary side containing a reactor power module and its specific supporting systems, and a secondary side containing a turbine generator and its specific supporting systems.

2.0 Implementation

2.1 Task Analysis Process Overview

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. The 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.

Input to TA from HFE Program elements include the following:

- Tasks identified in the operating experience review (OER) as human performance issues are evaluated for similarity with tasks identified for the plant. The TA confirms that the human performance issues are resolved by the plant design or HSI. The TA also resolves task-related human engineering issues identified during OER.
- Human actions, as determined in the functional requirements analysis and function allocation (FRA/FA) process (Reference 4.2.2), 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 then TA confirms the allocations.
- Important human actions (IHAs) identified by the Probabilistic Risk Assessment (PRA), transient and accident analysis, and diversity and defense-in-depth coping analyses (D3CA) are analyzed for feasibility and reliability in the TA. Time constraints on IHAs are analyzed to allow for performance-shaping factors and the necessary added time margins for completion of the task.

Output from TA to other HFE Program elements includes the following:

- The HSI inventory and its characteristics generated by the TA include the alarms, controls, displays, and procedures needed to monitor plant-critical functions, as well as to monitor and control their success paths. The HSI design uses the detailed TA results and inventory of alarms, controls, and displays to establish alarm logic, display and control designs, procedure step acceptance criteria, and grouping of HSI inventory, especially for task-oriented screens. Staffing assumptions related to roles and responsibilities of operators and crew size are developed for the concept of operations portion of the HSI design.
- Tasks are arranged into specific job categories and assigned to staff positions (e.g., licensed operators, non-licensed operators). These assignments are analyzed in the staffing and qualifications (S&Q) HFE element.
- Tasks are assigned knowledge and abilities (KA) required to perform the tasks. These KA requirements provide the foundation for the Operator Training Program development.

The TA information is captured in the FRA/FA & TA database that contains the FRA/FA information and is described in further detail in Section 3.6.1. The database is divided into three hierarchies: analysis, objective design, and program development.

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}}2(a),(c)

Figure 2-1 Database Structure

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}}2(a),(c)

2.2 Task Analysis Team Composition and Responsibilities

The TA is conducted and supported by an experienced team that includes input from the HFE team and from the System Engineering, Safety Analysis, and Operations organizations. The qualifications of the HFE team members are as stipulated in the NuScale HFE Program Management Plan (Reference 4.2.1).

The TA team lead and the remainder of the team are selected by the HFE supervisor from the HFE team members. As described in the HFE Program Management Plan, the HFE supervisor has the authority and organizational placement to reasonably ensure that the tasks assigned to the TA personnel who do not directly report to the supervisor are completed.

The TA team includes an FRA/FA & TA database coordinator. Assigned by the team lead, the database coordinator is responsible for managing the information that is recorded in the FRA/FA & TA database.

The TA team includes senior reactor operators and other personnel with experience in the operation of commercial nuclear power plants.

A TA team and TA team lead are selected by the HFE supervisor from available HFE team members to conduct TA. The TA team lead is responsible for

- organizing the TA team.
- directing the development of the FRA/FA & TA database.
- assigning team member responsibilities.
- managing resources and review schedule.
- ensuring that TA issues are completed with supporting documentation and entered into the Human Factors Engineering issue tracking system as necessary.
- production of the FRA/FA & TA database reports.

Responsibilities of TA team members conducting the reviews and completing disposition of the individual review items include

- reviewing TA documentation for identification of
  - accuracy of the functional requirements analysis.
  - task determination.
- reviewing the database and using reports to cross examine the results.
- continuing revisions to the data as necessary.

The FRA/A & TA database coordinator is responsible for ensuring the data are properly entered in the database. The database coordinator is also responsible for formatting and running reports to provide output from the database.

3.0 Methodology

The HFE Program includes TA as part of a series of analyses that relies primarily on design documents, subject matter experts (SME), and operating experience. The TA is a resource for S&Q, development of HSI, procedures, and training programs. For efficiency, the team conducts the FRA/FA and TA in sequence or in parallel, depending on the complexity of the functions and associated tasks. Where functions and tasks are not complex, have low safety significance, or are not expected to vary significantly from how other commercial nuclear power plants conduct them, the FRA, FA, and TA sequence may extend further to include preliminary development of HSI, procedures, and training.

The TA methodology remains the same whether conducted alone or as the first step in a series. Rigid sequencing is not practical for HFE analyses as the iterative nature of both the design and the HFE process necessitates flexibility. For example, new or modified tasks in the task analysis would require updating the function allocation table; conversely, changes to the function allocation table are reflected in the task analysis. Those changes are made or the necessary changes become HFE issues and are tracked using Human Factors Engineering issues tracking system.

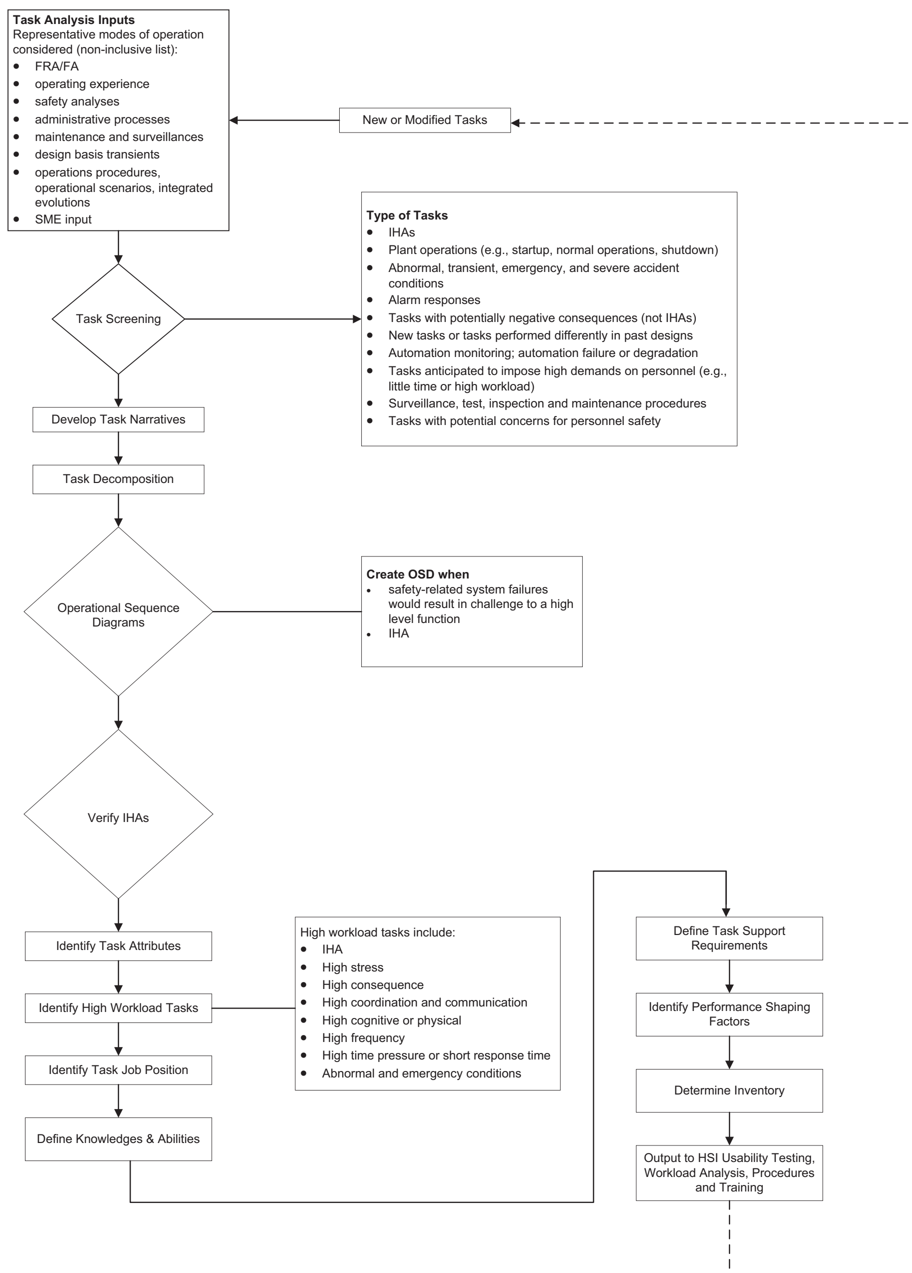
3.1 Task Analysis Development

The step sequence for TA development (Figure 3-1) is as follows:

1. screen for applicable tasks
2. develop detailed task narrative
3. decompose tasks
4. develop operational sequence diagram
5. verify IHAs
6. identify task attributes
7. identify high workload tasks
8. identify task job position
9. determine KAs
10. define task support requirements
11. identify performance shaping factors (assess workload)
12. determine inventory of components, alarms, displays, and controls to support accomplishment of tasks
13. output to HSI usability testing, control room staffing plan validation, procedures, and training
14. review modified tasks or new tasks for TA development

Not all steps are conducted for each task. The TA is iterative and higher levels of analysis are conducted as the plant design progresses. Also, as noted below, more complex tasks result in more detailed task narratives and involve more aspects of the overall TA. The TA steps may be omitted or conducted out of sequence during some iteration. The overall TA process is shown in Figure 3-1.

Figure 3-1 Task Analysis Flow Path



3.2 Task Identification

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

All tasks, regardless of importance, are analyzed so that the full extent of the work load can be determined. Examples of tasks to be analyzed include, but are not limited to, the following:

- The IHAs determined through the human reliability portion of the PRA and deterministic means (e.g., transient and accident analysis, D3CA). The TA for IHAs assumes use of the alarms, controls, displays, automation, and procedures that are normally available and operable during the scenario being analyzed.
- Tasks not identified as IHAs through probabilistic or deterministic means but that have negative consequences if performed incorrectly.
- Tasks that are identified to be new, compared to operating nuclear plants.
- Tasks that, while not new, are performed differently from operating nuclear plants.
- Tasks related to monitoring and control of automated systems that have augmented quality requirements, and to 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., administrative tasks that contribute to workload and challenge ability to monitor the plant).
- Tasks that are undertaken during maintenance, tests, inspections, and surveillances.
- Tasks with potential concerns for personnel safety.

Identification of tasks to be analyzed is performed by SMEs on the basis of their experience at operating nuclear plants. The process includes review of operating experience and available system design material.

3.3 Task Determination Methodology

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

All tasks within scope are analyzed for normal, abnormal, and emergency response operating procedures. Tasks based on use of operating procedures are analyzed in greater detail in later iterations as the plant design progresses. Personnel performing the analyses include former operators of commercial U.S. nuclear power plants and other SMEs. Procedures are not available for initial TA; therefore, the tasks analyzed may be 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 in the main control room performed by the control room staff are screened for applicability. 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 triggers 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. The process is iterative in nature and is kept current over the plant's life cycle, from design development through decommissioning.

Safety-related surveillance, test, inspection, and maintenance tasks are identified. The SME reviews the design material available, including system design packages, piping and instrument diagrams, logic diagrams, and electrical schematics for each system the task involves, and determines the tasks necessary to perform the surveillance, test, inspection, and maintenance functions of the system. Surveillance, test, inspection, and maintenance activities identified through SME judgment as having challenged operating crews at commercial U.S. operating nuclear plants, or which potentially impact the ability of a NuScale Power Plant operating crew to manage up to six units in one control room, are selected for TA.

The SME documents the safety-related surveillance, test, inspection, and maintenance activities for each system using the technical specifications as the basis. Systems are distributed among SMEs for this selection process.

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

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.
- an emergency action level declaration.
- a condition that places the plant in an unplanned technical specification action statement entry that requires plant shutdown.

When selecting human actions that are not identified as IHAs but have potentially negative consequences (such as precursors to plant transients), SMEs review the OER, the PRA, and use their own experience. Activities related to transients or PRA that according to SME judgment were caused by challenges to operating crews at commercial U.S. operating nuclear plants or which potentially impact the ability of a NuScale Power Plant operating crew to manage multiple units in one control room are selected for TA. The SME documents the basis for selecting these activities for TA. These tasks that have potentially negative consequences are considered; abnormal, emergency and annunciator response tasks and are covered in these procedures.

3.4 Operational Sequence Diagrams

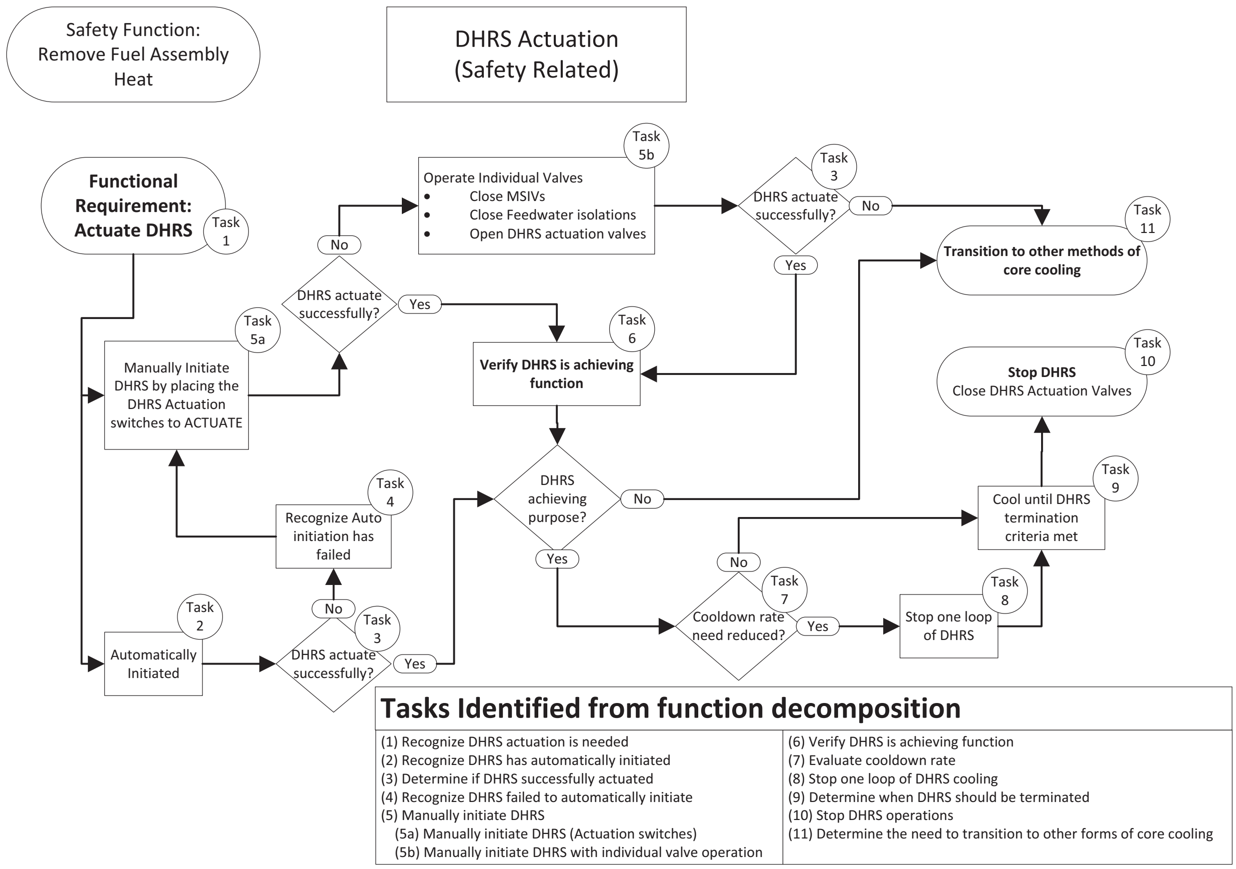
An operational sequence diagram (OSD) is created for safety-related tasks and used to aid in evaluating the flow of information from the point where the operator first becomes involved with the system to the completion of the task. Information flow includes operator decisions, operator control activities, 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 and response relationship for each lowest level task, each task is decomposed by identifying the parent task, subtasks, and task elements.

Depending on their types and complexity, tasks may be performed sequentially, in parallel, or in any order. Tasks may also be conditional, may involve coordinated actions among crew members, or among crew members and local personnel.

Figure 3-2 is a simplified OSD example for the decay heat removal system (DHRS) showing how the task "Actuate DHRS" is decomposed into its tasks. The figure demonstrates the sequence and decision points the operator follows to verify DHRS is achieving the function of removing fuel bundle heat. The table at the bottom of the drawing identifies the tasks by number, which corresponds to the tasks in the drawing.

Figure 3-2 Operational Sequence Diagram Task Decomposition Example



3.5 Detailed Task Narratives

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

- a description of the objectives of a specific system's operator tasks.
- an overview of the activities personnel are expected to accomplish to complete the task.
- a description of alarms, information, controls, and task support needed to accomplish the task.
- a basic outline of the procedure steps.

Narrative descriptions of operator activities contain detail for an operator to correlate the described task to the results of the completed task analysis. The length of the narrative is commensurate with the complexity of the task it describes. Each task narrative includes the following details:

- task title and identifier
- alarms and cautions associated with the task or that aid in the completion of the task
- parameters the operator must know or be able to locate during performance of the task and a means of knowing if actions taken to attain parameters are adequate (feedback)
- decisions the operator must make in performing the task (the type of decision and how the operator evaluates choices before reaching a decision)
- action(s) expected of the operator, accuracy requirements for the action(s), time available for the action(s), and ergonomic properties of the controls for completion of the action
- communication needs for the operator and associated teammates and alternative communication methods
- workload (the anticipated or measured cognitive and physical workload needed to complete the task)
- tools, equipment, protective clothing, job aids, or procedures needed for the task
- workspace needed to perform the task and environmental conditions applicable for the task
- situational considerations (ways that situations affect the outcome of the task such as time pressure, extreme environments, and team staffing shortages)
- hazards and the means for identification and mitigation of hazards for completion of the task

Task narratives are revised as relationships among tasks are better defined. The order and sequence of tasks selected for TA are crucial to understanding workload and communication needs.

3.5.1 Time Required for Performing Tasks

The time required to perform a task is a combination of cognitive processing time, physical movement time, and HSI response time (e.g., screen navigation, control operation, I&C platform processing, plant system response). Calculations of time required for task performance factor in 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 step of a task.

The analysis of time required for IHAs is also based on a documented sequence of operator actions. The estimated time for operators to complete the credited action is sufficient to allow successful execution of applicable steps in the emergency operating procedure. 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 are established through a method applicable to the HSI characteristics of digital computer-based I&C.

The time available to perform the actions is based on analysis of the plant response to the anticipated operational occurrences, accidents, and infrequent and special events, in accordance with NUREG-0711 (Reference 4.1.1).

3.5.2 Personnel Required for Performing Tasks

The number of personnel required to perform each task is determined by the task narrative, complexity of the task, time required to perform the task, and the time available. The task narrative developed for basic TA includes such information as:

- job function(s) or title(s) of person(s) who performs the task
- requirements for communication with other Operations personnel while performing the task
- how different levels of staffing affect the performance of a task
- the task time estimate

Where detailed TA determines that workload for an individual task or analyzed sequence of tasks is excessive, an HFE issue is entered into the Human Factors Engineering issues tracking system database. 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.

3.5.3 Task Support Requirements

Task support requirements are defined during the early TA. However, if not known, a later TA iteration captures additional considerations, such as:

- written job aids
- reference material
- calculation sheets
- tools
- equipment
- protective clothing
- instrument range
- instrument units
- instrument resolution - typically 1 percent of the range, but the SME may specify if other
- instrument refresh or update rate - considering limitations of the I&C platform
- instrument display characteristics

- instrument trend requirements
- calculation automation requirements

3.5.4 Task Considerations

Each task is evaluated to identify situational and performance-shaping factors that increase the cognitive workload and may influence human reliability. Examples include stress, reduced staffing, time pressure, and extreme environmental conditions. Table 3-1 shows how the HFE team compares the NUREG-0711 (Reference 4.1.1) with the NuScale attributes.

Table 3-1 Task Considerations

Topic	Examples (NUREG-0711)	Task Attribute (NuScale)
Alerts	• alarms and warnings	• alarms and warnings (alerts)
Information	• parameters (units, precision, and accuracy) • feedback needed to indicate adequacy of actions taken	• parameters (units, precision, and accuracy) • feedback needed to indicate adequacy of actions taken
Decision-making	• decision type (relative, absolute, probabilistic) evaluations to be performed	• decision type (relative, absolute, probabilistic) evaluations to be performed
Response	• actions to be taken • task frequency and required accuracy • time available and temporal constraints (task ordering) • physical position (stand, sit, squat, etc.) • biomechanics • movements (lift, push, turn, pull, crank, etc.) • forces needed	• actions to be taken (element steps) • task frequency and required accuracy • time available (IHAs); task time (non-IHA) • time constraints • physical position (such as sit, stand) • biomechanics force required • biomechanics description (such as turn, pull)
Teamwork and Communication	• coordination needed between the team performing the work • personnel communication for monitoring information or taking control actions	• coordination needed between the team performing the work • communication with other groups • communication reporting • external communication
Workload	• cognitive workload • physical workload • overlap of task requirements (serial vs. parallel task elements)	• cognitive workload • physical workload • overlap of task requirements (procedure development) • task relationships and task type
Task Support	• special and protective clothing • job aids, procedures or reference materials needed • tools and equipment needed	• special and personnel protective equipment • procedures • job aids • job aid description • procedures • procedure description • reference material • reference material description • tools, materials, and equipment needed
Workplace Factors	• ingress and egress paths to the worksite • workspace needed to perform the task • typical environmental conditions (such as lighting, temp, noise)	• ingress and egress paths to the worksite (work paths) • workspace needed to perform the task • typical environmental conditions (such as lighting, temp, noise)
Situational and Performance Shaping Factors	• stress • time pressure • extreme environmental conditions • reduced staffing	• stress • time pressure • extreme environmental conditions • staffing conditions
Hazard Identification	• identification of hazards involved, e.g., potential personal injury	• hazards

3.5.5 Inventory of Alarms, Controls, and Displays

Plant operations SMEs determine the HSI inventory by reviewing the detailed task analysis results for each task and identifying the alarms, controls, and displays required on the appropriate HSI to execute the task. The HSI inventory and characterization process is described in Human Factors Engineering Human-System Interface Design Implementation Plan (Reference 4.2.3).

For alarms and displays, the SME conducting TA for that task considers and documents the following:

- parameter - description and instrument number (if available)
- range
- units
- resolution - typically 1 percent of the range, but the SME may specify, if other
- refresh or update rate - considering limitations of the I&C platform
- display characteristics
- trend requirements
- calculation automation requirements
- alarms - criteria for and levels of alarms are established during HSI design; descriptions rather than setpoints are acceptable for earlier TA iterations

For controls, the SME conducting TA for that task considers and documents the following:

- equipment control requirements
- control function type and description
- indication of status
- alarm functionality - such as loss-of-power, mismatch between signal and position, thermal or high power overload, high vibration
- conditions when the controls will be interlocked, blocked, or overridden

Note that the TA subject matter expert uses qualitative language to define alarm and control setpoints (e.g., high, low), but actual setpoint determination is made by the plant designers.

3.5.6 Knowledge and Abilities Identification

In addition to the attributes included in the detailed task narrative, each task is analyzed to determine the KA needed for success of the task. The KA is used to complete other HFE activities such as the training program content and S&Q. The NuScale KAs are benchmarked against a modern pressurized water reactor using NUREG-2103 "Knowledge and Abilities Catalog for Nuclear Power Plant Operators:

Westinghouse AP1000 Pressurized Water Reactors - Final Report" (Reference 4.2.5), and a gap analysis is performed. The results of this analysis are used to develop the NuScale-specific KA catalog to address the unique characteristics of the NuScale Power Plant design.

The results of this analysis are used to develop the NuScale-specific KA catalog written to specifically address the unique nature of the design (e.g., the design does not include reactor coolant pumps so the NuScale KA catalog contains no KAs related to operation of reactor coolant pumps, but does include KAs related to monitoring natural circulation of core flow).

3.6 Iterative Nature of Task Analysis

The HFE Program itself is iterative in that elements of the program provide inputs to other elements and some design issues are only resolved by changing assumptions or re-analyzing based on new data. For example, applicable human engineering discrepancies 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 KA, which leads to learning objectives for training program development.

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

In addition, since TA is conducted for some 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. Task analysis SMEs revise the TA as details of the plant, system, or component designs emerge.

3.6.1 Functional Requirements Analysis and Function Allocation and Task Analysis Database

The VISION® developer application is a relational database that is used to store the FRA/FA, TA, and staffing and qualifications data. In this document it is also referred to as the FRA/FA & TA database, or database. The TA results of NuScale systems are available in the database.

Example screenshots from the database are provided below. The letters and icons in the hierarchy used in the database are described in Table 3-2. Database hierarchy is arranged in such a way to lay a foundation for training, task analysis, staffing and qualifications, and HSI. The image inset in the database screenshot is an illustration of the cross-reference table, where the data are stored for each item in the hierarchy. The cross-reference tables allow for retrieval of the data in many different forms and allows for the data to be changed in one location and used for different outputs.

Table 3-2 VISION® Icon Descriptions

Icon	Icon Title	Description
	Organizer	Top level of a Project
R	Responsibility Area	The NuScale system
F	Function	Introduction & FRA/FA Design categories (FRA/FA) Designates a system level function (Task Analysis)
P	Phase	Aspects of the FRA/FA
T	Task	A well-defined unit of work having an identifiable beginning and end, which is a measurable component of a specific job (Task Analysis)
E	Element	Steps in the procedure (Task Analysis)
	Job Position	A way to determine the roles and responsibilities of a task (Task Analysis)
SK	Skills & Knowledge	Describes knowledges and abilities required to perform a task

3.6.2 New Task Criteria

New tasks are developed if they are identified as tasks for new systems compared to existing nuclear plants or tasks that, while not new, are performed significantly differently from existing plants. NuScale uses the following criteria for determining if a task should be considered new.

- The system is unique or modified significantly for NuScale or not commonly used in the commercial industry.
- Any component or feature that is unique or modified significantly to NuScale or not commonly used in the commercial industry.
- Any component or feature that has a high reliance on automation.

Tasks that are considered new to NuScale are linked to the "New Task" table in VISION®.

3.7 Analysis of Feasibility and Reliability for Important Human Actions

The feasibility and reliability analysis for IHAs addresses the following:

- time available and time required to perform actions
- use of techniques to minimize bias
- sequence of actions
- estimated time for operators to complete credited actions

Time available to perform actions is the length of time from the initiation of the task to the time the task needs to be completed as defined in the analysis, which identifies the IHA (e.g., PRA, D3CA, and transient and accident analysis). Applicable regulatory guidance is considered for the analyses that determine each IHA, and for a task that industry experience identifies as a potential IHA. The time available is based on plant response to the anticipated operational occurrence or accident.

As discussed in Section 3.5.1, the 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. Time-required estimates for IHAs are simulated and measured when feasible, or obtained through operator and expert interviews, software modeling of human behavior during tasks, and OERs. The NuScale Power Plant US460 standard design does not include IHAs. The Treatment of Important Human Actions Results Summary Report contains more information (Reference 4.2.4).

4.0 References

4.1 Source Documents

4.1.1. U.S. Nuclear Regulatory Commission, "Human Factors Engineering Program Review Model," NUREG-0711, Rev. 3, 2012.

4.2 Referenced Documents

4.2.1. Human Factors Engineering Program Management Plan, TR-130414, Revision 0.

4.2.2. Human Factors Engineering Functional Requirements Analysis and Function Allocation Implementation Plan, TR-124333, Revision 0.

4.2.3. Human Factors Engineering Human-System Interface Design Implementation Plan, TR-130417, Revision 0.

4.2.4. Human Factors Engineering Treatment of Important Human Actions Results Summary Report, TR-130416, Revision 0.

4.2.5. U.S. Nuclear Regulatory Commission, "Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Westinghouse AP1000 Pressurized Water Reactors - Final Report," NUREG-2103