Task Analysis Implementation Plan

Technical Report

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ABSTRACT

This document provides the implementation plan for task analysis (TA), which is an element of the APR 1400 Human Factors Engineering Program.

The objective of TA is to identify the task requirements for accomplishing the functions allocated to plant personnel identified from the treatment of important human actions (IHAs) program element. The methodology described in this document provides:

(1) a basis for establishing human-system interface (HSI) inventories of indications, alarms, and controls
(2) the basis to verify that human-performance requirements do not exceed human capabilities based on the results of workload analysis
(3) basic information for developing procedures
(4) basic information for developing the staffing and qualifications, training, and communication requirements of the plant, such as the number of operating staffs, required knowledge and abilities, contact point between main control room and local control stations using communications devices;
(5) the basis for specifying the HSI inventory requirements for the detailed human system interface (HSI) design
(6) task support verification during human factors verification and validation.

TA is conducted by subject matter experts defined in the Human Factors Engineering Program Plan, such as plant operation experts and human factors engineering designers. TA is conducted iteratively and updated as detailed HSI design is better defined.

An initial TA may be conducted before detailed HSI instrumentation and control design requirements have been implemented, such as HSI inventory requirements (i.e. required alarms, indications, controls, and procedures). After the detailed HSI design has been developed, a subsequent TA confirms that the design is acceptable to the operating crews in a control room.

During this iterative process, discrepancies between the HSI design and the actual system design may be identified as human engineering discrepancies (HEDs). HEDs may also be identified during the human factors verification and validation.

The functional requirements analysis and function allocation process establishes qualitative functional requirements for human performance for systems in various plant conditions. TA uses quantitative calculations of time required and workload to confirm those functional requirements. HEDs are generated for any discrepancies.

In the absence of specific functional requirements, the TA will establish the necessary staffing for each task.

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List of Acronyms

ACR	advanced control room
AOP	abnormal operating procedure
ANS	American Nuclear Society
ANSI	American National Standards Institute
CEA	control element assembly
CTMT	containment
DCD	Design Control Document
EDG	emergency diesel generator
EOF	emergency operations facility
EOG	emergency operating guideline
EOP	emergency operating procedure
FA	function allocation
FRA	functional requirements analysis
GOP	general operating procedure
HA	human action
HED	human engineering discrepancy
HF	human factors
HFE	human factors engineering
HFEPP	human factors engineering program plan
HTA	hierarchical task analysis
HSI	human-system interface
KHNP	Korea Hydro and Nuclear Power
I&C	instrumentation and control
ICR	information and control requirement
IHA	important human action
LCS	local control station
LCP	local control panel
LDP	large display panel
LOOP	loss of offsite power
MCR	main control room
OER	operating experience review
PSF	performance shaping factor
SME	subject matter expert
SOP	system operating procedure
SGTR	steam generator tube rupture
TA	task analysis
P-T	pressure and temperature
RCS	reactor coolant system
SRO	senior reactor operator
RO	reactor operator
RSR	remote shutdown room
TSC	technical support center

1.0 Overview

1.1 Purpose

Task analysis (TA) is performed to define human-system interface (HSI) inventory and to confirm the allocations to humans from the results of function allocation (FA). TA provides input to inform Human Factors Engineering (HFE) design.

TA results are used to establish the instrumentation and control requirements needed for a crew to perform a task. This involves the analysis of a detailed description of both manual and mental activities, task and element durations, task frequency, task complexity, workload, environmental conditions, and necessary clothing and equipment. TA confirms the task allocations developed by the functional requirements analysis/function allocation (FRA/FA) process.

The results of the TA will:

- Provide a basis for making decisions on HSI detail design and be used to develop Information and control requirements (ICRs) and basic inventories of alarms, displays, and controls for the control room HSIs, including those that are needed beyond the selectable HSIs provided on the non safety-related, computer-based workstations normally used by the operators to monitor and control the plant.
- Verify that human-performance requirements do not exceed human capabilities
- Be used as basic input for developing procedures
- Be used as basic information for developing the staffing, training, and communication requirements of the plant
- Inform tool or equipment design
- Form the basis for specifying the design requirements for the displays, data processing, and controls needed to carry out tasks
- Be applied in the verification of the design in the human factor verification and validation program.
- Be used to identify and reduce excessive task demand on plant personnel, to decrease the potential hazard for human errors, and to increase the effectiveness of plant operations.

1.2 Scope

Human actions (HAs) are performed to accomplish the function that is allocated to plant personnel by the function allocation process (e.g., manual control; automatic systems with human oversight and manual backup; or shared control).

HAs can be divided into tasks. TA ensures that required tasks of the personnel, including important human actions (IHAs), can be successfully performed at the control stations. The control stations consist of the main control room (MCR), the remote shutdown room (RSR), the technical support center (TSC), the emergency operations facility (EOF), and local control stations (LCSs) where Important HAs (IHAs) are performed.

The TA scope includes a review of the following:

- IHAs as determined by probabilistic and deterministic means described in the Results Summary Report for Treatment of Important Human Actions

- Tasks associated with normal, abnormal, emergency, and alarm response procedures with human allocations from the FRA/FA process
- Tasks selected by subject matter experts (SMEs) related to:
  - surveillance, test, inspection and maintenance procedures;
  - operational tasks that are precursors to plant transients that are not procedure based (e.g., unusual failure modes that may not have alarm response procedures such as spurious opening of a pressurizer spray valve, spurious control rod withdrawal, or erroneous operation of any control system where the operators have had to revert to skill based manual operation such as for low power steam generator level control);
  - startup operations; and
  - low-power, shutdown, and severe accident conditions.
- Tasks selected by plant operation SMEs that are known to challenge operating crews based on their judgment
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1.3 Definitions

HFE-significant I&C degradations	The failure modes and degraded conditions of the I&C system that have the potential to impact HSIs used by personnel to perform important human actions.
Hierarchical Task Analysis	Hierarchical task analysis (HTA) is a task description method and a variant of TA. HTA is a method of deconstructing higher-level functions to identify the information and controls that personnel need to perform their tasks including the time required. HTA is used to produce an exhaustive description of tasks in a hierarchical structure of goals, sub-goals, tasks, and task elements including information and control requirements. In the HTA, tasks are broken down into progressively smaller units.
Human factors	Human factors (HF) are a body of scientific facts about human characteristics. The term covers all biomedical, psychological, and psycho-social considerations. It includes, but is not limited to, principles and applications in human factors engineering, personnel selection, job design, training, job performance aids, and human performance evaluation.

Human-system interfaces (HSIs)	A human-system interface is that part of the system through which personnel interact to perform their functions and tasks. HSIs include alarms, information displays, controls, and procedures. Their use can be influenced directly by factors such as: • the organization of HSIs into workstations (e.g., consoles and panels); • the arrangement of workstations and supporting equipment into facilities, such as a main control room, remote shutdown station, local control station, technical support center, and emergency operations facility; and • the environmental conditions in which the HSIs are used, including temperature, humidity, ventilation, illumination, and noise. The use of HSIs also can be affected indirectly by other aspects of plant design and operation, such as personnel training, shift schedules, work practices, and management/organizational-factors, such as the plant's safety culture.
Important human actions (IHAs)	IHAs consist of those actions that meet either risk or deterministic criteria. • Risk-important human actions - Actions defined by risk criteria that plant personnel use to assure the plant's safety. There are absolute and relative criteria for defining risk important actions. For absolute ones, a risk-important action is any action whose successful performance is needed to reasonably assure that predefined risk criteria are met. For relative criteria, the risk-important actions are defined as those with the greatest risk compared to all human actions. The identification can be made quantitatively from risk analyses, and qualitatively from various criteria, such as concerns about task performance based on considering performance-shaping factors. • Deterministically identified IHAs - Deterministic engineering analyses typically are completed as part of the suite of analyses in the DCD in Chapters 7, Instrumentation & Controls diversity and defense-in-depth (D3) analysis, and Chapter 15, Transient and Accident Analyses for credited manual actions.
Local control station (LCS)	A personnel interface for process control that is not located in the main control room. This includes multifunction panels; single-function controls, such as valves, switches, and breakers; and displays (e.g., meters) that are operated or consulted during normal, abnormal, or emergency operations.
Performance Shaping Factors	PSFs are factors that influence human reliability via their effects on performance. They include environmental conditions, the design of human-system interfaces, procedures, training, and supervision.
Subject Matter Experts	A subject matter expert (SME) is a person who is an expert in a particular area or topic. The SME's minimum qualification and typical contributions are defined in the Human Factors Engineering Program Plan (Reference 1)

Task	Task means a group of activities with a common purpose, often undertaken in close temporal proximity.
Task analysis	Task analysis is the identification of the specific tasks needed to accomplish all personnel functions, and the information, control, and task support required to accomplish those tasks.
Workload	Workload is comprised of the physical, cognitive, and other demands that tasks place on plant personnel.

2.0 References

1. KHNP, APR1400-E-J-NR-12002-P, “Human Factors Engineering Program Plan,” 2013.
2. NUREG-0711, Revision 3, “Human Factors Engineering Program Review Model”, 2012.
3. ANSI/ANS-58.8-1994, “Time Response Design Criteria for Safety-Related Operator Actions.”
4. NUREG-0800, Revision 2, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition”, Chapter 18, 2007.
5. NUREG/CR-3371, “Task Analysis of Nuclear Power Plant Control Room Crew”, 1983.

3.0 Methodology

Hierarchical task analysis (HTA) is a method of deconstructing higher-level functions to the information and controls requirements (ICRs) that personnel need to perform their tasks. The HTA process will be an integral part of the TA methodology.

HTA is useful when the detailed tasks that need to be performed to accomplish higher-level functions are not well defined. The HTA method produces detailed task descriptions that define the tasks to be performed, their relationship to higher-level tasks, HSI, and other requirements for task performance.

The following TA methodology is used:

- TA input
- HTA
  - Select tasks to analyze
  - Develop high-level descriptions
  - Develop detailed task descriptions
  - Identify task requirements
- TA output

The following sections describe the TA methodology.

3.1 TA Input

The main inputs to TA are the operating experience review (OER), function allocation (FA), IHAs, and detailed plant design information.

The OER provides information about which tasks are important to maintain the plant safety functions, which tasks have been problematic in the past, and which tasks might be targets of opportunity for improvements compared to the reference plant design. The FA provides information for human allocated tasks focusing on the level of automation. The IHAs provides information about which tasks are important to analyze operators' workloads. Detailed plant design information from the reference plant design includes information on systems, components, and plant procedures needed to properly describe the tasks.

The following topics taken from Table 5-1 of NUREG-0711, Revision 3, "Human Factors Engineering Program Review Model", 2012 (Reference 2) are considered in the analysis:

- Alerts
- Information
- Decision-making
- Response
- Teamwork and communication
- Workload
- Task support
- Workplace factors
- Situational and performance shaping factors
  Hazard identification

3.2 Hierarchical Task Analysis

Hierarchical task analysis (HTA) is an information development tool that is used to systematically expand upon the basic description of the activities that must be undertaken to perform a task. Results of the HTA produce a hierarchy of tasks. HTA provides an effective means of identifying how work should be organized in order to meet a specific goal.

A hierarchical structure is used as the framework to deconstruct selected event sequences into components as shown in Table 1. The hierarchical structure of gross-functions, sub-functions, tasks, and task elements are used as the framework to deconstruct selected event sequences into system or related components. This information is used to perform the following steps:

- Select tasks to analyze
- Develop high-level descriptions
- Develop detailed task descriptions
- Identify task requirements

Table 1. Hierarchical Structure for Task Analysis

Level	TA Structure	Procedure	Example
1	Gross function	Procedure/Sub-procedure	SGTR/Verify faulted S/G
2	Sub-function	Step	Ensure reactor shutdown
3	Task	Instruction	Collect information for control element assembly (CEA) position
4	Task element	Instrument/Control	CEA position indicator

3.2.1 Select Tasks to Analyze

The first step is to select a task to analyze from a screening methodology including HSI inventory of tasks that are new or significantly changed from the reference design.

The TA scope includes a review of the following:

- IHAs as determined by probabilistic and deterministic means described in the Results Summary Report for treatment of important HAs
- Tasks associated with normal, abnormal, emergency, and alarm response procedures with human allocations from the FRA/FA process
- Tasks selected by SMEs related to:
  - surveillance, test, inspection and maintenance procedures;
  - operational tasks that are precursors to plant transients that are not procedure based (e.g., unusual failure modes that may not have alarm response procedures such as spurious opening of a pressurizer spray valve, spurious control rod withdrawal, or erroneous operation of any control system where the operators have had to revert to skill based manual operation such as for low power steam generator level control);
  - startup operations; and
  - low-power, shutdown, and severe accident conditions.

- Tasks selected by plant operation SMEs that are known to challenge operating crews based on their judgment

The following materials are the source of information used to select representative tasks by subject matter experts (SMEs) in plant operations:

- Results from the FRA/FA process
- Emergency operating guidelines
  - APR1400 Emergency operating guidelines (EOG)
- Operating procedures from reference plant
  - General operating procedures (GOP)
  - Abnormal operating procedures (AOP)
  - System operating procedures (SOP)
- Important HAs,
  - OER
  - D3 from DCD Chapter 7
  - Credited operator actions from DCD Chapter 15
  - Risk-important HAs from DCD Chapter 19
  - LCS associated with important human actions (e.g., functionality and inventory of LCS controls, displays, and alarms)

Task information collected for this analysis is based on expert judgment by SMEs. Exact order of tasks performed may vary depending on operator preference. Independent operational reviewers will be used to help control this variance. A screening methodology is used to select the tasks for analysis, based on specifically established criteria. When the task requirements are not known in detail, an assessment can be made at a high level by SMEs in plant operations and HFE specialists as defined in the APR1400 Human Factors Engineering Program Plan (Reference 1). In this case, detailed analysis for selected tasks will be performed later in the detailed HSI design phase and will be fed back to the detailed design descriptions and updated design evaluation factors.

3.2.2 Develop High-level Descriptions

Once the tasks to analyze are selected, the next step is deconstructing a high-level task description to a level of detail precise enough to identify the requirements for performance. Thus, the HTA is a continuation of the process of hierarchical deconstruction that began in function analysis.

Even if the initial task details are not complete, it is acceptable to define a high level description, since the missing information can be added once the task is analyzed in more detail or as the design matures sufficiently to make such information available.

The HFE analyst determines what information already exists for the selected tasks. TA information may be available from the following sources:

- An existing verified plant procedure
- An analysis of the task from the reference plant
- An analysis of a similar task from the reference plant

Information to develop the task description can come from a variety of sources, such as:

- Knowledgeable personnel from the design team
- Subject matter experts
- Walk-throughs and talk-throughs
- Tests and evaluations

To establish analysis structure for task deconstruction, the hierarchical structure is used as the framework to deconstruct event sequences into components.

The high level descriptions should contain gross-functions and sub-functions.

3.2.2.1 Gross-function Level

The gross-function level is the highest level of TA hierarchy. It includes top level statements of the procedure such as purpose, entry condition, termination condition, and details that are associated with prerequisite conditions. The gross-function descriptions include the following major information:

- Object: The purpose of procedure execution
- Entry Condition: The condition that should be checked before entering the procedure execution
- Termination Condition: The condition that should be checked before terminating the procedure execution
- Warning/Caution Message: The warning/caution message considered in procedural execution

3.2.2.2 Sub-function Level

Sub-functions are high-level statements of the operator's general goal in performing a related set of tasks. They specify a basic operating goal (e.g., "Maintain RCS Heat Removal") from the operator's perspective. Each sub-function statement represents one or more tasks with a single main purpose. Sub-functions appear within sequences in a generic order of performance, per operating procedures.

The sub-function level of this analysis also specifies details that are associated with operation aids. The related data include:

- Error: A particular situation in which an operator can easily commit an error
- Calculation Aids: Aids that an operator can easily use to perform calculations (e.g., boron concentration)
- Graphical Aids: Graphic aids that an operator can easily use to perform monitoring of process conditions (e.g., trend graph, X-Y plot, comparison table/graph)

3.2.3 Develop Detailed Task Descriptions

3.2.3.1 Task Level

The task level analyzes operator behaviors in terms of a generic, closed-loop information processing model. It utilizes a simple but comprehensive database that can accommodate a large variety of specific tasks. The model views a task as falling into one of four basic categories:

- Collect: Collect or obtain needed information
- Plan: Plan, evaluate, calculate, or decide on a result or course of action based on collected or otherwise known information
- Action: Perform the act or manipulation specified
- Feedback: Monitor the results of output actions and transmit the results back to the input; this either verifies success or cues further processing and corrective action

Tasks in a sequence tend to cycle through these categories, although well-designed and skillfully performed tasks do not necessarily show four distinct components. The benefit of this framework is that it directs the analyst's attention to the necessary components of deliberate, rule-based (i.e., procedural) behavior.

A single task is expressed by a task statement. A task statement includes two basic parts, which are 1) a verb from the defined verb taxonomy (listed in the TA database), and 2) the object of the verb, (a parameter, component, etc.).

For example:

Collect pressurizer pressure
(verb) (object)

These task statements then serve as the centerpiece around which the remaining task element data are organized and documented. The Appendix defines the verb sets used in this analysis.

The task level also includes additional data that associate with operation and cognitive task information.

These data include:

- Task Entry Condition: The condition that should be checked before entering the task execution.
- Task Behavior: The evaluations to be performed or the calculations to be executed at task level.
- Time required: The period of time required, as assumed by the analysis, for the execution of the multiple elements comprising the task statement. The initial screening value of time allowed to perform each task statement is one minute (see Section 3.2.5).
- Time available: A limiting value based on the design that ensures that the consequences of any design based events or severe accidents do not result in (1) violation of plant safety criteria or (2) unacceptable degradation of components that are required to mitigate the consequences of these events or accidents. This information is input from the DCD Chapters 7, 15, and 19.

3.2.3.2 Task Element Level

The task element level of this analysis specifies critical details that may be associated with each task statement. These data complete the TA picture of task behavioral requirements (i.e., of how the task must be performed). The additional data include:

- Resources: HSI resources needed to perform the task (e.g., Alarm, Display, Soft Control, LDP, Local)
- Criteria: Component status or process value to meet the task criteria (e.g., Start/Open, Stop/Close, Process Value)
- Location: The place or position at which a given task is expected to be performed. Location data provides a basis to perform link analysis.
- Information and Control Requirements (ICRs): The requirements for display and control variables identified by the TA. Characteristics of the requirements include the following:
  - Device type: A recommendation for display/control type for each variable is provided based on the TA results, operating experience, human performance characteristics, and human factors guidance.
  - Range: The upper and lower value limits for each variable, as required for operations, are provided based on transient performance figures.
  - Accuracy: The instrument accuracy required for each variable is provided based on operations requirements.
  - Units: The recommended unit of measure for each variable is provided based on operational experience, industry preference, and engineering judgment.
  - Precision: The display precision of each measured variable is provided based on the operator task requirements.

3.2.4 Identify Task Requirements

Workload Analysis, IHAs, and Bias Control apply to the identification of task requirements as described below.

3.2.4.1 Workload Analysis

The event sequences identified are analyzed and reviewed by experts in plant operations. Workload is evaluated by comparing estimates of time available and time required to complete a task. The following screening criteria apply:

1. A conservative criterion based on ANSI/ANS-58.8-1994 (Reference 3) provides a minimum of one minute for each required manual action (i.e., task element). This is an initial criterion to identify a potentially excessive workload. Since ANSI/ANS 58.8 is based on conventional analog systems, expert judgment is used to modify the time for specific actions. When this is done, it is documented and reported in the Results Summary Report.

2. If task requirements exceed the limits of screening criterion 1, more detailed evaluation of the human performance requirements is performed by the HFE design team. Workloads under 75% are maintained to accomplish human actions.

Event time profiles are then plotted on time lines and sectioned into evaluation intervals (to minimize unnecessary detail, discrete activities may be summed within longer intervals). Process time estimates are then derived by evaluating data from event time profiles. The event time profile evaluation considers:

- The time into the event sequence at which the operator is expected to be cued to perform the tasks in an interval
- The time available to perform the tasks in the interval (i.e., plant process constraints)
- The time required to perform the tasks in the interval (i.e., human performance constraints)
- Whether time required exceeds time available for specified task intervals

If the time required exceeds the time available, then task loading is a concern. In such cases, the task sequence is reevaluated incorporating more refined timing assumptions. If this detailed evaluation continues to show that more time is required than is available for operator action, the issue is identified in the results, and receives formal assessment and resolution per the design process and HFEPP. This review will utilize the information in the Task and Task Elements Data Form, Table 3, and consider the number of operators and the crew qualification required to perform each task.

3.2.4.2 Important Human Actions

In addition to the representative event sequences, risk-important human actions and deterministic human actions are used to identify critical tasks. These are operator tasks described in DCD Chapters 7, 15, and 19.

IHAs are incorporated as separate tasks in the TA database. Findings from TA of IHAs are resolved through the formal documentation process per the requirements of the HFEPP.

The analysis of IHAs 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.

- The analysis of the time required is based on a documented sequence of operator actions (based on TA, vendor-provided generic technical guidelines for emergency operating procedure development, or plant-specific EOPs, depending on the maturity of the design)
- 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
- The sequence of actions uses only alarms, controls, and displays that would be available and operable during the assumed scenario(s)
- The estimated time for operators to complete the credited action is sufficient to allow successful execution of applicable steps in the EOPs
- 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
- The analysis of the action sequences is conducted at a level of detail sufficient to identify individual task components, including cognitive elements such as diagnosis and selection of appropriate response
- The analysis identifies a time margin to be added to the time required and the basis for the adequacy of the margin

3.2.4.3 Bias Control

Independent review by the HFE design team is performed to assure the completeness, consistency and correctness of the selection of the tasks to be analyzed. Reviewer identified discrepancies are resolved by the process defined in the HFEPP. Two independent operation reviewers analyze each task data to ensure accuracy. When a high degree of agreement is seen between reviewers, the TA process will summarize the results in sufficient detailed to define the alarms, information, controls, and task support needed to accomplish the task. If discrepancies are identified between reviewers, the issues are resolved and appropriate changes made to the data by the issue tracking procedures of the HFEPP.

3.3 TA Output

The TA process provides detailed information about what is needed to perform tasks. This information has many uses in subsequent analyses, including: staffing and qualification, HSI and procedure design, and training program development.

3.3.1 Staffing and Operator Performance

The results of TA are used as one of the major inputs to the staffing analyses. Based on the task requirements, tasks are assigned to personnel and staffing levels are examined.

For modifications to existing plants, it is unlikely that Operations staffing levels will change as a result of the HSI modifications, particularly since the staffing levels are tied closely to regulatory requirements. However, assignment of tasks among the crew members may change as discussed.

The detailed task descriptions developed in TA are used to initiate an evaluation of the types of human errors that can result when personnel perform tasks individually or in groups.

3.3.2 Human-System Interface Design

The TA process is also a significant input to HSI design, perhaps even more so when designing computer-based HSIs as compared with analog HSIs. This is because of the high degree of freedom that exists with computer-based HSIs to design the alarms, displays, and controls to be much more task-specific.

Task information is used to determine what should be displayed and how information should be grouped. For example, using the task element relationships can indicate how information should be grouped and how users will need the information in sequence. This is extremely important because when the HSI does not present information in a manner that is consistent with the task demands, user performance suffers.

3.3.3 Procedure Design

Task requirements and sequence information are key inputs to procedure design. In fact, draft procedures can be written directly from the TA documentation when new tasks are created. For modifications, the initial TAs usually start from established, verified procedures used for an existing system. Vendor component procedures also may be used as a starting point for analysis of tasks. Finally, the TA may be performed in conjunction with the development of new or modified procedures.

3.3.4 Training Program Development

TA information is an important input to trainers since the analysis identifies what skills and training users need to perform the tasks. For a new plant design, the skills, knowledge and abilities identified from the TA would be reflected in personnel selection/hiring and to initially develop the training program. For modifications to existing plants, changes needed to the existing training program should be defined based on results of the TA, which is particularly important for the unique considerations related to digital I&C/HSI upgrades.

4.0 Implementation

4.1 Screening Process to Select Tasks to Analyze

To select representative tasks, subject matters experts in plant operation consider the following:

- Tasks that were not identified as IHAs 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 power production, 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)

The following event sequences comprise a representative cross section of operations for the TA, including all Emergency Operating Guidelines (EOGs).

TS

The Task and Task Elements Data Form, Table 3, is completed when analyzing high-level functions (procedures) and task elements (information properties).

4.2 Develop Gross Functions and Sub-functions

Once the tasks to analyze are selected, the actual TA is a matter of developing a high-level task description and deconstructing this description to a level of detail precise enough to identify the requirements for performance.

The basic elements of the high level gross-functions and sub-functions are shown in Table 2, Gross Functions and Sub-functions Data Form.

TA information is available from the following sources:

- an existing verified plant procedure
- an analysis of the task from a previous activity
- an analysis of a similar task from a previous activity
- an analysis of the task from a similar plant
- an analysis of the task from vendor design efforts or vendor manuals

Information to develop the task description can come from a variety of sources, such as:

- Review of existing documentation
  - supplier documentation
  - existing procedures
  - manuals
  - training materials
- Knowledgeable personnel from the design team
- Subject matter experts
- Onsite or offsite personnel who perform the task
- Walk-throughs and talk-throughs
- Tests and evaluations

Often a combination of these information sources is used. The sources of information that are more readily available can be used to lay out the scope of the tasks. The more resource-intensive sources can be used as a last resort or reserved for those tasks of particular interest, for example, mission critical tasks, safety critical tasks, and tasks associated with new functionality.

Table 2. Gross Functions and Sub-functions Data Form

TS

4.3 Tasks and Task Elements

The Task and Task Element Data Form is shown in Table 3. An explanation of the headings in Table 3 is provided below:

Tasks

- Task number: Number of task in the current step
- Task verb: Describe "verb" in the current task pertaining to operator information processing
- Task object: Describe the object of the verb
- Procedure number: Database-defined procedure number
- Number of operators and knowledge
  - The number and type of operator required to perform the task (e.g., Reactor Operator, Equipment Operator)
  - Any special knowledge and abilities required to performed the task (e.g., RO license, SRO license)
- Task type will be Monitoring, Verification, or Action as described below:
  - Monitoring: Collect, compare and judge necessary information by detecting and observing changes in process variables (alarm, conditions, and state) such as main steam - feedwater flow mismatch alarm, temperature high, valve status, shutdown cooling system condition, etc. required for operator to perform tasks.
  - Verification: Situation or condition verification such as pump operation verification, valve array verification, post-trip band, P-T curve limit following operator action
  - Action: Operator action such as pump activation, valve control, damper control
- Decision
  - Individual: Task performed without comparison and estimate at the time of task execution

- Comparison: Task performed with comparison to multiple variables at the time of task execution
- Estimation: Task performed with estimate of specific value at the time of task execution

- System function: Describe system function associated with the current task.
- Notice: Describe details and situations manifested through operating experience to consider (conditions, specific values, actual factors, etc.) when performing current task.
- Remarks: Describe additional explanation for task, task-related details for designers to consider, task-supporting requirements such as drawings and publications, communication requirement between operators, radioactivity-associated dangerous tasks, etc.
- Expected Behavior Outcome: Describe the expected behavior outcome or judgement made based on existing or operator-collected information
- Teamwork and Communication: Describe the teamwork, if any, and communication methods used to perform the task.
- Workplace: Describe the workplace location where the task is performed.
- Situational Factors: Describe any unforeseen situational factors that may apply to executing the task.
- Performance Shaping Factors: Describe any applicable performance shaping factors that could have a significant bearing on the intended outcome of the task.
- Hazard Factors: Describe any workplace hazards that could could effect the intended outcome of the task.

Task Elements

Information and characteristics necessary for operators performing tasks are derived through HTA of operating procedures. Information requirements cover parameters (e.g., units, range, accuracy), alarm message, control (e.g., control type, control activities), feedback (e.g., operations, objectives, and monitoring).

- Instrument - Describe properties of various indicators required to perform the task element
  - Tag ID
  - Location (LCP, MCR, LCP + MCR)
  - Power Source (Class 1E/Non-1E)
  - Readings
  - Unit
  - Other
  - Time required to collect the necessary information (minutes)

- Control: Describe control or target device required to perform the task element
  - Control Tag ID
  - Location (LCP, MCR, LCP + MCR)
  - Power Source (Class 1E/Non-1E)
  - Other

- Time required to operate the control (minutes)

- Alarm: Describe any alarm required to perform the task element
  - Tag ID
  - Flag
  - Other
  - Time Required (minutes)

- Trend: Describe the variable that should display changes over time, e.g., pressurizer pressure – Narrow range / wide range trend indication

- Feedback: Record the results of actions taken, e.g., Increase of Containment humidity

Table 3. Task and Task Elements Data Form

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5.0 Records

The results of the TA will be documented in the Results Summary Report.

The TA data are stored on a database system to allow manipulation and updating of information. As additions are made to the database, existing portions of the analysis are updated to reflect any changes to the HSI design. This ensures the internal consistency between the final TA results and the APR1400 design.

When completed, the TA database incorporates all event sequences and the related results from the analysis of those sequences. A Results Summary Report will be issued including the following:

- A description of the applied method
- A discussion of how the method meets this Implementation Plan
- Result tables
- Any resulting HEDs between the results of the TA and the FA

APPENDIX - Verb List for Task Statements

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