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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: T. R. QUAY

SUBJECT: DRAFT SSAR SECTION 18.5 AP600 TASK ANALYSIS ACTIVITIES

Dear Mr. Quay:

Enclosed is a draft of the SSAR Section 18.5 AP600 Task Analysis Activities. The section has been revised to provide resolution to DSER open items 18.5.3-1 and 18.5.3-2. The items will be closed when the draft section is incorporated into the SSAR.

Please contact Susan V. Fanto on (412) 374-4028 if you have any questions concerning this transmittal.

Brian A. McIntyre, Manager
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/nja

Attachment

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J. O'Hara, BNL

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18.5 AP600 Task Analysis Activities

Task analysis, according to the Human Factors Engineering Program Review Model (NUREG-0711), has the following objectives:

- Provide one of the bases for the man-machine interface system design decisions
- Ensure that human performance requirements do not exceed human capabilities
- Provide input to procedure development
- Provide input to staffing, training, and communications requirements of the plant

This subsection describes the scope of the AP600 task analysis activities and the task analysis implementation plan. In addition to NUREG-0711, references __ through __ are inputs to this plan:

18.5.1 Task Analysis Scope

The scope of the AP600 task analysis is divided into two complementary activities: function-based task analysis (FBTA) and traditional task analysis, or operational sequence analysis (OSA). The scope of the function-based task analysis is driven by the 19 Level 4 Functions identified in Figure 18.5-_. This figure is the functional decomposition (goal-means analysis) for normal power operations in a standard pressurized water reactor. Examples of functions at Level 4 are "Control RCS Coolant Pressure" and "Control Containment Pressure." This set of 19 functions define the breadth of functions to be analyzed. The function-based task analysis will be expanded in scope to include any additional functions identified.

The traditional task analysis, or operational sequence analysis, is driven from a representative set of operational and maintenance tasks. The following guidelines are be applied to select tasks:

- Tasks are selected to represent the full range of operating modes, including startup, normal operations, abnormal and emergency operations, transient conditions, and low-power and shutdown conditions.

- Tasks are selected that involve operator actions that are identified as either critical human actions or risk-important tasks based on the criteria in Reference _, WCAP-14651, "Integration of Human Reliability Analysis and Human Factors Engineering Design Implementation Plan."

- Tasks are selected to represent the full range of activities in the AP600 emergency response guidelines.

- Tasks are selected that involve maintenance, test, inspection, and surveillance (MTIS) actions. A representative set of maintenance, test, inspection, and surveillance tasks will be analyzed for a subset of the "risk-significant" SSCs (Systems/Structures/Components) that are identified via the Reliability Assurance Program (RAP).

The set of tasks to be analyzed are not identified as a part of design certification. The human factors engineering program review model (NUREG-0711) indicates that task analysis should include tasks that are considered to be high-risk and tasks that require critical human actions. Reference _, WCAP-14651, "Integration of Human Reliability Analysis and Human Factors Engineering Design

Implementation Plan" defines criteria for critical human actions and risk-important tasks and has identified a preliminary list of AP600 tasks that meet these criteria.

Section 16.2 defines the elements of "risk-significance" used to identify the Systems/Structures/Components to be included in the Reliability Assurance Program (RAP). A subset of these Systems/Structures/Components and a representative set of associated maintenance, tests, inspection and surveillance tasks will be selected by an Expert Panel. This panel will be comprised of representatives with expertise from relevant groups in the design process, such as systems engineering, reliability engineering, probabilistic risk analysis, human factors engineering, and man-machine interface design. The set of maintenance, test, inspection and surveillance tasks identified through the expert panel process will be considered to be "risk important" tasks, and will be included in task analysis activities.

18.5.2 Task Analysis Implementation Plan

Figure 18.8-X shows the proposed sequence of task analyses. Specifically, Figure 18.8-X provides information concerning the Task Analysis and man-machine interface system design elements. Task analysis includes both a function-based task analysis and an operational sequence analysis. In Figure 18.8-X, the operational sequence analysis in the Task Analysis box is designated as OSA-1 since two operational sequence analyses will be implemented.

18.5.2.1 Function-Based Task Analyses

Function-based task analysis will be applied to each of the 19 Level 4 Functions. There are four components to a function-based task analysis. First, analysis is performed to identify the set of goals relevant to the function. Second, a functional decomposition is performed. This decomposition identifies the processes that, either individually or in combination, have a significant effect on the function. Third, a process analysis is performed by applying the eleven questions derived from Rasmussen's (1986) analysis approach (see subsection 18.5.X for the complete list of these questions). An example of a question from the process analysis is "Are the process data valid?" The results of the process analysis identify the indications, parameters, and controls that the operator uses to make decisions about the respective function. Finally, there is a verification that the parameters, controls, and the like, identified in the process analysis are all included in the current AP600 design.

From the function-based task analyses, the following types of information will be obtained that feed into man-machine interface system concept development:

- A completeness check on the availability of needed indications, parameters, and controls. This includes indications and controls needed for supervisory control of automated systems and manual over-ride.

- Input to the specification and layout of functional displays.

18.5.2.2 OSA-1

The operational sequence analysis completed as part of the Task Analysis process (that is, OSA-1) focuses on specifying the operational requirements for the complete set of tasks selected. For each task, an operational sequence diagram of the task's performance is created that includes the following:

- Plant state data (or other data) required at each step
- Source of the data (for example, alarm, display, oral communication)
- Action to be taken or decision to be made from the data
- Relevant criterion or reference values
- Information that provides feedback on the action's adequacy
- Time available for action
- Other temporal constraints (for example, ordering, tasks that need to be done in parallel)
- Task support requirements needed (for example, special clothing, job aids, required tools)
- Considerations of work environment (for example, location, environmental conditions)

The operational sequence diagrams are developed from the emergency response guidelines, the Probabilistic Risk Assessment event sequences associated with critical or risk-important actions, and the function-based task analysis. In addition to these analyses of tasks, the following potential limitations on task performance are considered:

- Limits on human performance (physical, perceptual, cognitive)
- Limits on hardware and software performance (from system specific documents)
- Limits on crew communications

This first operational sequence analysis will provide the following types of information that feeds into man-machine interface system development:

- Frequency and co-occurrence of plant state parameters and controls (for example, to support display layout and organization)

- Display design and organization constraints

- Performance time constraints

- Inventory of alarms, controls, and parameters needed to perform the sequences

As shown in Figure 18.8-X, the function-based task analysis and OSA-1 feed into man-machine interface system design by providing a set of requirements and constraints on task performance. Man-machine interface system concept development, especially display and operator workstation design, will proceed from this information.

During man-machine interface system design activities, man-machine interface system concepts are tested by evaluating human performance in simulated tasks using prototype interface elements (Reference __, WCAP-14396, "Man-in-the-Loop Test Plan Description"). By prototyping, testing, and refining man-machine interface system design concepts, the design can move toward the appropriate performance criteria.

18.5.2.3 OSA-2

The critical issues for the second operational sequence analysis are:

- Completeness of available information – This analysis determines whether all necessary information is available to the operator performing the task activities. The man-machine interface system design indicates the number of man-machine interface system elements that are used for each action or decision to occur.

- Time to perform tasks – Operational sequence modeling tools are used to provide a set of performance time assumptions and then determine the time required for actions to be completed. Assumptions can be made about minimum times to access displays and controls and, by running the task modelling network with these assumptions, the time required to perform tasks can be determined. The operational sequence analysis begins with conservative assumptions regarding the performance of hardware, software, and humans, and assumes minimal use of parallel task performance. These assumptions provide a conservative estimate of task performance times that can be compared to performance time requirements.

- Operator workload measures – Task network modelling tools are used to evaluate the effect of the man-machine interface system design on operator workload. Operator workload can be assessed at three levels of detail. First, workload can be measured against time available to perform each task related to time estimates to perform. When time to perform estimates are larger than the time available, operator workload is too high, and some corrective action is required. Second, operator workload estimates can be broken out into resource "channels." Typically, an analysis uses four to six independent channels, which may include visual, auditory, verbal, cognitive, psychomotor, and kinesthetic channels. For each task or activity, an assessment is made about the level of activity in each channel. When the task network model is executed, the workload values are accumulated over short time intervals (for example, every 2 seconds). Workload values on each channel are graphed and the analyst identifies points in task performance where workload exceeds some threshold value. When workload is too high, due either to demands from concurrent tasks or demands from a single task, some corrective action is required. The third approach to estimating operator workload is to add a consideration of cross-channel interference. Workload theories indicate that, although it is useful to think of multiple mental resources being tapped by task performance, there is also a need to be concerned with interference between concurrent activities. Several tools make it possible to extend the analysis of separate channels and create an interference matrix that reveals additional demands on operator workload. These tools use task rating schemes with built in assumptions about interference to produce the additional workload estimates.

- Operational crew staffing – The workload analysis operational sequence analysis provides an indication of the adequacy of staffing assumptions. In cases where the operational sequence analysis indicates high operator workload values, or insufficient time available for performance, alternative staffing assumptions or changes to the man-machine interface system design or task allocation to reduce operator workload will be evaluated.

This second operational sequence analysis is a representative subset of tasks that include the critical human actions and risk-important tasks and tasks that have human performance concerns (for example, potential for high workload or high error rates).

18.5.2.4 Task Analysis of Maintenance, Test, Inspection and Surveillance Tasks

The maintenance, test, inspection, and surveillance tasks that are identified to be "risk-important" will be analyzed using operational sequence task analyses. OSA-1 analyses will be conducted on the set of maintenance, test, inspection, and surveillance tasks identified to be "risk-important."

18.5.3 Job Design Factors

Section 18.6 addresses the control room staffing that applies to the AP600. Assumptions regarding skill requirements are consistent with NRC regulations on control room crew training. The staffing level of the main control room, job design considerations, and crew skills are the responsibility of the Combined License applicant.

18.5.4 Combined License Information Item

Combined License applicants referencing the AP600 certified design address the scope and responsibilities of each control room position, considering the assumptions and results of the task analysis..

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REFERENCES

- U.S. NRC Guidance: NUREG/CR-3371 - Task analysis of nuclear power plant control room crews
- IEC-964: Design for Control Rooms of Nuclear Power plants
- Department of Defense Documents: DI-H-7055 - Critical task analysis report and MIL-STD-1478 - Task Performance Analysis
- NATO Document: Applications of human performance models to system design. Edited by McMillan, Beevis, Salas, Strub, Sutton, & van Breda. New York: Plenum Press. 1989.

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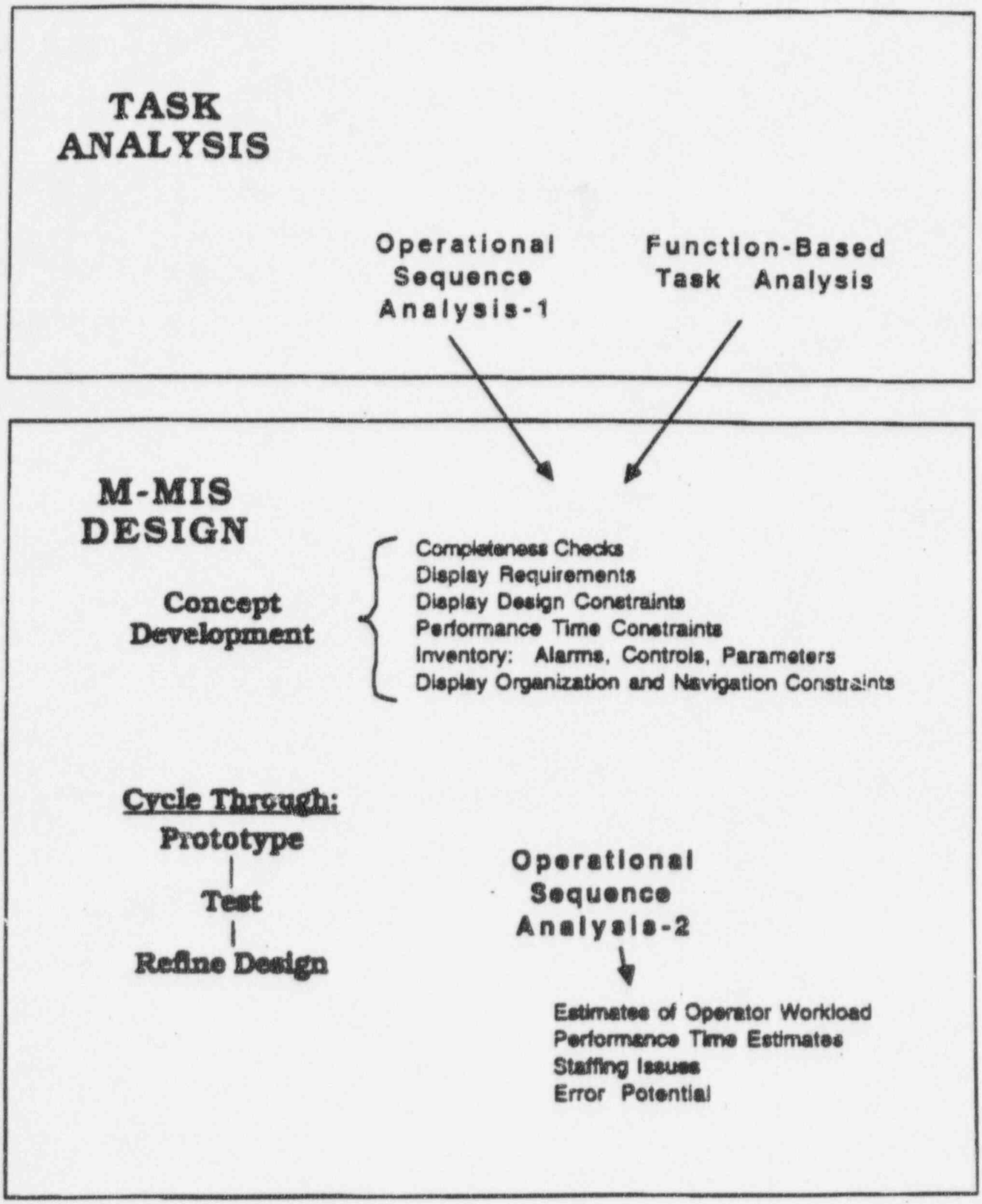

Figure 18.~~8~~5-X