GE Energy

David H. Hinds
Manager, ESBWR

PO Box 780 M/C L60
Wilmington, NC 28402-0780
USA

T 910 675 6363
F 910 362 6363
david.hinds@ge.com

MFN 06-401

Docket No. 52-010

October 28, 2006

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 64 – Human Factors Engineering – RAI Numbers 18.5-1 through 18.5-32**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter. Enclosure 2 contains a sketch of top down task analysis for the ESBWR. This sketch is referenced in and is intended to facilitate the understanding of several of the RAI responses.

If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-352, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 64 Related to ESBWR Design Certification Application*, September 25, 2006

Enclosure:

1. MFN 06-401 – Response to Portion of NRC Request for Additional Information Letter No. 64 Related to ESBWR Design Certification Application – Human Factors Engineering NEDO-33221, "ESBWR Task Analysis" – RAI Numbers 18.5-1 through 18.5-32
2. MFN 06-401 – Response to Portion of NRC Request for Additional Information Letter No. 64 Related to ESBWR Design Certification Application – Human Factors Engineering –Addendum to RAIs 18.5 Sketch of Top Down Task Analysis for the ESBWR

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0000-0059-4865

ENCLOSURE 1

MFN 06-401

Response to Portion of NRC Request for

Additional Information Letter No. 64

Related to ESBWR Design Certification Application

Human Factors Engineering
NEDO-33221, ESBWR Task Analysis

RAI Numbers 18.5-1 through 18.5-32

NRC RAI Number 18.5-1

Clarify what will be included in the task analysis scope for ESBWR. The following statements make the ESBWR analysis scope unclear:

- · *"Preliminary, interim and results summary reports from the task analysis will be design input to the human reliability analysis (HRA) analysis and changes from the Reference ABWR identified to the systems engineering process." (NEDO-33221, Section 1.3, Methodology, p. 11)* ·
- *"In the case of the ESBWR design, which builds directly upon the ABWR, a considerable number of interactions between design features and human tasks have already been accomplished." (NEDO-33221, Section 1.3, p. 11)* ·
- *"For the functions and tasks, which have not already been analyzed in previous designs, a task analysis should be performed based on the information available. A process for screening out duplication of effort should consider the degree of change in the ESBWR processes, changes to the human system interface (HSI), changes to cognitive skills required for the task, and applicability of generic task analysis for normal operations, maintenance, testing and emergency responses. For new or significantly changed functions the specific Human Factor techniques selected to conduct the initial [high level Task Analysis] are....." (NEDO-33221, Section 3.4.1, Task Analysis Methods, p. 19)*

If a screening process will be used to screen out tasks based on their similarity to the ABWR, then the criteria for such a screen process should be identified. If analyses performed for the ABWR are to be used for the ESBWR, then these analyses should be provided.

GE Response

The key elements of Task Analysis (TA) are described in Section 1.2 "Scope". The other sections provide methods, details of the approach, and examples.

Task Analysis results will be fed back as inputs into the next iteration of the HRA to support identification of tasks and qualitative performance factors. (Revision to NEDO-33221, Section 1.3, Methodology, p. 11)

Task Analysis results indicating a need for changes to reference ABWR HSI design tasks are addressed as described in the HSI Design and the HFE V&V Implementation Plans. Task analysis linked to the BWR fleet of plants deals primarily with actions required at the systems or subsystems level.

The initial High-level Task Analysis (HLTA) will focus on the safety critical tasks required to meet top level safety functions as described in the Addendum to RAIs 18.5. These tasks typically involve multiple systems and cross system boundaries. The ESBWR TAs will stand on their own and be independent of whether they were derived from previous ABWR task analyses or not. ABWR Task Analyses will be submitted to the NRC in support of Gap Analysis (when required) performed at the system or sub-system level. ESBWR TA will be performed in three iterative steps beginning with HLTA. Addendum to RAIs 18.5 is provided to illustrate how a top-down strategy will be implemented in the HFE design process through Functional Requirements Analysis (FRA), Allocation of Function (AOF) and TA. An example (SFRA demonstration) of the ESBWR RWCU System will be provided within the next revision of NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-2

NEDO-33221, Section 1.3, Methodology, Items 1, 3 and 4 include a scope statement that is not completely consistent with Section 1.2, Scope. For example, analyses of local control stations (LCSs) is not included in Section 1.3, but is included in Section 1.2. Clarification is needed as to which scope statements are applicable to ESBWR or the statements should be revised for consistency.

GE Response

The Section 1.2 "Scope" defines the commitments for the task analysis. Section 1.3 "Methodology" provides examples of methods that will be used to address a wide range of ESBWR applications. These sections will be reviewed for consistency and updated in the next revision of NEDO-33221 to stress the top down approach in the iterative task analysis as described in Enclosure 2, Addendum to RAIs 18.5. In the case of local control stations, the TA will be applied to those local control stations with a safety related function or a task identified by the High-level Task Analysis.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-3

NEDO-33221, Section 3.7 defines "critical tasks." Section 1.3 and 3.7 imply, but do not clearly state that the identified critical tasks will be subject to a task analysis. Please confirm that all such tasks will be analyzed.

GE Response

Yes, the critical tasks will be analyzed using TA methods. This will be made clear in the next revision of NEDO 33221 by starting with the critical functions for the ESBWR.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-4

On NEDO-33221, page 13, one of the characterizations of a task is that it be independent of other tasks. Please clarify what this means and how it impacts the selection of, or definition of, tasks to analyze.

GE Response

A task is carried out to accomplish one objective (e.g., open a valve, align an electrical bus, shutdown the reactor, switch to onsite power, etc.). For the purpose of the task analysis, it is assumed that this is an independent task that is performed with other systems operating as designed. The characteristics of an independent task for TA purposes is that the task has a defined objective from the AOF and SFRA, a clear beginning, specific interfaces, tools and requirements, and a clear end point. This definition helps define the tasks to be analyzed and places clear boundaries on the analysis.

This does not mean that other tasks can't be performed at the same time. The interaction of multiple tasks during accident sequences is addressed by starting with the critical safety functions for the TA and in the dependency analysis in the PRA/HRA. During simulation testing the emergency procedure guidelines can be used to evaluate and verify that the tasks can be performed.

DCD/LTR

No changes to the subject LTR will be made in response to this RAI.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-5

The methodology generally conforms to the basic elements of the review criterion:

- *· operational sequence diagrams are used as a linking technique*
- *· the methodology provides for the development of high-level task descriptions and more detailed task decompositions*
- *· the detailed task description should address the input, process, and output needed by and of personnel and the topics identified in the criterion.*

While these basic elements are generally described, some clarification of the details is needed as is identified in the questions below.

(A) Section 1.3. Methodology Background, states that "[t]his Task Analysis Implementation Plan recommends (emphasis added) methodology for performing task analysis during the design stage for human actions associated with the [main control room] MCR, [remote shutdown display] RSD, and other applicable [man machine interface systems] MMISs." Section 3.3 states that "[t]he actual human factor techniques and forms for data collection will be selected by the analysts." (p. 19).

Many other such statements exist in the document that qualify the methodology as a recommended practice rather than a commitment. The purpose of an Implementation Plan review is to certify the methodology that will be used, rather than what might be used. Please clarify why the methodology described is a recommendation only and not the actual plan that will be used to conduct that analyses.

(B) Figure 2, Task Analysis Implementation Process (p 86) needs clarification. Specific questions are:

- *Section 3.4.1, Task Analysis Methods, list the use of four approaches to task analysis. However, Figure 2 (p 86) providing an integrated overview of the methods does not include all of the methods listed, specifically Narrative Task Descriptions and operating sequence diagrams (OSDs) are included, but Mission Scenarios and functional flow diagrams (FFDs) are not.*
- *Why is task analysis (TA) evaluation not shown?*
- *Why do the reports listed not match those described in Section 3.9, Task Analysis Report?*
- *What is the meaning of dashed vs. solid lines?*
- *What is the meaning of the lines connecting the evaluation techniques at the bottom of the figure and the last three steps of the High-level task analysis?*
- *Explain why these particular steps (boxes) are connected?*

(C) An implementation plan should provide step-by-step, specific guidance on how to perform task analysis. The current document contains much background and tutorial information, and little in the way of step-by-step procedures. Absence of these type of specific procedural steps will make this document difficult for users and the intended methodology may be incorrectly and inconsistently applied.

(D) The document contains a detailed methodology with many steps and considerations. Provide a worked out example to illustrate the application of the methodology as it will be performed for ESBWR reflecting a slice of the methodology from top to bottom. Such an example does not need to reflect a complete analysis at any step.

GE Response

(A) The scope section defines the commitments and the methodology section defines a group of methods and approaches that can be applied to meet the objectives. Section 3 gives examples to explain the factors and elements considered in the task analysis process.

Section 3.4.1 shows a variety of Task Analysis methods and ways of displaying the information that have been used in the past. These methods are redundant and only one needs to be picked as shown in Figure 2, which is a sketch of the task implementation process.

(B) A revised Figure 2 will be provided in the next revision to NEDO-33221. It will reflect an iterative top down approach and will address items such as TA evaluation and the TA documentation reports with more clarity and detail. In the current Figure 2 the dashed and solid lines represent feed forward and feedback paths. The solid lines represent the first functional TA feed forward path. The dashed lines represent first, second, and third level feedback paths that lead to changes in the TA evaluation. The dotted lines from boxes 2) is the first feedback and from 3) is the second feedback. The 1), 2), and 3) boxes are combined because they represent evaluation of the TA using different methods that are applied as the design progresses. The revised Figure 2 will further clarify the lines for each pathway. For example, a single solid line going from Workload Assessment to Outputs to Allocation of Functions to HSID to In-Plant Installation will represent the feed forward path, long dashed lines represent the first evaluation feedback going to the paper step evaluation and then to the Convert Functions to Tasks medium dashed lines represent the second evaluation feedback going to the mock-up or part task simulator evaluation step and then to the Convert Functions to Tasks, and short dashed lines represent the third evaluation feedback going to the full scope simulator evaluation step and then to the Convert Functions to Tasks box. Each result at a level of analysis (e.g., a paper evaluation, a mock-up or part task simulator evaluation, and a full scope simulator evaluation) provides input to any of the boxes in the High Level Task Analysis Desk.

(C) This document needs to be simplified and focused on a clear step by step process. This will be done in the next revision to NEDO-33221 by linking the TA to the top level requirements in the SFRA Implementation Plan. See NEDO-33219r0 page 63 figure 4 for an example the top-level step by step process that is applied to safety related goals.

(D) We will provide an example of the application of the Detailed Task Analysis for the ESBWR RWCU system in the report identified in section 3.9 of NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-6

NEDO-33221, Section 2 has many references to additional documents. What role do these documents play in the plan? Many of the versions of the documents are old and have been replaced by newer, updated material. For example, the 1981 version of NUREG-0700 is referenced, while that document has undergone two extensive revision since then. MIL-STD-1472C is referenced, while that document has been revised three times since and is not in Revision F.

Other documents are old and may contain outdated and potentially incorrect guidance. For example, EPRI-NP3701 on Computer-Generated Display System Guidelines was published in 1984. Technology and display development approaches have advanced so much since then that the guidance is not fully applicable to today's systems. These documents have been replaced by a new generation of guidance documents.

It is also unclear how some of these documents relate to task analysis, such as EPRI-NP3701.

GE Response

References and methods need to be updated to reflect the advances in HSI technology and methods for evaluation. The references and approach will be re-examined and streamlined in the next revision to NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-7

Section 3.3, items 1 and 2 - Clarify that the data will come from the analyses conducted in accordance with the plans and not the plans themselves.

GE Response

Section 3.3 Items 1 and 2 will be revised in the next revision to NEDO-33221 to use the term "task analysis input data" rather than "data."

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-8

(A) Section 3.4.1, Task Analysis Methods, p. 19, discusses a process to screen out certain tasks from the analysis. Provide additional information about how an analyst will perform this screening and what criteria will be used to screen tasks out.

(B) Section 3.4.1, Task Analysis Methods, identifies one approach to task analysis as "Task Descriptions (TDs)." Later the same technique is identified as a "Narrative Task Description" and in another place as a "Narrative Description." If all of these refer to the same analysis, please make the name of the analysis consistent throughout the document.

GE Response

(A) The human actions considered in the TA will be those that are identified through the top down task analysis described in Addendum to RAIs 18.5. Additional, tasks qualitatively identified for safety importance will be reviewed during the TA. Other actions may be added to the TA through: the PRA/HRA, the Functional Requirements Analysis, the Allocation of functions and other actions, which potentially impact the plant safety. If an action has no quantitatively or qualitatively identifiable safety impact it may be screened out of the detailed and pre-operational TA.

Per the HRA Implementation Plan (NEDO-33267), the risk importance and sensitivity of manual tasks will be evaluated respective to reactor safety. Table 2 in NEDO 33266 provides example screening criteria to be applied during four of the HFE implementation plan steps for evaluating task interactions with the plant that have a potential safety impact. Thus, the safety important actions will be analyzed using TA to help refine details of the MMIS, whereas the non-safety actions will use standard MMIS established according to the general HFE design rules.

(B) Agree that "task description" needs clarification and will be made consistent and streamlined in the next revision to NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-9

The bullet list of steps presented in Section 3.5 refers to "Developing the basic statement of task performance requirements," while Figure 2 and Section 3.5.5 refer to developing the basic statement of task functions." Clarify inconsistency.

GE Response

The title of section 3.5.5 will be changed to "Developing the Basic Statement of Task Performance Requirements" to match the list of bullets in section 3.5 streamlined in the next revision to NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-10

Section 3.5.1, Converting Functions Into Tasks, states "[t]he aim of this step is to develop a high-level sequential description of the operations that must be carried out to fulfill the functions of a particular system (operational sequence)." (p. 23). The document also states "In order to develop the descriptions of the operating sequences, it is necessary to define scenarios that include all the operations that can be performed with the system" (p. 23). Thus it appears that the analysis begins at the system level rather than high-level functions which can include multiple systems or system operations.

Clarify how and where tasks that involve operations across systems, e.g., startup and shutdown, are analyzed. Also, Section 3.5.6, Decomposition of Tasks into Individual Activities, states "Due to the nature of the initial system TAs, the system OSD for most systems, do not have links with other system OSDs. Only when a TA of the integrated systems and plant operator would an OSD define interaction across OSDs." (p. 34). When is TA of the integrated systems performed, since the methodology only appears to address system TAs.

GE Response

The focus for TA in NEDO-33221 Rev. 0 had been on the system tasks, because through the development of the BWR fleet of plants, including the ABWR, the starting point for the HFE TA focused on the systems that were different from the previous designs, since the high level goals were addressed with physically similar systems and processes.

ESBWR employs process design features that are much different than previous BWR designs such as natural circulation and passive cooling. Therefore, the ESBWR HFE TA begins at a higher level in the station goal structure as described in the SFRA implementation plan (NEDO-33219 Figure 4 page 63) and refined in Addendum to RAIs 18.5 Figure 1. To accomplish the TA such that it will influence the ESBWR design; an iterative process has been adopted. The first (high-level) iteration will address the safety related goals. As more system information is developed, the next iteration for (Detailed) TA will address the non-safety equipment needed to operate the plant, and then a third iteration (Pre-operational) TA will address the issues associated with surveillance, testing, maintenance, and engineering support tools. Each of these iterations will address start up, operation and shutdown conditions and the transitions between them. Thus, the TA will be performed in three stages: High Level Task Analysis, Detailed Task Analysis and Pre-operational Task Analysis. Enclosure 2, Addendum to RAIs 18.5, describes this process in more detail.

The integrated system tasks will be addressed through:

1. The top down FRA/SFRA, AOF and TA identifies tasks needed to address safety and operational requirements in different systems, during specific events.
2. The development of the Operational Sequence Diagrams to establish an order and timing for complex multiple tasks,
3. Interactions with the PRA/HRA as described in the HRA implementation plan (NEDO-33267) to verify and enhance completeness of multiple task processes, and
4. Evaluation of the EPGs/EOPs, and other procedures to verify that the tasks are addressed.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-11

Section 3.5.6 Discusses the use of the Berlinger task taxonomy. In Section 3.6.1, Rasmussen's decision-making model is presented, then in the same section a simplified version of Rasmussen's model is offered. The data tables that the analysis will presumably use, e.g. Table A-1, do not seem to be derived from any of these specific models.

What is the role of these different approaches and why are multiple models necessary?

GE Response

The task taxonomy and decision making models discussed in these section both provide models and support insights into the way that human's organize and process information. Using these models helps verify that the HSI design supports each element in the information processing and decision-making process. When supporting elements are missing the chance of human cognitive errors increases. Thus, both the model and taxonomy aid the analysts when developing the task analysis details to see potential errors that could occur during the task. Use of the models is an aid and not a necessity in all cases. For example, the models are used by HFE members of the TA team to examine potential errors and consequences on specific tasks that might have been overlooked or not considered previously.

DCD/LTR Impact

No changes to the subject LTR will be made in response to this RAI.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-12

Section 3.6, states "The detailed task descriptions will provide the principal results for direct use in identifying human engineering discrepancies." (p. 36). Explain the role of task descriptions in identifying Human Engineering Discrepancies (HED).

GE Response

Task descriptions provide a baseline expectation of the information, cues, interface controls and feedback on actions taken. If the information in the HSI due to the software configuration, hardware implementation, and procedure interface does not meet the initial requirements; this is a possible way to identify Human Engineering Discrepancies (HED). For example, if a parameter defined by specific units in the task analysis uses different units in the HSI, but the same in the procedures, this would be an HED.

DCD/LTR Impact

No changes to the subject LTR will be made in response to this RAI.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-13

Section 3.5.6, Decomposition of Tasks into Individual Activities - The bottom of p. 36, beginning with "The results..." to the end of the paragraph on p. 37, "... perform assigned tasks successfully" appears to restate activities already completed earlier in the high-level TA. Explain why these activities are performed again.

GE Response

The last three paragraphs summarize the previous information. To eliminate redundancy and confusion about the TA these paragraphs will be removed in the next revision of NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-14

(A) Section 3.6.1, Operator Decision-Making Model states, "The plant-specific operational-task analysis is accomplished by superimposing the generic questions from the operator behavior model work onto the functional structure." (p. 40). Clarify the meaning of this statement and how the analyst will accomplish this activity.

(B) Section 3.6.1, Operator Decision-Making Model, p. 40 references Figure 16. It appears that it should be Figure 14. Please clarify.

GE Response

(A) In Section 3.6.1, Operator Decision-Making Model: When key decision-making tasks are identified during the TA, the model helps the analyst consider some of the thinking paths that are needed to accomplish a specific task. Error modes can be identified from these pathways, and then HSI features needed to minimize the error potential can be defined. This is what is meant by superimposing the generic questions from the operator behavior model work onto the functional structure. The HFE representative on the TA team uses this approach to help the team identify design features that minimize the potential for human error.

(B) Agree that in Section 3.6.1 the figure number should be 14 and will be changed in the next revision of NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-15

Section 3.6.2, states: "Assuming that the complete list of tasks is available at the end of this first part of the task analysis, there are three main steps in the performance of the task analysis: · Table Top Analysis (TT) · Walk Through/Talk Through (WTTT) · Simulator Analysis (SA) Of these, the first two should be regarded as mandatory in all Task Analysis, and when a simulator is available, the third should also be regarded as mandatory." (p. 42). Why are all steps considered mandatory for all analyses?

GE Response

They are not mandatory in all cases. Paragraph 4 page 41 will be deleted in the next revision of NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-16

(A) Section 3.6.4 states "Any required information not available from the display system must come from some other source such as training, experience, and/or procedures." (p. 45). Since required information should be available in the display system, please clarify the circumstances when it is not necessary.

(B) Section 3.6.4 states "The process begins with the definition of the objectives of the computer-generated display system." (p. 45). Why is a task analysis, with the aim to identify task requirements, starting with objectives of the display system?

(C) Section 3.6.4 references a Table A-2, yet no A-2 is provided.

GE Response

(A) The TA will provide a list of all required control and display parameters for the operator to successfully complete his tasks. ESBWR designers will provide a list of the controls and displays mounted on the operators control board along with their designed range and accuracy. HFE team will verify that there is a control or display for each required control and display parameter. If any control or display is found missing in the verification process, it will be added. The sentence "Any required information not available from the display system must come from some other source such as training, experience, and/or procedures." will be deleted in the next revision of NEDO-33221.

(B) The task analysis will follow the process outlined in RAI 18.5-10 and Enclosure 2, Addendum to RAIs 18.5. "The process begins with the definition of the objectives of the computer-generated display system." will be deleted in the next revision of NEDO-33221.

(C) The table in Appendix A is on two pages, but still called A-1. The A-2 reference will be deleted in the next revision of NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-17

Methodology, Section 3.6.9 states "A multi-disciplinary technical staff is needed to conduct the task analysis. The disciplines and experience of the staff should include nuclear engineering, instrumentation and control engineering, and human factors engineering." (p. 55). Additional expertise is needed to conduct task analysis, including operations, maintenance, training, and procedure developers, where appropriate. Clarification of the statement is needed.

GE Response

The term multi-disciplinary team implies a wide range of skills is needed for task analysis. The information given represents example backgrounds. The ESBWR HFE team maintains a matrix of team members and associated areas of expertise to demonstrate alignment with NUREG 0711 Rev. 2 Appendix A. Any additional expertise requirements will be integrated within section 3.6.9 as example skills needed for TA in the next revision of NEDO 33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-18

(A) *Section 3.6.10, Workload Assessment, states that "[t]o assist in the task assessment and rating, the Table Data Form (Section 3.6.2) may be used." (p. 56). Explain how this form can be used for workload assessment.*

(B) *Section 3.6.10, Workload Assessment, discusses graphical depictions of workload on p. 56. Provide an example of such a depiction.*

(C) *Section 3.6.10, Workload Assessment, states that "[t]he time is associated with the timeline for each task element (first column of the Figures 13 through 15)." (p. 57). Should this reference be limited to Fig 13?*

(D) *Section 3.6.10, Workload Assessment states that "It is usually acceptable to have very short periods of high workload. As a rule of thumb, for sustained tasks, workloads of between 50% and 75% can be considered acceptable." (p. 58). What is the technical basis for this statement? Also, if the analysis is limited to system level task analyses, how can the overall workload level be assessed, given that operators are often performing multiple tasks involving more than one system?*

(E) *Section 3.6.10, Workload Assessment, states that "Workload differences measured by physiological means must be used to infer that performance breakdown would result or to infer how the operator would feel about the task.." (p. 62).*

Please clarify this statement. Section 3.6.10, Workload Assessment, provides a discussion of many different approaches to workload measurement. Which approach will the ESBWR analysis use?

GE Response

In general the most important workload assessments will be for risk important actions involved in managing accidents. For other actions during normal operation the schedule can be adjusted to match standard crew member availability. Thus, the workload assessment involves developing a basis for estimating the ratio of being involved in necessary tasks to the time available during event scenarios. This approach follows the Addendum to RAIs 18.5 and will be reflected in the next revision of NEDO 33221. This addresses all of items above. In addition:

(A) The inputs to the time required to carry out a task considers information from the TA results which are presented in Appendix A. The main data will be timing estimates for each task assigned to a specific person or job category. This will be clarified in the next revision of NEDO 33221.

(B) In complex activities a graphical depiction of workload would illustrate the paths that each individual in the control room and the plant would take to verify conditions, to read instruments, and to operate controls or valves. This tool may be used for complex risk important actions that need special evaluation. Such an example will be provided in the task analysis report, if it used to illustrate the complexity of actions in dealing with an accident scenario. It is expected that design simplifications will be made prior to developing this graphical workload illustration.

(C) Figure 13 Sheets 1 – 3 provides the example of the graphical depiction of workload.

(D) Yes, the timeline reference is Figure 13 or an equivalent. The task performed during normal operation have flexibility in scheduling whereas actions required during event scenarios are time limited with little flexibility. The analysis using PRA/HRA defined scenarios and TA critical actions (Enclosure 2, Addendum to RAIs 18.5) will be used to identify multiple actions in more than one system. These tasks will be examined in detail using a work load assessment

(E) As outlined in Enclosure 2, Addendum to RAIs 18.5, the top down High-level FRA, AOF and TA approach will identify multiple tasks that will need to be performed during the same time interval.

The reference for the workload measurement statement comes from Meister, David (1985). Behavioral Analysis and Measurement Methods. New York: John Wiley & Sons [ISBN 0-471-89640-3]. This reference will be added to the reference listing in NEDO-33221. A technical basis for the statement about workload acceptability can also be found in NUREG/CR-1278, 1983 chapter 17. The discussion relates workload as a contributing performance factor to stress when estimating human error probabilities. The optimum stress is in the midrange of workload activities. The evaluation will consider the qualitative impact of cognitive and physical energy expended during emergency task performance and over time prior to an emergency event, the number and duration of rest periods during the day, and length of the workday for the routine tasks that have a flexible schedule.

(F) It is expected that workload differences measured by physiological means is used as a last resort. This judgment basis process supports analysis of complex high risk actions such as those involving fire scenarios.

(G) The ESBWR FRA, AOF and TA will start with the top-down approach to ensure that time and human resources are sufficient to address tasks in risk important event scenarios. One or more of methods described in NEDO-33221 will be selected to address the complexity and timing of the actions as appropriate for the case being analyzed. For example, timing analysis of human actions using operational sequence diagrams (OSDs) may be based on the cue from the displayed information, the cognitive workload and operator control actions assigned to each CR staff against a postulated scenario time/event-line that defines the human response requirements.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-19

Section 3.7, Methods for Identification of Critical Tasks - NUREG-0711, Task Analysis Criterion 1, 3rd bullet states "[human actions] that have been found to affect plant risk by means of PRA importance and sensitivity analyses should also be considered risk-important. Internal and external initiating events and actions affecting the PRA Level I and II analyses should be considered when identifying risk-important actions." Section 3.7 defines critical tasks and references Section 19.4 of the PRA. However, neither the scope or section 3.7 address all aspects of this criterion. Section 19.3 of PRA is titled Determination of Important structures systems and components (SSCs) for Level I and 19.4 is Determination of Important SSCs for Level II. Section 19.3 did sorts by Fussell-Vesely (FV) and risk achievement worth (RAW) and developed Tables 19.1 and 19.2. This section noted that there were several human error contributions, but they are not listed anywhere and they were apparently eliminated from these tables. Section 19.4 relates to the PRA level II analysis and discusses ADS and containment venting as important but actually only addresses the systems and components and does not clearly conclude that any HAs are risk- important or critical. There does not appear to be a list of risk important operator actions anywhere in the PRA. Please address the risk aspects of this criterion.

GE Response

Use of the term PRA in the TA implies that PRA Level I and II with internal and external initiating events are included. It is also important to note that a design level PRA has less detail and uses broader definitions of basic events than for a completed plant specific PRA. Thus, the top down TA (Enclosure 2, Addendum to RAIs 18.5) provides input to and gets information from the PRA/HRA to identify risk-important actions.

The list of important human actions is an on going development and is subject to significant change during the design process; thus, the list is not fully developed until later in the design process. The listing of these actions will be communicated between the HFE and the PRA and will be available for NRC review when developed. There are over 150 human action basic events and about 30 of those are in the importance ranking. Furthermore, the listing of system and component basic events includes both human and hardware failure modes. The determination of whether human or automatic functions will be accomplished will not be set until after the Allocation of Function step of HFE is complete. Thus, it is premature to present the listing of important human actions until the initial iterations between the TA and PRA/HRA have been completed.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-20

Section 3.7, Methods for Identification of Critical Tasks (and the associated Figure 16), identify several ways that a task may be designated as a critical task. A few aspects of these definitions require clarification. The risk aspects were addressed by the previous RAI.

- *the section refers to the GE ABWR ESBWR SSAR). Please clarify what is meant by this reference.*

- *the section adds actions to "isolate the reactor and to inject ..." Please explain the basis for adding this action and why it was not identified by the PRA.*

- *the section adds tasks involved in the achievement of a "critical function to safety." The section also mentions a "safety critical function." The ESBWR System Functional Requirements Analysis Implementation Plan" discusses "plant critical functions" and "systems critical functions," in Table 3 but not a "critical function to safety" or a "safety critical function." Neither one of these discussed in the PRA would seem to provide the HA or task that would serve as the "critical function to safety." Please explain from where the "critical functions to safety" are derived.*

- *the section adds actions that relate to "a task with a great potential for human error." Please explain how these tasks will be determined.*

GE Response

a. The reference should be to the ESBWR DCD Section 18 and will be changed in the next revision to NEDO-33221.

b. PRA models identify the risk important human tasks. The top down SFRA, AOF and TA processes identify human tasks that are critical to safety. The HRA implementation plan insures that the actions critical to safety are addressed in the PRA and evaluated for their risk importance. Potentially risk important tasks involving "isolate and inject tasks" for a range of events were emphasized, because from the design viewpoint they are the key to switching modes from power production to shutdown cooling. The ESBWR uses isolation and injection tasks to establish the passive cooling systems and control fission product barriers following a triggering event. The operator's role is to monitor automatic initiation and to act as a backup should automated systems fail to initiate the isolation or injection.

c. Critical actions that are important to safety for the ESBWR will be derived using the top down approach described in Addendum to RAIs 18.5 during the high level TA. The detailed TA at the system or subsystem level may use previous ABWR TA, Logic, and SFRAs if the system functions and means of achieving the functions are comparable such that the human tasks for the ESBWR system are essentially the same as the tasks in the ABWR system. Critical safety functions are illustrated in NEDO-33219 Figure 4 and in Figure 1 of Addendum to RAIs 18.5. This approach will be further explained and clarified in the next revision of NEDO-33221.

d. The top down TA approach focuses on the items and tasks critical to safety. This requires separating risk critical actions from those that are not critical to safety. The risk critical tasks will be evaluated with TA tools to insure that the error potential is low. The non-critical human actions will be handled through normal interface designs, procedure development and training that reflect standard human factor design guidance.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-21

Section 3.7, Methods for Identification of Critical Tasks, references Figure 18. The proper reference appears to be Figure 16.

GE Response

The reference to Figure 18 will be changed to Figure 16 in the next revision to NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-22

Section 3.9, Task Analysis Report, does not address the main outputs of task analysis: HSI requirements, procedure input, and training input. Where will these be documented?

GE Response

They are covered under item 4.

> "Presentation and discussion of the results of the task analysis, including discussion of design change recommendations derived from these analyses and/or negative implications that the current design may have on safe plant operations"

Item 4 will be clarified to specifically address HSI requirements, procedure input, and training input in the next revision to NEDO- 33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-23

Section 4.1, Objectives, states that "[t]he objective of evaluating the results of task analysis is to ensure that the task analysis defines the system design goals" (p. 564). This is not consistent with the purpose of task analysis, which is to define the requirements for task performance. Please clarify this statement.

GE Response

The top down TA will map into the system design goals, not define the system design goals. This will be changed in the next revision to NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-24

Section 4, Methods for the Evaluation of the Task Analysis Results - In general, this whole section seems to focus on evaluation of the actual design and not the task analysis results themselves.

The HSI design is the result of many inputs, of which task analysis is one. Evaluating the design in the ways described in this section does not, in itself, constitute an evaluation of the task analysis. For example, the following display characteristics, identified on pp. 66-67 of the plan, are identified as part of the evaluation:

"1. Content density
The design team may be able to evaluate content density by considering the following questions for each picture:
a. Does the picture appear congested?
b. Is it difficult to locate needed information due to the large number of picture elements?
c. Are there likely to be many elements competing for the user's attention?
d. Does this picture require lines of demarcation or other symbols to separate elements from one another?
e. Does scanning this picture for important information, require focusing on each individual element separately?"

These aspects of a display are more related to the use of human factors engineering (HFE) design guidelines than to the task analysis results.

Please clarify the proposed approach.

GE Response

NEDO-33221, Section 4 will be reviewed for consistency with the top down approach described in the Addendum to RAIs 18.5 and will be revised to focus on the evaluation of the tasks themselves rather than elements of the interface design.

DCD Impact

No DCD changes will be made in response to this RAI.

LTR NEDO-33221, Rev 0 will be revised as described above.

NRC RAI Number 18.5-25

Appendix A, provides the data table to be used by analysts. The information section of this table does not match the information provided on Table 6 (p. 81). Please explain.

GE Response

The purpose of the table in Appendix A is to document in a database the key items that result from the overall task analysis. The focus in Table 6, which supports the definition of the parameters in the HSI, is to identify the information needs of the user in terms of the attributes of the data to be presented as cues and feedback.

The database outline in Appendix A will be expanded in the next revision to NEDO-33221 to include additional information from designer choices in Table 6 for specific tasks. The choices for measurement range, accuracy, unit dimensions, refresh and update response times, required locations for information and control, and information presentation colors will be included when different from the HSI style guide (see Figure 1 NEDO-33221).

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-26

If the ESBWR task analysis focuses only on a selected subset of tasks (as discussed above in Criterion 1), e.g., those that are new or significantly changed, then how is the integration of all tasks into a specific job assessed?

GE Response

The approach for addressing task interactions during the task analysis will use a top down approach as shown in Enclosure 2, Addendum to RAIs 18-5. NEDO-33221 will be revised to include the top down approach which naturally defines task interactions.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-27

The topic of minimum inventory is not adequately addressed in NEDO-33221. In Section 1.2, Scope, a commitment to define a minimum inventory is made; however, it is not addressed in the detailed methodology. Additional information is needed as to how the minimum inventory will be identified and what criteria will be used in the selection process.

GE Response

In the case of safety parameters the top down HLFA, AOF and TA as described in the Addendum to RAIs 18.5 will identify the minimum inventory of information and cues needed to accomplish start up, operation and shutdown and trigger entry into the plant emergency procedures. This pattern for functional and task analyses is followed for the non-safety operational functions (detailed analyses), and then for the conditions for taking equipment out of service for surveillance, maintenance, testing, and repair (pre-operational analyses). The output provided by each iteration lists a minimum set of alarms, displays and controls necessary for the crews to perform required functions to meet the requirements of the human tasks in performing system operations as well as developing strategies for adjusting plant states and configurations.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-28

The methodology indicates that the results will be used as input to the design of HSIs, procedures, and training. Sufficient detail is provided for training applications in Section 5. However, while the detailed methodology discusses the analysis of specific information requirements, including detailed data tables, it is not clear how the requirements transmitted to HSI designers will be identified and communicated. For example, this topic is specifically addressed in Section 3.8, which states:

> *"Requirements for alarms, displays, controls, and data processing are obtained from the Table Data Form described in Section 3.6.2. This table should be detailed enough to identify all these requirements. A complete set of requirements will be those defined in the ESBWR standard design features complemented with those derived from other matching areas identified in the Table Data Form." 12 (p. 63).*

What is the role of the ESBWR standard features in HSI requirements identification? Which specific columns of the detailed data table, e.g., from Table A-1, constitute the HSI requirements? Where are alarm requirements identified?

GE Response

As illustrated in Enclosure 2, Addendum to RAIs 18.5, the top down approach will be used to identify HSI requirements for those functions and systems identified in the SFRA (e.g., Figure 4 page 63 of the SFRA implementation plan). Standard features are those that are generic to the Fleet of BWRs and in particular the ABWR, which help establish the basis for the ESBWR control strategy.

The HSI requirements summarized in the Table A-1 database columns include: the name of parameter, plant state, plant system, information and control capability required, information available, connection to other tasks, feedback requirements, feedback timing, job performance aids, tools and equipment, location, and communication.

The initial alarm requirements are developed and identified from TA during the process described in section 3.5.4 for developing the task description, and 3.6 for the detailed description. Many alarm signals for BWR systems have been defined for systems in previous designs. Others may be defined to address accident management requirements. The TA and use of the PRA/HRA help prioritize alarms that are needed during emergency events. The application of the top down TA approach discussed in Enclosure 2, Addendum to RAIs 18.5, helps define the minimal set of alarms needed to address the safety functions (including entry into procedures). Use of safety system scenarios, EPGs, and PRA/HRA accident scenarios also support identification of and priority for the alarms.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-29

Explain the role of task analysis as input to procedure development and modification.

GE Response

Results of the task analyses are identified as inputs procedures in Figure 1 of NEDO-33221. The role of the task analysis is to determine what tasks need to be performed to accomplish the functions identified by the functional requirements analysis. TA also identifies the interface cues, feedback information, and any needed tools. Finally, the TA identifies other environmental condition requirements that might influence the ability of an operator to carry out the task. The TA verifies that the task can be accomplished and the HRA provides an estimate of the probability and consequences of the task not being performed. The procedure writers use this information to check and verify that the cues, sequencing and plant/system conditions for implementing the task are properly integrated into the procedures.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-30

Identify what changes will be made to DCD Tier 2, Section 18.5, Task Analysis, in response to the Task Analysis Implementation Plan and any revisions made on the basis of the RAIs.

GE Response

The DCD tier 2 will be updated, if needed, to reflect changes in the HFE implementation plans when the revisions in NEDO-33221 are complete.

DCD/LTR Impact

No changes to the subject LTR will be made in response to this RAI.

No DCD changes will be made in response to this RAI.

NRC RAI Number 18.5-31

Identify what changes will be made to DCD/Tier 1 Design Commitments and ITAAC, specifically Commitment 4[6] addressing task analysis, in response to the Task Analysis Implementation Plan and any revisions made on the basis of the RAIs.

GE Response

This RAI requests Tier 1 or ITAAC changes and/or additions; therefore, it has been reviewed per GE internal Tier 1 content determination guidelines, which are based on draft SRPs 14.3 through 14.3.11, and DG-1145 (as of July 31, 2006). This response is provided consistent with those guidelines.

All of the HFE implementation plans identified in Table 3.3-1 have been submitted for NRC review. DCD Tier 1 Table 3.3-1 entry 6.a will be deleted in the next revision.

DCD, tier 1, Table 3.3-1 Item 6.b
SRP section 14.3 Appendix A Section IV.B.2.c Column 3, acceptance criteria in the second paragraph states, " For example, the acceptance criteria for the design integrity of piping and structures may be that a report exists that concludes the design commitments are met."

NEDO-33221 section 3.9 commits to providing a report for the TA with example details suitable for review of the process. This level of detail is commensurate with the safety significance of the human tasks evaluated [SRP Section 14.3 guidance].

Based on the availability of the TA documentation (report), no changes will be made to the DCD, tier 1 Table 3.3-1 item 6b.

DCD/LTR Impact

No changes to the subject LTR will be made in response to this RAI.

DCD Tier 1, Table 3.3-1 will be revised as noted in the attached markup.

NRC RAI Number 18.5-32

The title of NEDO-33221 should state that the document is an implementation plan. Please clarify document title.

GE Response

The new title for NEDO-33221 will be "ESBWR Human Factors Engineering (HFE) Task Analysis (TA) Implementation Plan" in the next revision of NEDO-33221.

DCD/LTR Impact

LTR NEDO-33221, Rev 0 will be revised as described above.

No DCD changes will be made in response to this RAI.

ENCLOSURE 2

MFN 06-401

Response to Portion of NRC Request for

Additional Information Letter No. 64

Related to ESBWR Design Certification Application

Human Factors Engineering

Addendum to RAIs 18.5
Sketch of Top Down Task Analysis for the ESBWR

Addendum to RAIs 18.5
Sketch of Top Down Task Analysis for the ESBWR

Introduction

To address a number of the RAIs the HFE team has decided to modify the TA strategy to use a top down approach rather than a modification to deltas from previous designs. There are a number of advantages to using the top down process.

(1) It matches the SFRA link in Figure 4 page 63 of NEDO-33220.
(2) It naturally supports the identification of task interactions needed to accomplish top level goals.
(3) The high level task analysis can be started earlier in the design process before systems and procedures are developed.
(4) The task analysis process is easier to describe and covers significant ESBWR engineering changes in an integrated fashion.
(5) The process is more likely to have an impact on the design features.

Key points of the System Functional Requirements and Task analysis

Analyses will be performed in three stages:

- High Level Task Analysis
- Detailed Task Analysis
- Pre-operational Task Analysis

High Level Task Analysis

The High-level Task Analysis will address Critical Safety Functions (CSF) and the tasks required to:

- Monitor CSF status and verify automatic actions
- Identify when CSF related parameters have exceeded (or trend indicates it is imminent)
- Determine the correct mitigating action
- Implement mitigating actions
- Verify effectiveness of mitigating actions

The High-level Task analysis inputs will be:

- DCD Chapter 6 "Engineered Safety Features" (via SFRA & AOF)
- DCD Chapter 15 "Accident Analysis (via SFRA & AOF)
- PRA (via HRA)
- MMIS Implementation Plan (via SFRA & AOF)

Addendum to RAIs 18.5 (continued)
Sketch of Top Down Task Analysis for the ESBWR

The High-level Task analysis outputs will be:

- Listing of the key tasks required to meet safety functions
- Inventory of instruments and information needs for monitoring and controlling ESF elements.
- Initial inventory of simulator scenarios for V&V
- System design input
- Inputs to content of EPG/EOP outlines and SAG
- Emergency Action Level procedure outlines
- Minimum (Tech Spec) staffing requirements
- Input to Detailed TA

Detailed Task Analysis

The Detailed Task Analysis will address operational tasks including:

- Reactor Startup
- Power ascension
- Turbine Roll
- Low Power Operation
- Normal Steady State Operation
- Power Maneuvering
- Transient and abnormal operating conditions
- Refueling and outage activities
- Reactor shutdown
- Normal plant heat-up and cool-down
- High-level TA
- Plant Automation

The Detailed Task Analysis inputs will be:

- ESBWR Plant Design Baseline Review Record (via SFRA & AOF)
- Inputs to content of SOPs, AOPs, ARPs, IOPs, and GPPs
- System Design Documents (SDD) (via SFRA & AOF)
- PRA (via HRA)
- MMIS Implementation Plan (via SFRA & AOF)

Addendum to RAIs 18.59 (continued)
Sketch of Top Down Task Analysis for the ESBWR

The Detailed Task Analysis outputs will be:

- Critical system design refinement inputs
- System design inputs (to non-critical systems/functions)
- ESBWR procedure outlines (AOP, Startup, Refueling, System operating)
- ESBWR recommendations for training on tasks and input to staffing considerations

Pre-operational Task Analysis

The Pre-operational Task Analysis will address operational tasks including:

- Testing and Surveillances
- Maintenance and Calibration
- Safety Tagging/lockout
- Staffing & Training
- NLO activities
- System Monitoring

The Pre-operational Task Analysis inputs will be:

- ESBWR Plant Design Baseline Review Record (via SFRA & AOF)
- System Design Documents (SDD) (via SFRA & AOF)
- PRA (via HRA)
- MMIS Implementation Plan (via SFRA & AOF)
- Inputs to content of STPs
- Refinements for EOPs, AOPs, SOPs, ARPs, IOPs, GPPs, and SAGs

The Pre-operational Task Analysis outputs will be:

- Verification of or recommendations for Staffing levels
- Inputs to Training Requirements
- Operator Rounds (guidelines)
- System Monitoring (guidelines)

The following Figure 1 provides an illustration of the analysis structure related to Figure 4 page 63 in the SFRA implementation plan NEDO-33220 that provides the top level input to the TA.

Addendum to RAIs 18.5 (continued)
Sketch of Top Down Task Analysis for the ESBWR