



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

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Subject: **Response to Portion of NRC Request for Additional Information
Letter No. 64 – Human Factors Engineering – RAI Numbers 18.4-1
through 18.4-25**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter.

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

Sincerely,

A handwritten signature in cursive script that reads "Kathy Sedney for".

David H. Hinds
Manager, ESBWR

D068

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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 06-400 – Response to Portion of NRC Request for Additional Information Letter No. 64 – Engineered Safety Features – RAI Numbers 18.4-1 through 18.4-25

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

ENCLOSURE 1

MFN 06-400

**Response to Portion of NRC Request for
Additional Information Letter No. 64
Related to ESBWR Design Certification Application
Human Factors Engineering
RAI Numbers 18.4-1 through 18.4-25**

NRC RAI 18.4-1

As described in the DCD, it is clear that the ESBWR design is mature and quite complete. However, the ESBWR functional requirements analysis (FRA) described in NEDO-33219, "System Functional Requirements Analysis Implementation Plan," is not clear regarding how particular aspects of the analysis have been or will be performed for ESBWR, as follows:

- a) Section 3, paragraph 3, notes that the ESBWR functional analysis begins at the System Level because it is an evolutionary design. This may be acceptable, but the higher-level plant goals, subgoals, critical functions, and plant performance requirements that are being adapted from ABWR should be documented as part of the ESBWR functional analysis. Any functions that are different also should be documented.*
- b) Section 3, paragraph 4, states that the top-level structure created in this section is only an example and that the top-level structure is included implicitly in the design basis of the ESBWR plant systems. Please provide a description of this top-level structure.*
- c) Sections 3.1.1 and 3.1.2 note that definitions of several aspects of ABWR are needed and then describe the development of safety related and availability subgoals. In the actual ESBWR functional analysis, will such subgoals be developed for ESBWR? Please explain.*
- d) Section 4.2, paragraph 3, states that the functional analysis for ESBWR can take advantage of predecessor ABWR designs and that depending on the ESBWR project schedule, systems analysis could also be based on functions defined in ABWRs. Does this mean that a functional analysis will not be performed for ESBWR? Please explain.*
- e) Section 4.2 uses as an example of the methodology the reactor water cleanup (RWCU) System for a BWR-6 plant. Please explain why a system from a BWR-6 was used rather than an ESBWR system or an ABWR system (the predecessor plant for ABWR).*
- f) Please discuss how the plan ensures that all high-level functions for ESBWR necessary for the achievement of safe operation are identified, and that all requirements of each high-level function are identified.*
- g) Similar language appears in NEDO-33220, "ESBWR Allocation of Functions [AOF] Implementation Plan." Section 1.2, Scope, states:*
 - "The function allocation can follow the same allocation from proven previous designs when the interface and information is unchanged. Thus, in many cases the HFE work performed for the previous ABWR designs applies directly to the ESBWR."*

- *"Detailing the steps of the AOF process for both new systems and changes to existing systems."*
- *"The AOF will be developed as a delta process to the ABWR plant designs. The Baseline Review Record established as precursor to these activities will form the bases from which a gap analysis will document the level of application of the technologies described herein. The systems will undergo execution of the described AOF activities, either because they are new systems or the design and/or regulatory basis is sufficiently changed to warrant reevaluation/reengineering."*

Please provide clarification of the above areas, so that the actual planned implementation of functional requirements analysis and allocation can be properly understood.

Specifically:

- *What ABWR analyses will be used as part of the ESBWR design certification? Provide documentation of the analyses.*
- *How will the gap analysis be performed? What criteria will be used to determine when a gap exists?*

GE Response

- (a) The higher-level plant goals, subgoals, critical functions, and plant performance requirements that are being adapted from ABWR will be documented as part of the ESBWR Functional Requirements Analysis (FRA). In addition, any other functions that are different will also be documented.
- (b) The methodology for developing the top level functional structure starting from the plant primary goals (PFL-1) is discussed in Sections 3.1 through 3.3. An illustration of the top down Task Analysis (TA) approach is being developed in response to RAIs 18.5, (See Addendum to RAIs 18.5). This illustration depicts the process to be used. This process will follow through the allocation of functions (FA) and into the Task Analysis (TA) where the system functional analysis methodology begins (Section 4.2). This will be clarified in the next revision of NEDO-33219 and NEDO-33220.
- (c) Yes. The FRA will be performed for each ESBWR system and will identify the safety related and availability subgoals.
- (d) No. As stated in 18.4-1 (c) above, the FRA will be performed for ESBWR systems. This paragraph is allowing us to use previously verified design inputs from ABWR and other BWR plants as a starting point for the ESBWR FRA.
- (e) When this document was issued, the Lungmen FRA for the reactor water cleanup system was not available. The processes identified in Figures 7 thru 12 are the same for the BWR6 and the ABWR. An example featuring the ESBWR RWCU system will be provided in the next revision to NEDO-33219 and NEDO-33220.

- (f) As stated in Section 3.1, second paragraph the "...safety related and non-safety related system functions and design information are defined in the ESBWR System Design Description(SDD). In addition to system functions, the SDD defines mandatory allocations of functions prescribed by regulatory requirements or design goals."
- (g) See response to RAI 18.3-25 (b) previously submitted.

The GAP analysis will be performed using checklists contained in the BRR Plan:

"Table 2 - Identification of Equivalent Systems Between Predecessor and ESBWR for HFE Evaluation", and

"Table 3 – Identifying Differences Between Predecessor and ESBWR Systems"

DCD/ LTR Impact

LTRs NEDO-33219, Rev 0 and NEDO-33220, Rev 0 will be revised as noted above.

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

NRC RAI 18.4-2

- a) *NEDO-33219, Section 2.3, identifies Regulatory Requirements and Guidelines. NEDO-33219 lists NUREG-0700, 1986, which is outdated. The current version is Rev. 2, dated May 2002. Also, EPRI NP-3659, dated 1984, has been supplanted by several later EPRI documents. Please explain the rationale for referencing these older versions.*
- b) *NEDO-33220, Section 2.1, identifies reference documents for function allocation. NUREG-0700, Rev. 2 is listed. How is this document relevant to function allocation? The 1987 version of the Handbook of Human Factors is listed. There are later versions of this document, the latest being 2006. Please explain the rationale for referencing these older versions.*

GE Response

- (a) Corrections will be made to the referenced documents to ensure that revision numbers and/or dates of issuance are correct for each referenced document in NEDO-33219 and NEDO-33220. Some superseded documents will continue to be referenced if they contain valuable information for use in GE ESBWR HFE plans.
- (b) NUREG-0700, Rev 2 will be deleted from NEDO-33220 Reference Section 2.3.3 and the Handbook of Human Factors 1987 version will be corrected as stated in 18.4-2 (a) above.

DCD/LTR Impact

LTR NEDO-33219, Rev 0 & NEDO-33220, Rev 0 will be revised as noted above.
No DCD changes will be made in response to this RAI.

NRC RAI 18.4-3

Section 3.2 of NEDO-33219, p. 19 states that, "The ESBWR PFL-3 Critical Functions for the primary containment have been identified and they are the bases for EPGs [Emergency Procedure Guidelines]. These Critical Functions are identified in the EPGs and in the ESBWR DCD." This is one of several cases where this plan is lacking in ESBWR-specific information. The statement acknowledges that it is available. Please include information on critical functions for primary containment in the plan.

GE Response

The cited paragraph will be replaced with the following at the next revision to NEDO-33219:

“The final PFL-3 Critical Functions for the ESBWR primary containment are:

- Monitor & Control suppression pool temperature
- Monitor & Control drywell temperature
- Monitor & Control drywell pressure
- Monitor & Control suppression pool water level – high and low
- Monitor & Control primary containment hydrogen concentration”

DCD/LTR Impact

LTR NEDO-33219, Rev 0 will be revised as noted above.

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

NRC RAI 18.4-4

Section 5.1 of NEDO-33219, p. 39, when discussing the plant's safety related plant critical functions states that "[t]hese functions cover the accident conditions because if one of these functions was not achieved, the respective subgoal (and consequently the primary safety subgoal) will be not satisfied." This does not appear to be accurate, because if true it would imply that the ESBWR has inadequate defense-in-depth (when failure of one critical function results in unacceptable release of activity to the environment). Also, please clarify the part of the statement that says, "these functions cover the accident conditions." Clarify statements in Section 5.1 of NEDO-33219, p. 39 regarding safety related plant critical functions.

GE Response

Figure 4 depicts logical "AND" relationships between subgoals and critical functions for a BWR6. Therefore, for document clarity, BWR6 will be added to the Title lines of Figures 4 & 5.

Section 5.1 will be revised as follows:

"The methodology of analysis proposed in Section 3 identifies the safety-related plant Critical Functions as those functions needed to accomplish the plant's safety functional requirements. These functions, based on EPGs and Design Basis Accidents (DBA), are identified for the BWR6 and are shown in Figure 4. The Critical Functions mitigate accident consequences and if they are not achieved then the risk levels associated with safety subgoals and the primary safety goal are challenged. The Responsible System Engineers will identify the safety related Critical Functions for the ESBWR plant systems as described in the ESBWR Project SDDs. For the System Level Functional Analysis described in Section 4, all the events analyzed in the ESBWR DCD Chapter 15 Accident Analysis will be considered to satisfy the design basis conditions."

DCD/LTR Impact

LTR NEDO-33219, Rev 0 will be revised as noted above.

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

NRC RAI 18.4-5

Figure 1 of NEDO-33219 presents a Block Diagram for the plant Safety Goals. The scope of the FRA in Section 1.3 is stated to include both probabilistic and deterministic evaluations. Based on this, two important aspects appear to be lacking from the goals in Figure 1, namely prevention of initiating events (as defined by the PRA) and any consideration of emergency planning activities. Please update or explain how these aspects are addressed.

GE Response

Section 1.3 is establishing the scope elements for the “GAP” analysis which is part of the Baseline Review Record (BRR) Plan currently under development. Using the “GAP” analysis along with the ESBWR HFE Human Reliability Analysis Implementation Plan (NEDO-33267) allows the ESBWR PRA/HRA team to evaluate the risk impact of changes between predecessor designs and ESBWR plants. This is one of the HFE methods used to prevent initiating events (as defined by the PRA) and includes both probabilistic and deterministic evaluations.

Emergency Planning activities are site specific and addressed in DCD Chapter 13.

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 18.4-6

Figure 2 of NEDO-33219 presents the availability-related subgoals including AG-4, Shutdown and Refueling. Is risk related to Shutdown and Refueling included in the safety-related goals as well? If so, where? If not, why not?

GE Response

Risk is considered in the shutdown and refueling sub-goals. The tasks associated with the functions defined will be addressed in the task analysis. Also as part of the OER review process, it was clear that shutdown and refueling presented many problems to the existing nuclear power plants and appropriate areas have been screened for correcting and improving BWR operations. These improvements are being carried forward into the overall ESBWR design.

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 18.4-7

Please provide clarification of the following aspects of NEDO-33219 methodology.

- a) *Section 5.2, last paragraph states, "[f]uture reviews of the important PRA sequences address beyond design basis events from the ESBWR DCD (Chapter 19) can challenge the operators to interact through the HSI [human system interface] in different ways with the plant." Please clarify.*
- b) *Section 5.3, last paragraph states, "[c]ritical functions can also include non-safety functions involving high asset value components, those that support plant availability, and capacity factor, and those requiring human resources that can become unavailable for other safety related tasks." Please clarify the portion discussing human resources that can be unavailable.*
- c) *Section 7.1, p. 46, states, "[t]he following types of events should be included, consistent with analyses documented in Chapters 15 and 19 of the ESBWR DCD: "Please explain the purpose of this portion of the analysis and how these events will be used.*
- d) *Figure 2 of NEDO-33219 is for a BWR-6 and not ESBWR and should be labeled as such for clarity.*
- e) *Figure 16 shows flow in units of MPa. Please correct.*
- f) *Table 3 lists Level 6 as Systems Subgoals (SFL-2) and Level 7 as Systems Critical Functions (SFL-3). However, the example provided in Figure A-4, lists SFL-2 as System Process and SFL-3 as System Processing Elements. Please explain the inconsistency.*

GE Response

- (a) As the ESBWR design progresses, future reviews of the important PRA sequences will address plant scenarios beyond those listed in the design basis events (ESBWR DCD Chapter 19) that have a probability of challenging the operators to interact with the plant through the HSI interfaces in different ways. This will be performed during operator training sessions on the simulator.

- (b) During plant transients, operators are challenged with simultaneous/almost concurrent tasks which need to be addressed leaving them unavailable to perform secondary tasks. The Control Room staffing assignments, workload, and task coordination will be assessed in the Task Analysis (TA).

Many transients start with an initiating event and quickly follow with other secondary events which must be dealt with. Following an incident, additional control room personnel normally report to the Senior Reactor Operator (SRO) on-shift to provide additional assistance.

- (c) These events will be analyzed during the FRA and the TA process and then used by the HFE team to monitor operator interaction with the HSI equipment. They will be included in the overall operator training program to ensure operator proficiency.
- (d) Figure 2 will be corrected by adding BWR-6 into Title line at the next revision of NEDO-33219.
- (e) Figure 16 units for "Pumps discharge flow" will be corrected at the next revision of NEDO-33219."
- (f) The titles in Table 3 for Levels 1, 2, 5, 6 and 7 will be changed, to be consistent with Figure A-4 and the titles of Sections 3.1, 4.2.1 through 4.2.3 as follows:

Level 1 Change "Plant General Goals" to "Plant Primary Goals"

Level 2 Change "Plant Subgoals" to "Plant Primary Subgoals"

Level 5 Change "System Goals" to "System Functions"

Level 6 Change "System Subgoals" to "System Process"

Level 7 Change "System Critical Functions" to "System Processing Elements"

To ensure clarity, the word "Plant" will be inserted in the last paragraph of Section 3 and in the headers of Sections 3.2 and 3.3. Also, the word "Purity" will be corrected to "Purify" in the Title line of Figure A-4. These changes will be made at the next revision of NEDO-33219.

DCD/LTR Impact

LTR NEDO-33219, Rev 0 will be revised as noted above.

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

NRC RAI 18.4-8

An implementation plan should provide step-by-step, specific guidance on how to perform the allocation of function analysis. The current document does not provide step-by-step procedures. Absence of specific procedural steps may make this document difficult for reviewers to understand the proposed methodology. While the document contains a fair amount of detail, it is not clear how will the methodology be applied for ESBWR. Perhaps a worked-out example, included in the plan, (or some other approach) is needed to illustrate the application of the methodology reflecting a slice of the methodology from top to bottom. Such an example does not need to reflect a complete analysis at any step. Clarify how the methodology will be applied to ESBWR.

GE Response

An Appendix will be added to NEDO-33220 which shows the Allocation of Function (AOF) process for one ESBWR system.

DCD/LTR Impact

LTR NEDO-33220, Rev 0 will be revised as noted above.

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

NRC RAI 18.4-9

The methodology is presented more as a recommended practice rather than as an approach to be used. The purpose of an Implementation Plan is to provide the methodology that will be used rather than what might be used. Please clarify if the methodology described is the actual approach that will be used to conduct that analyses.

GE Response

The methodology presented will be the approach used for the ESBWR design.

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 18.4-10

Among the key considerations in allocating functions are performance demands like time available and personnel workload. These types of considerations are appropriately identified in GE's methodology. However, the analysis begins at the system level rather than high-level functions which can include multiple systems or system operations. The consideration of operators' combined responsibilities, including those of monitoring and backing up automation, does not appear to be addressed until the function allocations are evaluated (as discussed in Section 4.3 of NEDO-33220).

The function allocation analysis should consider the context in which functions will be performed. For example, a set of scenarios with which the analysis is performed. Scenarios provide operational context and a means to evaluate multiple concurrent demands on personnel. It may also be difficult to evaluate functions in the absence of scenarios because the same function may be easily performed in one scenario but difficult in another.

Clarify how and where function allocation analysis considers integrated personnel responsibilities.

GE Response

We agree that scenarios provide operational context and a means to evaluate multiple concurrent demands on personnel. The allocation of function is iterative and the initial allocation will be based on assumptions. These allocations will be analyzed for appropriateness as in section 4.3 of the plan, but moreover, they will be assessed in the task analysis in the context of scenarios for workload and task coordination, and validated in the HFE V&V activity.

A 5th Precursor to Function Allocation will be added to Section 3.5: "5. Integrated Personnel Responsibility (operational context)"

The following new paragraph will also be added:

"3.5.5 Integrated Personnel Responsibility (Operational Context)

The function allocations will consider the requirements for the higher level Plant Performance Requirement function goal (PFL-4) where operators are interacting with multiple systems at the same time in order to improve the HFE MMIS interface early in the design process. This will be an iterative process beginning with the EPGs and then followed by other plant operations procedures. The HFE team members will provide insight and guidance early in the design phase."

DCD/LTR Impact

LTR NEDO-33220, Rev. 0 will be revised as noted above.

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

NRC RAI 18.4-11

NEDO-33220 Section 1.4, states that HFE is not within the scope of AOF and that it is "a separate discipline." Please clarify this statement.

GE Response

The statement clarifies that it is not required that a Human Factors Engineer necessarily perform the AOF (e.g., an operations person could perform it). Therefore, in the next revision of NEDO-33220, the sentence will be changed as follows: "AOF is based on HFE principles and is part of the MMIS HFE process, but HFE is not necessarily the one, and only, discipline involved in performing AOF. The evaluation of the AOF is an HFE activity and will be performed by HFE staff."

DCD/LTR Impact

LTR NEDO-33220, Rev. 0 will be revised as noted above.

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

NRC RAI 18.4-12

NEDO-33220 Section 3.2, states, "Specific guidelines from Section 4.4 of NUREG-0711r2 [2.3(4)] will be followed. The guidelines are paraphrased herein for clarification and convenience purposes" (P. 13). Eight guidelines follow this statement. However, the guidelines paraphrased are not from NUREG-0711, Rev 2. The guidelines appear to be from the original version of NUREG-0711 published in 1994. That guidance has been replaced by the guidance in Rev 2.

Guideline 6 states references a Figure 4.1 in NUREG-0711. However, the figure reference is incorrect and appears to be a reference to a figure in the 1994 version of NUREG-0711.

Page14 references Figure 1 of NEDO-33220. This figure is Figure 4.1 from NUREG-0711.

Clarify the relationship between NEDO- 33220 and NUREG-0711.

GE Response

Section 3.2 will be revised in its entirety to be in agreement with NUREG-0711R2 at the next revision of NEDO-33220.

DCD/LTR Impact

LTR NEDO-33220, Rev. 0 will be revised as noted above.

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

NRC RAI 18.4-13

NEDO-33220 Section 3.2.2.3, states, "When the allocations pass the evaluation tests, the function allocation process is complete, and the results obtained (functions and tasks allocated to humans) should provide the inputs needed for task analysis." (p. 17). What are the evaluation tests referred to in this statement?

GE Response

The next revision to NEDO-33220 will amplify Section 3.2.2.3 by adding the following sentence to the end of the paragraph:

“The function allocation will be evaluated further in the Task Analysis and the HFE V&V as acknowledged in Section 3.2.3 of the plan.”

The tests are covered in Section 4.3 Evaluation of Function Method.

DCD/LTR Impact

LTR NEDO-33220, Rev. 0 will be revised as noted above.

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

NRC RAI 18.4-14

NEDO-33220 Section 3.5.1, states, "General expected roles of the human, an initial allocation of functions, and an operator crew organization have been determined for the ESBWR in the DCD Chapter 18. These elements of the GE ESBWR design have evolved from a five year (1986-1991) research program which covered allocation of functions and validation testing (Chapter 18.4 of ABWR DCD) and subsequent ABWR deliveries." Please provide the results of this research program and experience gained from subsequent ABWR deliveries for NRC review.

GE Response

The response will be provided in RAI 18.6-7.

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 18.4-15

NEDO-33220 Section 4.1.1 provides consideration for defining functions to be allocated. There is an un-numbered Table on page 26 where some information is provided. However, the table does not contain all the considerations listed on page 25, e.g., accuracy and frequency are listed in the considerations, but not on the table. Are there specific criteria for these considerations that the analyst uses, e.g., what is a moderate rate? Are worksheets or some other guidance available for the analysts? Please clarify.

GE Response

The un-numbered table will be revised to include, Accuracy, Frequency and Hostile Environment. In addition the criteria will be defined, e.g. moderate, large, simple, etc.

DCD/LTR Impact

LTR NEDO-33220, Rev. 0 will be revised as noted above.

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

NRC RAI 18.4-16

NEDO-33220 Section 4.2 addresses the process for allocating functions.

- a) The decision guidelines on page 26 appear to be incomplete. The first bullet addresses allocation to multiple regions in Figure 9. Are decision guidelines needed for allocation to each region of the figure? Clarify second bullet decision guideline.*
- b) This section contains many criteria for allocating functions. Most are stated at a very general level. Are there more specific criteria available for analysts to use as part of the decision making process?*
- c) Figure 17 identified criteria for allocating a function to humans. One is "Objective of Function is Maintain ON/OFF control." Please clarify what this means.*
- d) On page 34 the following criterion is provided: "1. Automated Data Display. Examine each function and function segment and specify points where automated 9 display will simplify the core performance requirements for detecting, monitoring, planning or executing." Clarify the meaning of this statement.*
- e) Figure 21, the second diamond appears to be mislabeled. It should contain a title per the description on page 40.*

GE Response

- (a) The first bullet says "...follow the process for the rest of the function..". The process is covered in Sections 4.2.1 through 4.2.3.
- (b) No "more specific" criteria are available. Specificity typically originates on a case-by-case basis as the system design is developed and detailed, or new requirements come about (e.g., severe accident guidelines).
- (c) Control room operators need to physically perform the ON/OFF action either by hard switch/button or Software/Touch Screen interface.
- (d) Core Performance is described in Section 3.3.3. Core performance is the working categorization for describing the steps to process data from sensors to control signals, whether performed by human or machine. They consist of Detection, Monitoring, "Planning and Decision Making" and Control.
- (e) The wording will be changed to "Man meets human performance requirements" in the next revision of NEDO-33220.

DCD/LTR Impact

LTR NEDO-33220, Rev. 0 will be revised as noted above.
No DCD changes will be made in response to this RAI.

NRC RAI 18.4-17

Please confirm that the functional requirements analysis and function allocation (FA) will be kept current over the life cycle of design development and kept until plant decommissioning so that they can be used for analyses and modifications over the life of the plant. This is not clearly stated in either DCD Chapter 18 or NEDO-33219. Clarify inconsistencies between FRA and FA.

GE Response

The FRA and FA documents will be kept current over the life cycle of the design development and turned over to the COL upon completion of Site Acceptance Testing. The COL applicant will then be responsible for maintaining the FRA and FA for analysis and modifications over the life cycle of the plant. This is specified in DCD, Tier 2, Section 18.12 and NEDO-33278, Design Implementation plan, i.e., "...the integrity of the HFE infrastructure is maintained throughout the life cycle of the plant."

Any identified inconsistencies between the FRA and FA will be corrected at the next revision to both documents, i.e., NEDO-33219/33220.

DCD/LTR Impact

LTR NEDO-33219, Rev. 0 and NEDO-33220, Rev. 0 will be revised as noted above.

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

NRC RAI 18.4-18

Section 3.3.1 of NEDO-33219, Safety Related Subgoals Identification, states, "[t]o accomplish these objectives, the EPGs are intended to maintain the integrity of the barriers against fission products release. Top level objectives of EPGs will constitute the PFL-2 safety subgoals for the functional structure." It appears that some of the objectives of normal operations procedures would also be appropriate for safety subgoals at the PFL-2 level, since they also contribute to the Safety goal (PFL-1) Prevention of Activity release to environment. Also in Section 3.3.1 the first bullet under the PFL-2 subgoals is "Reactor Protection (fuel, coolant boundary, etc.)" The use of "etc." is not appropriate for a high level safety goal. Please complete this with all necessary detail.

GE Response

The Section number referenced is incorrect. It should be Section 3.1.1

Some normal operating procedures may be required to meet nuclear power plant safety goals. Upon completion of the Task Analysis for each ESBWR system, an iterative process involving EPGs and other plant procedures will take place across systems to ensure that the plant safety subgoals are met.

In the next revision to NEDO-33219 change the 1st bullet under Section 3.1.1 PFL-2 subgoals as follows:

- Reactor Protection (Fuel, Fuel Cladding, Reactor Coolant System Pressure Boundary)

DCD/LTR Impact

LTR NEDO-33219, Rev. 0 will be revised as noted above.

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

NRC RAI 18.4-19

Given the current stage of the ESBWR design, it is expected that GE should know now if there are any modifications to high-level functions between the ABWR and the ESBWR. However, this is not documented in NEDO-33219. The final report should provide this information and an explanation of the reasons for any changes that exist. Please provide a commitment in the plan to provide this information.

GE Response

See response to RAI 18.4-1 (a) and (b).

DCD/LTR Impact

LTR NEDO-33219, Rev. 0 will be revised as noted.

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

NRC RAI 18.4-20

Figure 6 of NEDO-33220 provides an example of the content of an allocation of function document. However, this is only an example, the actual structure of the contents should be provided. Section 3.5.4, Organization of the Documentation, includes a discussion of the use of an electronic database, "if applicable." When would it be applicable?. Will this approach be used by the ESBWR design team?

GE Response

See response to RAI 18.4-8 for structure contents.

Section 3.5.4 last paragraph, the words "If applicable" will be deleted in the next revision to NEDO-33220. GE will be using an electronic database for documentation storage, control and verification.

DCD/LTR Impact

LTR NEDO-33220, Rev. 0 will be revised as noted above.

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

NRC RAI 18.4-21

Section 5 makes reference to Appendix A for the criteria that may be used as a decision basis. Why was this appendix not referenced in the function analysis section where the basis for allocation is presented? And why isn't the basis the analysis that results from the methodology in Section 4.2, Function Allocation?

GE Response

The basis is the analysis that results from the methodology of Section 4.2.

The next revision of NEDO-33220 will include the following change:

In Section 5, remove the 1st sentence of the 2nd paragraph and add the following words to the last sentence of Section 4.2.1: “and Appendix A, Human Capabilities and Limitations.”

DCD/LTR Impact

LTR NEDO-33220, Rev. 0 will be revised as noted above.

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

NRC RAI 18.4-22

For the functional requirements analysis, the verification of NUREG-0711, Element 4, Criterion 10 will be accomplished if the top-down approach in NEDO-33219 is followed. However, as noted in RAI 18.4-1, there is not a clear commitment to actual performance of the top-down method. Discuss whether all high-level functions for ESBWR necessary for the achievement of safe operation are identified, and that all requirements of each high-level function are identified.

GE Response

GE will perform a top-down approach as stated in NEDO-33219.
See further discussion in response to RAI 18.4-1.

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 18.4-23

Verification of Function Assignment - NEDO-33220, Section 4.3, Evaluation of Function Allocation, addresses the verification of function assignment. The following clarifications to the methodology are requested:

1. *In Section 4.3.1 reference is made to Figure 20. Should this be Figure 21? Clarify reference.*
2. *On page 39, the makeup of the team is identified as including engineering and human factors. Will operations expertise be included as well? Page 40 indicates that a "chairperson" will resolve undecided cases. How will the chairperson be determined?*
3. *What procedures will be followed to obtain, integrate, and resolve expert evaluations? What data forms will be experts use?*
4. *Page 40 states that the following should be considered:*
 - a. *Psychological/physiological environment: shift length, job coherence, learning/performance requirements, and stress levels.*
 - b. *Physical environment: heat, lighting, noise, glare, etc.*
 - c. *Social structure: inter/intra-group characteristics, work team structure, and interpersonal interaction and support.*
 - d. *Organizational policy and structure: channels of communication, supervisory structure, and operator autonomy/responsibility.*

Similar detailed factors are evaluated in Phase 4 (page 44), e.g., "Can the organization be expected to provide personnel at the times and places required?"

The methodology is being performed as part of a hypothetical allocation using a static process. How can these factors be evaluated until there is an operating plant with an established organization? For example, how can the team evaluate whether the organization be expected to provide personnel at the times and places required? Will the methodology provide guidelines that can be used by the experts to evaluate these factors.

In general, these evaluations appear inconsistent with the stated purpose of the plan. "To describe a methodology for static function allocation" (p. 6). And the plan acknowledges the limitations of static allocation as not addressing the very factors that are evaluated:

Static function allocation does not account well for the dynamic (changing) nature of plant operations (e.g., due to component aging, plant modifications, and changes in the operating points) and human performance (e.g., due to procedures, training, cultural factors, attitude, boredom, fatigue, learning, adapting, etc.) (p. 5-6).

5. *Section 4.3.2.5, "Phase 5: Is Cognitive Support Adequate," and Section 4.3.6, "Phase 6: Is Job Satisfaction Optimum?" appear to require experts to evaluate important factors, but no guidance is provided as to how the evaluations can be made. Explain how can the experts evaluate this without a great deal of plant and control room design information. Is guidance going to be provided? Please provide examples of guidance to be used.*
6. *Section 4.3.3 discusses tradeoff studies for deciding between different function allocations. Since the methodology has not produced alternatives, clarify the purpose of the tradeoff studies at the evaluation stage of the process. Why isn't the consideration of alternatives part of the function allocation process itself.*
7. *Will dynamic evaluations be performed? Page 52 states "As necessary, the [control room design team] CRDT may elect to perform static and/or dynamic evaluation to verify the allocation of functions before the formal [verification and validation] V&V." When will dynamic evaluations be performed and where is the methodology described?*

GE Response

1. Section 4.3.1 reference is made to Figure 20. This should be Figure 21. This will be corrected at the next revision of NEDO-33220.
2. On page 39, the makeup of the team is identified as including engineering and human factors. This includes operations expertise.
Page 40 indicates that a "chairperson" will resolve undecided cases. The chairperson will be selected by GE management and will be well versed in HFE principles.
3. Section 4 "Phases of Function Allocation" will be used during the iterative process to obtain, integrate and resolve function allocation issues using members from the HFE team.

4. See page 40, Section 4.3.2.2 – 3. Checklist items will be tested using the simulator when it becomes available. This will allow for static and dynamic checking/testing of many items except for those that require the actual physical main control room environment. Some of the questions will require COL applicant input.

The HFE documentation and program will be turned over for the COL holder to maintain for the life of the plant. This will ensure that the HFE MMIS safety features designed into the plant remain intact, throughout the life of plant.

5. HFE staff will be used to evaluate function allocation. Operational and technical guidance will be provided by members of the HFE staff who have a great deal of operations background and control room design experience. As stated previously, the function allocation will be evaluated in the Task Analysis and HFE Validation & Verification (V&V) plans (Section 3.2.3).
6. Section 4.3.3 “Tradeoff Studies” are involved with evaluations that are relevant to decision making, i.e., machine (system) performed function or human (personnel) performed function. They also involve the solution to complex problems and will continue through the entire design process until satisfactory HFE results are achieved, i.e., a correct balance between man and machine interaction. These are iterative processes and the consideration of alternatives is part of the function allocation process.
7. If the simulator is available before the final V&V is scheduled, dynamic testing will be required for those functions that failed FA testing. The methodology for testing is contained in the Task Analysis Implementation Plan (NEDO-33221).

DCD/LTR Impact

LTR NEDO-33220, Rev. 0 will be revised as noted above.

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

NRC RAI 18.4-24

The Inspection Test Analysis and Acceptance Criteria (ITAAC) for Functional Requirements Analysis is in DCD Tier 1, Table 3.3-1, Item 4. Item 4.a relates to developing an system functional requirements analysis (SFRA) plan, which has already been completed (NEDO-33219) and is being reviewed as part of design certification of the ESBWR. Therefore 7.a does not belong in the ITAAC. Item 7.b relates to the implementation of the SFRA Plan and is appropriate, but should be modified to follow the guidance in the Standard Review Plan (SRP) Section 14.3, Draft Revision 0, September 1996.

Similarly, the ITAAC for Functional Allocation is in DCD Tier 1, Table 3.3-1, Item 5. Item 5.a relates to developing an FA plan, which has already been completed (NEDO-33220) and is being reviewed as part of design certification of the ESBWR. Therefore 5.a does not belong in the ITAAC. Item 5.b relates to the implementation of the SFRA Plan and is appropriate, but should be modified to follow the guidance in SRP 14.3.

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.

DCD, Tier 1, Table 3.3-1, Item 4.a and 5.a

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, Section 4.a and 5.a entries will be deleted at the next revision.

DCD, Tier 1, Table 3.3-1, Item 4.b and 5.b

SRP 14.3, Appendix A, Section IV.B.2.c Column 3, Acceptance Criteria, 2nd 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-33217, Rev 1, "ESBWR MMIS and HFE Implementation Plan" presents a thorough plan for implementing all HFE elements needed to meet applicable regulatory requirements and guidance. This includes implementation plans for the FRA and AOF elements that are described in NEDO-33219 and NEDO-33220, respectively. NEDO-33219 Section 4.3.5 indicates that for the functional analysis, "Interim and Results Summary of this analysis is input to Allocation of Functions". NEDO-33220 Section 4.4 indicates "The SFRA interim and results summary reports will include description of the functions and systems will be provided along with a comparison to the reference plants/systems.....". Section 4.4 also indicates "The functional requirements analysis and function allocation will be verified.....". It also indicates "Interim and results summary reports will be design input to the task analysis.....".

Based on the availability of the above reports/documentation, no changes will be made to DCD, Tier1, Table 3.3-1, Items 4.b and 5.b.

DCD/LTR Impact

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

DCD, Tier 1, Table 3.3-1, Section 4.a and 5.a entries will be deleted at the next revision.

NRC RAI 18.4-25

Function allocation is addressed in Section 18.4.2.

- (a) *Item (1) (e) states "[a]nalyses shall confirm that the personnel can perform tasks allocated to them while maintaining operator situation awareness, acceptable personnel workload, and personnel vigilance." The implementation plan does not clearly address this analysis. Please address.*
- (b) *Item (2)(b) (ii) states "[d]evelopment of alternative function allocations for use in the conduct of comparative evaluations. The implementation plan does not clearly address this analysis. Please address.*
- (c) *Item (2)(b) (v) states "[d]evelopment of test and analysis methods for evaluating function allocation alternatives." The implementation plan does not clearly address this analysis. Please clarify.*

Note: NEDO-33219, NEDO-33220, and DCD Tier 2, Section 18.4, should be updated to reflect the responses to RAIs 18.4-1 through 18.4-24 above.

GE Response

- (a) Section 4.2.4 Global Test and Section 4.3 Evaluation of Function Allocation clearly defines the analysis to be performed to maintain operator awareness (Section 4.2.4.2), acceptable personnel workload (Section 4.2.4.1/4.3.2.2) and personal vigilance (Section 4.3.2.5/4.3.2.6).
- In addition to the above, the TA will assess the personnel workload issues directly by making a personnel assignment in a scenario context and assessing the workload. In the same way, the decisions and information needs for the operational context will be assessed and this information will become the basis for the operator event training. As regards to vigilance, the planned HSI interface is designed to minimize operator vigilance decrement by involving the plant automation system in the monitoring and tracking of the various procedure steps and actions that may be happening simultaneously. The operator to automation interface will be designed and verified through plant automation simulations, addressed in the task analysis and training and procedure development, and validated in the HFE V&V activity.
- (b & c) Section 4.3.3 "Tradeoff Studies" of the FA plan addresses the development, test and analysis of FA alternatives. These include the relevant topics, such as, identify alternatives, selection criteria, weighting criteria, evaluating the alternatives and performing a sensitivity check.

DCD/LTR Impact

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

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