September 5, 1995

Mr. Nicholas J. Liparulo
Nuclear Safety and Regulatory Activities
Westinghouse Electric Corporation
P.O. Box 355
Pittsburgh, Pennsylvania 15230

SUBJECT: STATUS OF AP600 DRAFT SAFETY EVALUATION REPORT (DSER) OPEN ITEMS RELATED TO ELEMENT 4 OF THE HUMAN FACTORS ENGINEERING PROGRAM REVIEW MODEL (HFEPRM)

Dear Mr. Liparulo:

The Nuclear Regulatory Commission Human Factors Assessment Branch has recently completed reviewed a May 24, 1995, draft document from Westinghouse on the AP600 task analysis activities. This document addresses DSER open items related to Element 4 of the HFEPRM. To facilitate communications and coordinate work effort with Westinghouse, our technical staff has provided a formal assessment of how the draft task analysis document resolves these open items. The detailed status evaluation of HFEPRM Element 4 issues are contained in the enclosure to this letter. This information is being provided to Westinghouse to ensure that a common understanding of issue closeout in the human factors engineering area is maintained.

If you have any questions regarding this matter, you can contact me at (301) 415-1141.

Sincerely,
original signed by:

William C. Huffman, Project Manager
Standardization Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Docket No. 52-003

Enclosure:
DSER Open Item
Resolution
Element 4
Task Analysis

cc w/enclosure:
See next page

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Mr. Nicholas J. Liparulo
Westinghouse Electric Corporation

Docket No. 52-003
AP600

cc: Mr. B. A. McIntyre
Advanced Plant Safety & Licensing
Westinghouse Electric Corporation
Energy Systems Business Unit
P.O. Box 355
Pittsburgh, PA 15230

Mr. John C. Butler
Advanced Plant Safety & Licensing
Westinghouse Electric Corporation
Energy Systems Business Unit
Box 355
Pittsburgh, PA 15230

Mr. M. D. Beaumont
Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
One Montrose Metro
11921 Rockville Pike
Suite 350
Rockville, MD 20852

Mr. Sterling Franks
U.S. Department of Energy
NE-42
Washington, DC 20585

Mr. S. M. Modro
EG&G Idaho Inc.
Post Office Box 1625
Idaho Falls, ID 83415

Mr. Frank A. Ross
U.S. Department of Energy, NE-42
Office of LWR Safety and Technology
19901 Germantown Road
Germantown, MD 20874

Mr. Ronald Simard, Director
Advanced Reactor Programs
Nuclear Energy Institute
1776 Eye Street, N.W.
Suite 300
Washington, DC 20006-3706

STS, Inc.
Attn: Lynn Connor
Suite 610
3 Metro Center
Bethesda, MD 20814

Mr. James E. Quinn, Projects Manager
LMR and SBWR Programs
GE Nuclear Energy
175 Curtner Avenue, M/C 165
San Jose, CA 95125

Mr. John E. Leatherman, Manager
SBWR Design Certification
GE Nuclear Energy, M/C 781
San Jose, CA 95125

Barton Z. Cowan, Esq.
Eckert Seamans Cherin & Mellott
600 Grant Street 42nd Floor
Pittsburgh, PA 15219

Mr. Ed Rodwell, Manager
PWR Design Certification
Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, CA 94303

Mr. Charles Thompson, Nuclear Engineer
AP600 Certification
U.S. Department of Energy
NE-451
Washington, DC 20585

AP600 DSER Open Item Resolution
Element 4 Task Analysis

Element 4, DSER Open Items 18.8.1.3-1 through 3-8 (OITS items 1354-1361), is being reviewed at an *Implementation Plan Review* level. Therefore, Westinghouse's submittals should describe the proposed methodology in sufficient detail for the staff to determine whether the methodology will lead to products that meet the HFE PRM acceptance criteria for the element. The actual completion of the plan will then take place after design certification. While some implementation plans can be reviewed on their own merits, the staff may request a sample analysis which demonstrates the application of the methodology and its results. ITAAC/DAC are needed for completing the implementation plan and providing the results to the staff for review.

To address task analysis open items, Westinghouse submitted a document describing their task analysis process, entitled "AP600 Task Analysis Activities (transmitted to the staff on 5/24/95). The results of the staff's review of this document follow.

The following is an overview of the status of the results of the staff's review:

Open Item (OITS #, DSER #)	Current Status
1338 18.5.3-1: Task Analysis Scope	Action W
1339 18.5.3-2: Critical Task Evaluation	Action W
1340 18.5.3-3: Task Analysis Methods	Resolved (Action W-ITAAC and SSAR)
1341 18.5.3-4: Task Analysis Job Design	Resolved (Action W-ITAAC and SSAR)
1342 18.5.3-5: TA Methodology Source Materials	Resolved (Action W-ITAAC and SSAR)

Related Open Items:

1364 18.9.3-2: Input to Procedure Development	Action W (Part of Procedures)
1395 18.12.3-1: Task HSI Inventory	Action W (Part of Minimum Inventory)

ENCLOSURE

Open Item 18.5.3-1: Task Analysis Scope

Open Item 18.5.3-1: Task Analysis Scope

1. *Criterion 1:* The scope of the task analysis should include selected representative and important tasks from the areas of: operations, maintenance, test, inspection, and surveillance. The analyses should be directed to the full range of plant operating modes, including start-up, normal operations, abnormal and emergency operations, transient conditions, low power and shutdown conditions.

DSER Evaluation: In response to RAI 620.29 Westinghouse indicated that the scope of task analysis will include all operations tasks for the full range of plant operating modes for the MCR. The analysis will cover operations that are critical to plant safety both inside and outside the MCR related to any facilities where these actions need to be performed. Maintenance, test and inspection task analyses will be performed for those tasks determined by the PRA to be potential areas of high safety risk. While this scope is acceptable, the response indicates that the threshold for defining critical or high-risk has not been determined. Since this threshold determines whether or not maintenance, test and inspection tasks will be included in the analysis, the threshold definition is needed for the staff to accept the task analysis scope. Also, further discussion is necessary to clarify how the PRA will be used to identify the tasks and the PRA levels to be included (e.g., Level 1 - core damage and Level 2 - release from containment).

Proposed Resolution: To address the issue of task analysis scope and the other task analysis open issues, Westinghouse submitted a document describing their task analysis process, entitled "AP600 Task Analysis Activities (transmitted to the staff on 5/24/95), hereafter referred to as the "TA Plan."

The Westinghouse approach to task analysis is to evaluate tasks from two perspectives: function-based task analysis (FBTA) and operational sequence analysis (OSA). The scope of the FBTA is on decomposition of the higher level functions (as described in Level 4 in Figure 18.6-9 of the SSAR). As indicated in the DSER, this approach is an appropriate and acceptable means of assuring that function-based requirements are identified that are not dependent on specific operator tasks.

The scope of the OSAs is identified on page 1 of the TA Plan. The scope is identified as including the full range of plant operating modes, including start-up, normal operations, abnormal and emergency operations, transient conditions, low power and shutdown conditions. These will include tasks representing the full range of activities in the AP600 ERGs and tasks identified as critical or risk-significant. (While the discussion in the DSER for this open item raised the issue of critical task definition, that discussion is more appropriate to the Open Item 18.5.3-2: Critical Task Evaluation and will be discussed under that open item.)

While this information clarifies part of the task analysis scope issue, the TA plan does not address whether task analyses will be performed on representative maintenance, test, inspection, and surveillance tasks. This will have to be clarified before the open item can be resolved.

STATUS OF OPEN ITEM: **ACTION W**

Open Item 18.5.3-2: Critical Task Evaluation

2. *Criterion 2:* Tasks should be linked using a technique such as operational sequence diagrams. A review of the descriptions and operational sequence diagrams should identify which tasks can be considered "critical" in terms of importance for function achievement, potential for human error, and impact of task failure. Human actions which are found to affect plant risk via PRA importance and sensitivity analyses should also be considered "critical." All critical tasks shall have specific task analyses performed for them. The determination of PRA/HRA critical human actions should consider internal and external initiating events, and actions affecting the PRA Level I and II analyses (see Element 6 for an explanation of PRA/HRA analyses). Where critical functions are automated, the analyses should consider all human tasks including monitoring of the automated system and execution of back-up actions if the system fails.

DSER Evaluation: There are three aspects of this criterion to be addressed: (1) identification of critical tasks in task analyses (such as operational sequence diagrams) and PRA, (2) analysis of critical tasks, and (3) analysis of human tasks associated with automatic actions.

Regarding (1), as is discussed in the DSER Evaluation of criterion 3 which follows, the Westinghouse approach to task analysis focuses on the cognitive requirements of tasks which are organized in a decomposition of plant functions. It is unclear whether operational sequences, which tend to be event/scenario based, are considered. Thus the role of task analysis in specifying tasks as critical needs to be clarified.

With respect to PRA, Westinghouse's response to RAI 720.133 indicates that the identification of critical human actions is not completed pending the completion of sensitivity analyses.

Regarding (2), the SSAR does not indicate how critical tasks were evaluated in the task analysis. (In a meeting on 6/14/94 at the NRC, Westinghouse indicated specific task analyses were performed for those tasks that were identified as critical but these have not been provided to the staff for review.)

Regarding (3), as described in RAI 620.72, the Westinghouse approach explicitly identifies human tasks associated with automated systems in order to identify monitoring and control requirements. Thus this aspect of the criterion is acceptable.

Proposed Resolution: While the scope of the task analysis includes critical or risk-significant tasks, the TA plan indicates that at present PRA results indicate that "there are no AP600 tasks that meet the criteria for critical or high-risk tasks" (p. 1).

This issue is not addressed further in this document because it is currently the subject of ongoing discussions between Westinghouse and the staff.

STATUS OF OPEN ITEM: **ACTION W**

Open Item 18.5.3-3: Task Analysis Methods

3. *Criterion 3:* Task analysis should begin on a gross level and involve the development of detailed narrative descriptions of what personnel must do. Task analyses should define the nature of the input, process, and output required by and of personnel. Detailed task descriptions should address (as appropriate):

- Information Gathering
- Decision-Making Requirements
- Response Requirements
- Feedback Requirements
- Workload
- Task Support Requirements
- Workplace Factors
- Staffing and Communication Requirements
- Hazard Identification

NUREG-0711 contains a more detailed breakdown of the types of information contained in each area identified above.

DSER Evaluation: The Westinghouse functional task analysis methodology begins with the high-level functional goals and decomposes them. A goal-means structure will be used to map the cognitive and physical tasks that define the operational space of the plant to each plant function. The goal means structure representation is based on the concept of describing the plant's functional processes in terms of the goals to be achieved and the means/mechanisms available for achieving them.

Cognitive task analysis methodology is used to identify the monitoring/feedback, planning and control requirements. A set of 11 questions are identified for each node in the functional decomposition model in SSAR Section 18.6.7 and RAI 620.47 that are organized into these categories (see also Table 1 in WCAP-13957). The answers to the questions become the database which is used to write task descriptions which are used to support HSI design. Samples of the task descriptions are contained in Westinghouse's response to 620.71.

Since the emphasis of the task analysis is of cognitive requirements, the methodology described will acceptably provide the necessary information to support the definition of requirements for information gathering, decision-making requirements, response, and feedback.

It is not clear how the methodology will address the other categories of information identified in the criterion above. For example, it is not clear how the methodology will address the time flow and workload effects of performing crew tasks, such as following a procedure. These considerations are typically addressed in what Westinghouse refers to as "traditional" task analysis (RAI 620.70 gives the task analysis approach described in NUREG-0700 as an example). In response to RAI 620.28, Westinghouse stated that "the cognitive task analysis deals only with the decision making tasks that are to be made by the operations staff. The complete function-based task analysis includes both the results of cognitive task analysis and the traditional task analysis that includes the control actions required and the steps needed to get to the appropriate control actions." The function-based task analysis methodology described in the SSAR does not appear to include such methods. In fact, SSAR Section 18.6.7 indicates that traditional task analysis approaches "are of little or no use in those areas where effective decision making is the essence of the task."

SSAR Section 18.6.4 does indicate that "traditional" task analyses will be used for personnel tasks such as field equipment operation but a methodology is not described beyond a reference to Drury et al., 1987 which does not in itself adequately describe the methodology as it will be applied to AP600 tasks. It would also seem appropriate to address the same cognitive questions in these task analyses as well.

The staff agrees that the functional decomposition approach and cognitive task analysis methods are appropriate to the design of an effective HSI (as the HFE PRM criteria indicate). However, the temporal, workload, staffing, etc. aspects of performing tasks in a control room are an important considerations at the task analysis stage and are an important contributor to HSI design. Thus, while the emphasis on cognitive factors is supported by the staff, these other factors should be given consideration. Clarification of the application of task analysis methods is needed to satisfy this criterion. Specifically, how are the cognitive task analyses and "traditional" methods integrated to analyze crew tasks, what decision criteria are used to judge whether tasks need the cognitive task analysis, and what is the total set of task analysis data that will result from the completion of all task analysis methods.

Proposed Resolution: Westinghouse provides information regarding task analysis in the section entitled "Task Analysis Implementation Plan" of the T/ Plan. The section includes a discussion and clarification of the integration of both FBTA and OSA approaches the task analysis in the AP600 design process. While the focus of FBTA is on decomposition of the higher level AP600 functions as described in detail in the SSAR, the focus of the OSA will be the analysis of the operational tasks as defined within the scope of task analysis activities.

The OSAs will be performed in two phases. First, tasks will be developed to include: plant state data. data source, actions, criteria/reference values, feedback, time, sequencing requirements, support requirements, and work environment considerations. These results will provide the operational requirements for task performance. These requirements and constrains provide input into MMIS design development.

The resulting designs will be tested in concept tests which will enable further refinement of the analysis results. To accomplish this a second OSA will be performed on a representative subset of the tasks analyzed in the first phase of OSA, which include those which are risk important and those where there are performance concerns. These analyses will address the: completeness of available information, time to perform tasks, operator workload, and staffing.

This information addresses the staff's concerns regarding the use of traditional analysis methods, their integration with FBTA, the information to be derived from task analysis activities, and its input and use in the detailed MMIS design. In summary, the combination of FBTA and OSA provides a particularly strong technical basis for identifying operational requirements to be addressed in the detailed MMIS design.

Based upon this information, this DSER issue is considered resolved.

This criterion will be satisfied when the commitment to task analysis is made in an appropriate ITAAC and the SSAR is revised to include a description of the proposed task analysis process.

STATUS OF OPEN ITEM: **RESOLVED (ACTION W-- ITAAC and SSAR)**

Open Item 18.5.3-4: Task Analysis Job Design

4. *Criterion 5:* The task analysis should incorporate job design issues such as:

- The number of crew members
- Crew member skills
- Allocation of monitoring and control tasks to the (1) formation of a meaningful job, and (2) management of crew member's physical and cognitive workload.

DSER Evaluation: This is not addressed as part of task analysis in the SSAR as discussed in conjunction with the previous DSER Evaluation of criterion 3.

Proposed Resolution: A indicated in the discussion of Open Item 18.5.3-3 above, the second set of OSA evaluation will incorporate crew staffing considerations. the workload analyses as part of these analyses will provide "an indication of the adequacy of staffing assumptions" (p. 4). Where high workload or time limits occur, alternative staffing assumptions, task allocations, or design changes will be evaluated. With respect to skills, Westinghouse indicated that skill requirements addressed by NRC requirements for training are assumed, i.e., no special skills are assumed for AP600 operators. This is an acceptable approach.

Westinghouse further addresses this issue in the section entitled "Job Design Factors" of the TA Plan (p. 4). The section indicates that job design considerations such as staffing and crew skills are the responsibility of the COL. A COL action item is identified that indicates: "Combined License applicants referencing the AP600 certified design will develop a job design document that specifies the full scope and responsibilities of each control room position" (p. 4). This is acceptable provided the document considers the assumptions and results of the task analyses described in the SSAR and the TA Plan.

Based upon this information, this DSER issue is considered resolved.

This criterion will be satisfied when the staff concern regarding the staffing document is addressed and the commitment to task analysis is made in an appropriate ITAAC and the SSAR is revised to include a description of the proposed task analysis process.

STATUS OF OPEN ITEM: **RESOLVED (ACTION W-- ITAAC and SSAR)**

Part of Open Item 18.12.3-1: Task HSI Inventory

5. *Criterion 6:* The task analysis results should be used to define a minimum inventory of alarms, displays, and controls necessary to perform crew tasks based upon both task and instrumentation and control (I&C) requirements.

DSER Evaluation: This item is deferred until resolution of the minimum inventory issue (see DSER Section 18.12).

Proposed Resolution: Not addressed.

STATUS OF OPEN ITEM: **ACTION W**

Open Issue 18.9.3-2: Input to Procedure Development

6. *Criterion 7*: The task analysis results should provide input to the HSI design, procedure development and personnel training programs.

DSER Evaluation: In response to RAI 620.75, Westinghouse indicated that task analysis "is the foundation of the design of the information and control system." Task analysis results are translated into task descriptions which serve as the basis for HSI design. SSAR Section 18.6.5 indicates that "the impact of cognitive task analysis is for the AP600 human engineering design team to realize that the responsibility of the operators to continually evaluate the operational success or failure of executing the current procedure. It is a fundamental assumption in the design of the computerized support system of the AP600 that the human operators have a thorough understanding of the functional purpose or objective of each procedure...Providing the operators with a thorough understanding of purposes and objectives is a requirement of the AP600 Operator Training Program."

With respect to the input of task analysis results to training and procedures, SSAR Section 18.8.9.4.1 specifically identifies the results of task analysis as providing a basis for the development of the AP600 training program. In SSAR Section 18.6.7, task analysis is identified as being used to derive procedures; however, SSAR Section 18.9.8 on procedure design does not indicate the use of the task analysis results.

Though task analysis is specifically identified as providing a basis for HSI and training program design, its status with respect to procedure development is unclear. Since the issue is limited to procedures, it has been identified in Open Issue 18.9.3-2: Procedure Basis. Resolution of this criterion is, therefore, linked to that open issue and a separate issue is not warranted.

Proposed Resolution: The TA Plan does not address the inputs of task analyses to procedure development.

STATUS OF OPEN ITEM: **ACTION W**

Open Item 18.5.3-F: Task Analysis Methodology Source Materials

7. *Criterion 8:* The applicant's effort should be developed using accepted industry standards, guidelines, and practices. A list of documents which may be used as guidance is provided in the HFE PRM.

DSER Evaluation: The cognitive task analysis methodology is based largely on the work of Rasmussen (1986) and Westinghouse (Woods, et.al.), and is consistent with the recommendations of IEC964 as per the HFE PRM. However, this criterion cannot be found acceptable until the issues discussed under Criterion 3 are resolved.

Proposed Resolution: In the TA Plan, Westinghouse identified the documents that served as the basis for the development of their task analysis methodology. These documents included: NUREG/CR-3371, IEC 964, MIL-STD 1478, and a NATO document entitled "Applications of human performance models to system design. These documents in conjunction with the basis documents for the FBTA provide a solid and acceptable technical foundation for a comprehensive task analysis.

Based upon this information, this DSER issue is considered resolved.

This criterion will be satisfied when the commitment to task analysis is made in an appropriate ITAAC and the SSAR is revised to include a description of the proposed task analysis process.

STATUS OF OPEN ITEM: **RESOLVED (ACTION W--ITAAC and the SSAR)**