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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 74 – ESBWR Human Factors Engineering NEDO-33276 REV 0 ESBWR HFE Verification And Validation Implementation Plan – RAI Numbers 18.11-1 through 18.11-33**

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,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-383, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 74 Related to ESBWR Design Certification Application*, October 11, 2006

Enclosures:

1. MFN 06-446 – Response to Portion of NRC Request for Additional Information Letter No. 74 Related to ESBWR Design Certification Application –ESBWR Human Factors Engineering NEDO-33276 Rev. 0 ESBWR HFE Verification And Validation Implementation Plan – RAI Numbers 18.11-1 through 33

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0000-0061-7770

Enclosure 1

MFN 06-386

Response to Portion of NRC Request for

Additional Information Letter No. 74

Related to ESBWR Design Certification Application

Human Factors Engineering

NEDO-33276 REV 0 ESBWR HFE VERIFICATION AND VALIDATION IMPLEMENTATION PLAN

RAI Numbers 18.11-1 through 18.11-33

NRC RAI 18.11-1

A. Relationship to GEEN EOPs - NEDO-33276, p. 7 indicates that the V&V plan is used to supplement the GEEN EOPs. Please clarify the parts of the GEEN EOPs that are supplemented by this document as they may be needed by the staff to complete its review.

B. Safety critical LCSs - NEDO-33276, p. 8 indicates that the scope of the plan includes "LCSs that all critical to plant safety." Identify the criteria used to select the LCSs to be included.

C. Applicable documents - NEDO-33276, pp. 10-13 lists documents that are applicable to the plan. Some of these documents are quite old and may not be suitable to support V&V activities of a modern, computer-based control room. Examples of such documents include the two EPRI documents and NUREG CR–4227. The guidance contained in these documents does not reflect current control and display technology. Please clarify how such documents will be used.

D. Facilities included within the scope of V&V - the facilities identified as being addressed by the plan are not consistently identified throughout the document. For example, p. 7 states that the plan addresses the MCR, RSS, and LCS designs. On p. 9, the plan identifies the FB, rad waste building, TSC, and EOF as within the scope. On p. 14, indicates that the FB, Rad waste building, TSC,and EOF are included to the extent they directly involve actions critical plant safety. Please provide a clear and unambiguous statement as to the facilities addressed by this plan.

GE Response

A. References in Section 2.1.2 list the GE Energy Nuclear Engineering Operating Procedures (GEEN EOPs) that are used. These are:

- Work Planning and Scheduling – EOP 25-5.00
- Design Review – EOP 40-7.00
- Independent Design Verification – EOP 42-6.00
- Design Record Files – EOP 42-10.00

These are internal GE work procedures and are available for NRC review. The NRC staff members reviewed these procedures during the August 2006 meeting. The list of GEEN EOPs referenced in this implementation plan has been removed from DCD Chapter 18 and a reference provided to the ESBWR QA program.

B. This plan prescribes V&V requirements, and a program of compliant V&V activities, for verifying and validating the human factors engineering of the MCR, the RSS, and any LCSs with a safety-related function or as defined by the operational analysis.

C. While the references from EPRI and NUREG CR–4227 don't address HFE issues associated with newer human interface technology, they do describe:

- information content,
- cognitive issues,
- operator interactions, and
- applicable interfaces.

Such background is useful in understanding operational experience events and supporting changes to the previous control room designs. It also provides a link to the basis of previous BWR control room designs.

D. The facilities addressed by the plan will be clarified in NEDO-33276 by substituting the following paragraphs for the first two in section 1.0 Purpose. Also, references to locations in other sections will be removed.

> "The purpose of this document is to prescribe a plan for comprehensively verifying that the MMIS supports safety important actions that are identified through the qualitative operational analysis. Required manual tasks are identified through operational analysis as illustrated in Figure 2. The risk important actions are identified through the quantitative PRA/HRA process. Experienced based tasks are identified through review of OER data.
>
> The Main Control Room (MCR) is the primary location for HSI panels for safety important actions. Under various anticipated events such as a fire in the MCR alternate control stations provide backup HSI panel locations outside the MCR. Additional local control stations (LCSs) that have control and monitoring features involving safety-related tasks include:
>
> - Remote Shutdown Station (RSS) outside the MCR,
> - Fuel movement in the Fuel Building (FB),
> - Controlling potentially radioactive water in Radwaste Building, and
> - Plant monitoring in the emergency response facilities such as the Technical Support Center (TSC) and the Emergency Operations Facility (EOF)."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-2

NEDO-33276, Sections 4.3.1 addresses implementation of operational conditions sampling. This section contains four subsections that do not seem to be related to this topic. They are: 4.3.1.5, Test and Evaluation Condition, 4.3.1.6. Acceptance Criteria, 4.3.1.7, Performance Measures, and 4.3.1.8, Data Collection and Analysis. Please clarify what role each of these topics plays in implementation of operational conditions sampling.

GE Response

As indicated in section 4.3 the same format topics are listed for each of the main V&V activities. If a topic is not applicable to a particular activity, it is so indicated.

Section 4.3.1 will be revised to address the process for implementing operational condition monitoring. The sampling conditions include all tasks identified as safety-related manual actions through the operational analysis, through risk important actions from the PRA/HRA, through the OER and through specific actions called out in the EPGs.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-3

NEDO-33276, Sections 4.2.1 and 4.3.1.4.1 describes the sampling dimensions and indicates that a "multidimensional sampling strategy" (p. 18) will be used. Section 4.3.1.4.1, Items 1 through 3 largely restate the dimensions listed in NUREG-0711 (as presented in the sections below). While this is acceptable, the methodology or strategy that will be used to identify the sample of operational conditions that will reflect these dimensions is not identified. In the absence of such methodology, the staff has no basis to determine whether the sample characteristics described will be achieved. Please describe the method that will be used to the select the set of operational conditions along the sampling dimensions described in NEDO-33276.

GE Response

The multidimensional sampling strategy for establishing the sample of required operator actions for specific plant conditions to be used during simulations uses the actions defined as required to achieve the safety functions from the operations analysis.[2] The strategy will also sample human back up actions to automatic systems, actions required during normal startup, shutdown, and trip simulation scenarios. The strategy includes the use of risk important actions required in scenarios that lead to core damage as quantitatively identified in the PRA/HRA. The strategy also includes actions identified thru the OER process and a sampling of actions that exercise the use of the MMIS information and control features.

The method for selecting the actions to be sampled will incorporate the actions into a set of scenarios that cover all important actions, information, and control features that are tested under different conditions during each of the three V&V simulation phases.

The final set of scenarios defined for use in the integrated validation phase will satisfy the criteria for the range of plant conditions, personnel tasks, and situational factors known to challenge personnel performance, and the combined set of sequences will comprise all of the HSI and actions represented in the information and control needs derived from the operations analysis.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

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[2] "Operational analysis" includes the high-level FRA to determine critical safety functions, the plant level FRA (plant goal to subsystem functions), the SFRA (system functions as described in the system design specifications to discrete actions), the gap analyses (to reconcile inconsistencies between the above analyses), the allocation of functions, and the task analyses.

NRC RAI 18.11-4

NEDO-33276, Section 4.3.1.4.2 describes the identification of scenarios. The section restates the two criteria from NUREG-0711. While this is acceptable, the methodology that will be used to develop the scenarios is not identified. In the absence of such methodology, the staff has no basis to determine whether the scenarios developed will acceptably meet the criteria. Please describe the method that will be used to develop the scenarios reflect the scenario characteristics described in NEDO-33276.

GE Response

V&V scenarios will be developed to call on the required human actions for normally operating the plant (e.g., startup and shutdown using manual trip, monitoring actions, surveillance actions, and tagging control processes). Scenarios will be developed to trigger each representative alarm type to verify the process for entering and acting upon the AOPs. Scenarios will be developed to verify human actions needed to monitor and respond to the design basis events; they will exercise all entry conditions and required actions in each EOP. Scenarios based on risk important PRA/HRA cutsets will be used to develop a set of ESBWR specific malfunctions for use in V&V simulations. The library of malfunctions and their combined use will support V&V and future training exercises.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-5

NEDO-33276, Section 4.2.2 indicates that task support verification will be applied to safety critical tasks identified by task analysis, PRA/HRA, and emergency operating procedure analysis. However, Section 4.3.2.1 identifies the scope of the task support verification as panel and layout drawings and computer-generated displays. However, the scope of this type of verification should be defined by the operational conditions and their associated tasks by HSI's. Please clarify the scope of task support verification and describe the criteria for identifying tasks as safety critical.

GE Response

The following paragraphs will replace the current paragraph in Section 4.3.2.1 of NEDO-33276 Rev. 0.

> "The scope of the task support verification is to verify that the HSI provides all the alarms, information, and control capabilities that are required for the tasks identified in the operational analysis, which includes the task analysis.
>
> The criteria for identifying tasks that are safety critical include those tasks with high importance identified thru the PRA/HRA, the tasks identified in the EOPs, and those identified as important thru the OER process."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-6

NEDO-33276, Sections 4.3.2 addresses Task Support Verification. This section contains four subsections that do not seem to be related to this topic. They are:4.3.2.5, Test and Evaluation Condition ,and 4.3.2.7, Performance Measures. Please clarify what role each of these topics plays. Section 4.3.2.7 states "Performance measures associated with detailed HSI Task Support Verification are the performance requirements (e.g., from applicable hardware/software design specifications) and HFE design guidelines (e.g., Style Guide for Graphical User Interfaces." This statement is unclear. There are no real performance measures associated with task support verification and it is not clear what role HFE design guidelines play. Please clarify.

GE Response

See response to RAI 18.11-2.

Section 4.3.2.7 will be revised to delete the last two sentences.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-7

NEDO-33276, Section 4.3.2.4 discusses the methods and procedures for conducting task support verification. This section states "Task performance requirements (e.g., HSI Design Implementation Plan, Style Guide for Graphical User Interfaces, and Display Primitives Design Specification) are imposed on the various HSI hardware and software components. These requirements are included (directly or by reference) in hardware and software specifications (e.g., DCIS Hardware/Software Specification)." (p. 33) The documents listed as performance requirements seem to be HSI requirements rather than task driven-requirements. However, on the same page, the plan indicates that HSIs and their characteristics will be compared to the personnel task requirements identified in the task analyses. Please clarify the criteria to be used in task support verification.

GE Response

See response to RAI 18.11-5. This section will be revised to link the tasks to be addressed in the verification stage to the operational analysis as shown in Enclosure 2 of MFN 06-401. A process diagram will be added to replace the first two figures in NEDO-33276.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-8

NEDO-33276, Section 4.3.2.4.1 describes the review of panel drawings as part of task support verification. The section states "HSI Task Support Verification of panel drawings is achieved through an iterative process of reviews by several groups and organizations." Please clarify what process these groups use to perform the verification. Also, why are there only sections for drawings and for computer generated displays? How are the other HSI's evaluated?

GE Response

See also responses to RAIs 18.11-2 and 18.11-5 for the process for verification of the entire MMIS including all forms of displays and information to the operator (e.g., VDU, mimics, alarms, tag out and configuration control).

DCD/LTR Impact

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

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

NRC RAI 18.11-9

NEDO-33276, Section 4.3.2.9 discusses the documentation of task support verification results. This section indicates that HED's will be logged into the HFEITS if it matches at least one of the HFE issue entry criteria. The section does not indicate what those criteria are, or specifically what information will be logged into the system. Please identify the HFE issue entry criteria and specifically what information will be logged into the system.

GE Response

The following criteria will be used for considering entries to the HFEITS from the task support verification:

- HSI needed for task performance, but not available
- HSI characteristics do not match personnel task requirements
- HSI present but not needed for any task.

The information to be included in the HFEITS is described in NEDO-33276 section 4.3.5.10 and in NEDO 33217 Rev. 0 section 4.12.3 and Appendix A.

DCD/LTR Impact

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

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

NRC RAI 18.11-10

NEDO-33276, Section 4.2.3 states that "HFE Design Verification verifies that each HSI component design meets personnel task requirements and operational considerations, and reflects HFE guidelines, standards, and principles reflected in the ESBWR style guide." Please explain why personnel task requirements are included in this verification when a separate HSI task support verification exists. Section 4.3.3.1 discusses the scope of an HFE design verification. The section notes that the HFE analyses are within the scope of HFE design verification. Please clarify what is meant by the statement. Methods for applying HFE design verification to HFE analyses is further described in Section 4.3.3.4.1. The description in this section, seems more appropriate to a QA process than to HFE design verification. Please clarify.

GE Response

Section 4.2.3 will be revised at the next revision of NEDO-33276 to state that verification of HSI characteristics and the environment in which they are used will conform to the ESBWR Human Factors Guidance Manual, which includes reference to general HFE guidelines such as those in NUREG-0700.

In section 4.3.3.1 the reference to personnel task requirements and HFE analyses within the scope of the HFE design verification will be removed in the next revision of the section.

The criteria for the HFE design verification are the HFE guidelines, which apply to task-independent features such as font size and color scheme, task-specific features such as scale units used for cues, and task-integration features such as proximity of the control to the display.

The verification is performed in accordance with ESBWR GEEN EOP requirements that include engineering requirements for independent verification. The HFE design verification will be applied during the earlier verification stages (e.g., GETS and BS).

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-11

NEDO-33276, Section 4 .3 .3 .2 discusses the objectives of an HFE design verification. The section notes that the objectives include that the HFE analyses meet QA requirements and that they are accomplished in accordance with the implementation plan requirements for the respective analyses. Please clarify the role that these two objectives play in HFE design verification. The listed objectives are followed by five numbered items. These items seem to be related to defining sample characteristics of operational conditions. Please clarify the role of this information.

GE Response

The following replaces the contents of section 4.3.3.2:

"The HFE design verification verifies that the characteristics of the HSI and the environment conform to ESBWR Human Factors Guidance Manual. The verification record is maintained in the GE electronic documentation system.

The criteria for HFE Design Verification are contained in the ESBWR Human Factors Guidance Manual. HFE Design Verification covers design aspects such as:

1. The MMIS characteristics meet ESBWR Human Factors Guidance Manual requirements for overall plant consistency (e.g., coding, conventions, input devices, dialog, display navigation, grouping, and labeling).

2. MMIS consistently incorporates applicable system level and other information on the VDUs based on HFE requirements (ESBWR Human Factors Guidance Manual), and results in an intuitive interaction process for maneuvering on screens for all operator MCR tasks.

3. Room layouts and panel configurations meet ESBWR Human Factors Guidance Manual (e.g., anthropometrics, ergonomics, and panel interaction requirements).

4. MCR and other LCS areas meet environmental requirements needed to accomplish tasks identified through the HFE process (e.g., lighting, space, air conditions, floor design, noise mitigation, and habitability conditions).

The HSI designs are compared to ESBWR Human Factors Guidance Manual to determine whether their acceptability accounts for human characteristics and capabilities."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 section 4.3.3.2 will be revised as described above at the next revision.

NRC RAI 18.11-12

NEDO-33276, Section 4.3.3.5 describes a number of testbeds including mockups, the general electric test system, the baseline simulator, and the full scope simulator. Yet the role of each in HFE design verification is not discussed. Please clarify.

GE Response

Section 4.3.3.4.2 will be modified to add the following.

> "The purpose of a mock-up is to use experience with current control rooms and verify the physical control room layout by demonstrating sight lines, workspace arrangement and operator activity patterns during procedure and event walk/talk-throughs to verify that anthropometric conditions for the control room are suitable for the intended population of operators. Operating experience has established general boundaries and arrangements that have been effective in the past. The entire mockup process can be handled using computers (e.g., 4.3.3.5.1).
>
> The GETS is not a verified simulator. It is used to develop and test simulation models, displays and controls (e.g., 4.3.3.5.2).
>
> The baseline simulator (BS) provides the MMIS for each system. The BS is a simulator that is verified to have the fidelity required by ANSI 3.5; but limits scope to a system or group of systems and may be used to verify the operational analysis for these systems. It supports the verification of system level tasks for controlling, testing, surveillance, maintenance and monitoring of the system (e.g., 4.3.3.5.3).
>
> The FSS is verified to both the fidelity and scope requirements of ANSI 3.5 and is suitable to verify the plant-level and system-level operational analyses. The full scope simulator provides the means to evaluate dynamic interactions through the MMIS for the integrated systems, procedures and event types (e.g., 4.3.3.5.4).
>
> The FSS is used as a tool to validate:
>
> - Suitability of the HFE design of the MCR and RSS for manual tasks,
> - Plant automation of allocated tasks,
> - Plant procedures, and
> - Licensed operator training programs.
>
> The FSS is suitable for training and evaluating licensed operators."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-13

NEDO-33276, Section 4.2.3 states "Designs are compared to HFE guidelines to determine whether they account for human characteristics and capabilities. Deviations from accepted HFE guidelines, standards, and principles are documented as HEDs for resolution/correction and acceptably justified on the basis of documented rationale such as trade study results, literature-based evaluations, demonstrated operational experience, tests and experiments." This definition is consistent with the staff's review guidance. Further, Section 4.3.3.6, Acceptance Criteria, states that HFE guidelines are the criteria for verifying the design. But the method described in Section 4.3.3.4 seems to discuss evaluations outside the scope of this definition. Specific concerns are identified below:

A. *NEDO-33276, Section 4.3.3.4.2 discusses HFE design verification for panel anthropometrics. This section indicates that measurements from a sample of COL holder personnel will be used. Collecting such measurements in such a way as to be representative of the user population is a tedious and expensive process. HFE design guidelines already provide information suitable for this process. Please clarify precisely how this evaluation is to be performed.*

B. *NEDO-33276, Section 4.3.3.4.3 discusses design verification for operating procedures. However, the numbered items identified as what procedures are checked for do not involve HFE guidelines.*

C. *NEDO-33276, Section 4.3.3.4.3 discusses HFE design verification of HSI components. This section starts off by saying these checks are that the components are built as specified. This would appear to more appropriately fall within the scope of final design verification, as it is defined in Section 4.2.6.*

D. *NEDO-33276, Section 4.3.3.4.7 addresses workplace layout. The section states that "Final verification against HFE guidelines such as those in NUREG-0700 occurs at the site with the COL Holder." HFE design verification of workplace layout can be performed during the design stage, with detailed drawings and/or mockups. At such time, changes in the design to improve its human factors engineering are more likely to be made. Waiting until the control room is built on site hearkens back to the 1980s NUREG-0700 evaluations of the as built control rooms where the opportunity for improvements were limited. Please, explain the rationale for waiting until such a late date, to conduct this evaluation.*

Please clarify precisely what methodology and criteria will be used for HFE Design Verification.

GE Response

A. NEDO-33276, Section 4.3.3.4.2 will be modified to better describe the process for HFE design verification for panel anthropometrics.

The anthropometric design of digital ABWR control rooms has undergone two evolutions. The balance between VDU space on the control panel and the mimic board has been clearly refined. The ESBWR MCR design will use the current control rooms as a starting point

and verify that physical changes for ESBWR conditions don't violate anthropometric issues for the US operators. This process diminishes the use of a mock up for HFE anthropometric evaluations of the MCR and RSS panels.

B. NEDO-33276, Section 4.3.3.4.3 will be revised as follows.

"The objective of the HFE V&V is to verify that the operating procedures are clearly usable by the control room crew in performing the key tasks determined from the operational analysis, risk important tasks from the PRA/HRA, actions from the OER, and actions identified in the procedures. The HFE guidelines for procedure verification focus on the dynamic usability given cues from the MMIS. Verification criteria are ease of locating the procedure, space for using the procedure, names and symbols in the procedures match those on the MMIS and VDU screens, and response actions can be identified and performed for allowed configurations of the plant.

The operating procedures include the following specific types of procedures:

1. Integrated Operating Procedures (IOP)

2. System Operating Procedures (SOP)

3. Abnormal Operating Procedures (AOP)

4. Emergency Operating Procedures (EOP)

5. Annunciator Response Procedures (ARP)

6. Surveillance Test Procedures (STP)

EOPs undergo a significant degree of development and verification before the HFE verification process. For example, procedures are based upon the ESBWR Plant Specific Technical Guidelines (PSTGs) that, in turn, are derived from the BWR Owners' Group Emergency Procedure and Severe Accident Guidelines (EPGs/SAGs), Revision 2, dated March 2001. The EOPs consist of EOP Support Procedures and EOP Flowcharts. The EOP Support Procedures may consist of certain SOPs and AOPs containing detailed instructions for abnormal system operation or abnormal overrides of interlocks. EOP flowcharts address the four main guideline controls (RPV Control, Primary Containment Control, Reactor Building Control, and Radioactivity Release Control) and the three contingencies (Emergency RPV Depressurization, RPV Flooding, and Level/Power Control). The flowcharts also include EOP graphs.

Prior to the HFE Verification written procedures are developed in accordance with the procedure writer's approved QA program. Procedures are checked for:

1. Compliance with the Procedure Development Implementation Plan, ESBWR Procedure Writer's Guide and other requirements and guidelines

(e.g., BWR Owners Group Emergency Procedure Guidelines and Severe Accident Guidelines, BWROG EPGs/SAGs)

2. Technical accuracy and format quality

3. Correct references to HSI components"

C. HFE design of HSI components is addressed in Section 4.3.3.4.4 and will be revised in the next revision to address task evaluation as follows. The 1st sentence of Section 4.3.3.4.4 in NEDO-33276 will be revised to read: "..checks that the full-scope simulator components are built as specified."

The objective of the HFE V&V for HSI components is to verify that they are clearly usable by the control room crew in performing the key tasks determined from the operational analysis, risk important tasks from the PRA/HRA, the OER, and actions identified in the procedures. The verification focus for HSI components is on their dynamic usability to provide monitoring of the plant state, cues for actions, feedback on actions taken (including the process of changing state), and response of the plant to the changed condition. Verification criteria are ease of monitoring key parameters, clarity of plant status, clarity of cues for taking actions, consistency of the process for implementing control actions through VDU, hand switches or push buttons, clarity of dynamic feedback of component response to a control action, and ease of monitoring the overall plant response to a change in configuration.

In the next revision to NEDO-33276, the current information in Section 4.3.3.4.4, will be moved to Section 4.2.6.

D. Section 4.3.3.4.7 last sentence will be changed to: "Final verification against HFE guidelines such as those in the ESBWR Human Factors Guidance Manual (based on NUREG-0700) occurs during the final design verification as described in NEDO-33278."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-14

NEDO-33276, Section 4.3.3.9 discusses the documentation of HFE design verification results. This section indicates that HED's will be logged into the HFEITS if it matches at least one of the HFE issue entry criteria. The section does not indicate what those criteria are, or specifically what information will be logged into the system. Please identify the HFE issue entry criteria and specifically what information will be logged into the system.

GE Response

The paragraphs in section 4.3.3.9 of NEDO-33276 will be replaced with the following paragraph.

> "The HSI component characteristics are compared with HFE guidelines throughout the HFE Design Verification process. For each guideline, it will be determined if the HSIs are acceptable or discrepant. Any noncompliance, full or partial, is deemed discrepant, and the nature of the discrepancy will be documented, and a deficiency (HED) is logged into the HFEITS."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-15

Provide details of validation and training NEDO-33276, p. 8 indicates that "the validation supports training program development." Please provide more detail on how this will be done.

GE Response

The link between validation activities and training support is not directly part of the V&V process. However, training benefits by using the training team and operators in training to perform various verification and validation tasks. The training team benefits from the development of simulator scenarios that can be kept in a library for future use. The information collected during the validation process also acts as benchmarks for the way that crews perform for the various scenarios and provides confirmation that procedures, HSI and training are working in an integrated fashion.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-16

Please indicate when the various simulator capabilities (GETS, BS, and the FSS) will be available relative to the overall schedule of the HFE activities.

GE Response

Development of simulation-assisted engineering is an ongoing activity. System design and simulation are developed concurrently. As systems are designed (simulated) they will be added to the GETS. The system level simulation fidelity will be verified per ANSI 3.5 and added to the BS. Systems simulations will then be integrated and verified per ANSI 3.5 yielding the FSS (see RAI 18.11-16 Figure 1).

The GETS will begin operations after the AOF is complete for the system tested.

The BS will start operation when the HSI plan is completed. This will include applications of most of the interfaces and be the workhorse for procedure development, and HSI prioritization of information to the operators.

The FSS will be started when the procedures and training program HFE implementation plans are complete enough to fully address the integrated responses to complex simulated events.

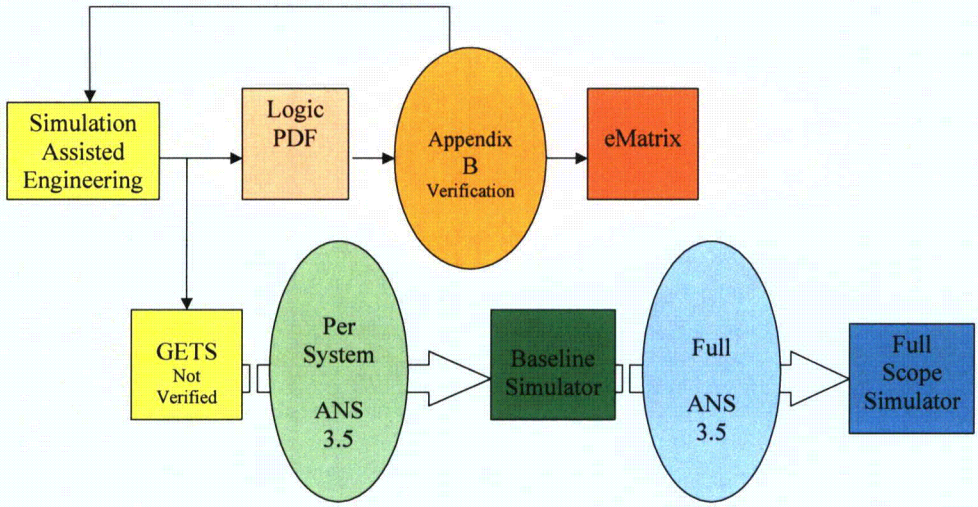

Figure 18.11-16-1 Simulator testing process

DCD/LTR Impact

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

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

NRC RAI 18.11-17

Please indicate whether the FSS will be ANSI/ANS-3.5 compatible.

GE Response

The Full Scope Simulator will be an advanced control room using Visual Screens with an interface system for computer control. While the principle of having a training simulator that matches in detail the actual control room applies (e.g., ANSI/ANS-3.5), the standard itself has been withdrawn by the supporting technical committees. Therefore, the standard will be referenced and used in broad scope areas as shown in Figure 1 of RAI Response 18.11-16 to verify that BS and FSS meet fidelity requirements, but not in interface detail since the standard does not apply to the current HSI digital components that are available for a full scope simulator.

DCD/LTR Impact

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

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

NRC RAI 18.11-18

NEDO-33276, Section 4.3.4.4.1 states that "Validation is a progressive, cumulative activity. Applicable ESBWR specific procedures, if available, are used as necessary when simulating validation scenarios. Non-ESBWR specific procedures and/or the experience of test subjects and participants can also be used. Some Integrated System Validation can be conducted without operating procedures. For example, validation of display navigation and validation of HSI component layouts on consoles are not dependent on operating procedures and scenario simulations." For the purposes of integrated system validation. The staff considers it necessary to have ESBWR procedures. The main purpose of these tests is to show that acceptable performance is achieved when all important influences on human performance are integrated together. Procedures are an important aspect of the integrated system. While we do agree that validation in general is a progressive cumulative activity, the aspect of validation being addressed in this review is of an essentially completed design. Within the framework of the staff's evaluation, a validation of display navigation for HSI component layouts in the absence of procedures or the full integrated system are also important but considered HSI subsystem evaluations as part of the HSI design process. The notion that one can evaluate operational safety and task performance in a nuclear power plant environment without operating and emergency procedures is not consistent with the type of evaluation being addressed as part of integrated system validation. Please clarify the role of ESBWR procedures in the integrated system validation test program.

GE Response

The 3rd paragraph of section 4.3.4.4.1 will be replaced with the following:

"Validation is a progressive, cumulative activity as shown in Figure 1 [See Figure in RAI Response 18.11-16]. ESBWR procedures play a vital role in validation during the integrated system test program on the full scope simulator. This testing is performed after the part task simulations of systems are used to verify that the system level procedures are consistent in form, style and accuracy. System procedures guide responses to cues that may require system level responses in the MCR and local control stations. Until ESBWR procedures are fully developed, existing procedures for similar systems can be useful in system level validation testing.

When scenarios are used to challenge multiple system operation, the ESBWR EOPs can be verified as usable in whatever form they are in (e.g., electronic or paper) if names in procedures match the component and HSI component names and if required actions are clearly defined. The integrated procedures should have a consistent style and maneuvering process as all the procedures, their input and output names need to match with each other.

The ESBWR operating procedures include the following specific types of procedures:

1. Integrated Operating Procedures (IOP)
2. System Operating Procedures (SOP)

3. Abnormal Operating Procedures (AOP)
4. Emergency Operating Procedures (EOP)
5. Annunciator Response Procedures (ARP)
6. Surveillance Test Procedures (STP)

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-19

NEDO-33276 does not address how important actions at complex HSIs remote from the main control room will be addressed in validation. Specific operational conditions and scenarios to be used in validation have not yet been identified, it is not possible to know what important actions remote from the control room should be represented. Please provide information as to how it will be determined which actions outside the control room should be included in validation scenarios and how these actions will be modeled.

GE Response

The part task simulations and full scope test scenarios will be developed to address actions that are defined in four categories. The first set comes from the operational analysis as shown in Figure 2 of NEDO-33276. The second set comes from PRA/HRA identified risk important actions that involve multiple actions in the same scenario from different locations. The third set comes from specific actions identified in the procedures for systems or integrated plant actions. The fourth set of actions are based on events and experience.

The design of the ESBWR attempts to minimize complex actions by providing a large time interval to take the action, by using natural circulation for cooling and maintaining a passive heat removal system for decay heat.

The validation of actions begins with the part task simulator which provides an accurate control room interface for each system. In this case outside actions at local system control stations are estimated using drawings or mockup panels.

The validation of integrated actions begins with the full scope simulator (which may use electronic versions of back panels and the RSS).

If some complex actions could not be fully validated during full scope simulation the process can be extended to the plant itself to verify that complex coordinated actions between the control room and local stations can be carried out using the plant procedures and MMIS.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-20

Please provide information as to how testbeds will be verified before validation tests are conducted.

GE Response

The test beds will be validated as matching the plant at each phase of testing by noting that the same software and computers used for development of the part task simulators and full scope simulator will match what is going into the plant. The MMIS will be adjusted as the system is developed so that by the time the full scope simulator is developed the MMIS is expected to be stabilized.

The software system for simulating plant behavior will be replaced with actual inputs from the plant sensors, controllers and the plant computer. The simulation code elements are verified by a combination of experience from similar systems in operating plants, experiments in areas where processes are new and use of engineering principles to verify correct use of the models to realistically model the plant dynamic behavior.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-21

NEDO-33276, Section 4.3.4.3 discusses participants in validation exercises. The section simply states that V&V teams will be made up of GE personnel, GE subcontractors, and COL holder personnel. However, this section does not describe the types of personnel, that will actually serve as operating crews for the simulations. Nor is any information provided on how the sample of participants will be constructed. Please provide information as to what types of personnel will participate in validation tests and how they will be sampled.

GE Response

The HFE V&V teams performing qualitative validation of display usability for a wide range of tasks in the mockup, part task and full scope simulators will include GE personnel, COL Holder personnel (operations, maintenance, training, QA, etc.), and GE subcontractors. The personnel selected for the validation will include BWR/ABWR/ESBWR trainers, people with SRO licenses at various nuclear plants, start up engineers, I&C engineers, PRA/HRA engineers and Human Factors engineers. The crews will include former SROs and people training to be ESBWR operators and SROs. For mock ups and part task simulations one simulated crew member at a time might be sufficient to test the MMIS for a single system. In the case of a full scope simulator a minimal crew of three would be used to test the MMIS.

The observers will be selected as appropriate from HFE staff experienced in Human Factors, C&I, Nuclear Engineering, System Engineering, Plant Operation, Computers, Procedures, Training, PRA/HRA, SPDS, System Safety Engineering, Maintainability, and Reliability.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 section 4.3.4.3 will be revised as described above at the next revision.

NRC RAI 18.11-22

While NEDO-33276, Section 4.3.4.5 lists generic considerations for scenario development, NEDO-33276 does not address the specific scenarios to be used in validation or how they will be defined. Please provide information on the specific scenarios to be used in validation and how they will be defined.

GE Response

The following paragraphs will be added to section 4.3.4.5:

> "Specific scenario details are not included in this implementation plan as they will be developed as the ESBWR design progresses
>
> The scenarios will be defined to challenge the human actions identified through the operational analysis, the risk important PRA/HRA actions, the OER and procedural actions. The scenarios will address normal startup and shutdown for each system and the plant. The scenarios will include each initiating event group that is expected to impact power operation, and is modeled in the PRA. The risk important sequences that lead to core damage will be evaluated. Complex sequences will be developed considering realistic loss of electrical power events, fires and floods that impact a zone or an adjacent zone. Computer control system faults identified through experience will be developed."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 section 4.3.4.5 will be revised as described above at the next revision.

NRC RAI 18.11-23

NEDO-33276 does not discuss the measurement characteristics, such as reliability and validity. For measures that are new or unique to the ESBWR V&V, please provide information on measurement characteristics that are relevant to that type of measure.

GE Response

The level of detail in the implementation plan was not intended to discuss issues about the characteristics of measurement process, because a high degree of engineering judgment is required to evaluate the acceptability of the MMIS. As a minimum, a range of qualitative and quantitative measures can be used to verify that the MMIS is acceptable.

Validity of the measure is the degree to which the accuracy of the assessment based on both objective and qualitative measures in the context of simulated events. Examples of quantitative measures are:

- Are there sufficient cues to ensure an operator can successfully maintain steady operation after single failures?
- Can the operator perform manual trip if it is required?
- Is the time line for cues and actions suitable for avoiding core damage?

Examples of qualitative measures are:

- Is the interface consistent for different screens?
- Do the operators feel comfortable using the MMIS?
- Is the presentation of information suitable for a wide range of people?

These measures need to be sufficiently accurate for the purpose of validation.

Since "operators" will be exercising the interfaces during different phases of the V&V and observers different from the operators will be evaluating the measures and observations, several types of measures are considered during the validation process. The MMIS can be validated on the basis of convergence of the assessments (e.g., reliability of observers) where many people agree that the MMIS operation is successful. The MMIS can be validated on the basis of face validity where knowledgeable people with real world experience agree that the operation meets requirements for the actions tested (judgment basis validity). The MMIS can also be validated on the basis of predictive validity where the observations in the test case can be used to support HRA assessments of the probability of error that are within the assessments in the PRA. Each of these measures will be considered when appropriate for the validation test being conducted. If the observers diverge, knowledgeable people disagree or note that the operation is not successful, or the HEP value is to high for the PRA study, then an HED would be written for the HFEITS.

DCD/LTR Impact

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

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

NRC RAI 18.11-24

NEDO-33276, Section 4.3.4.4 does describe in varying levels of detail, the types of performance measures that will be used. These measures include some of the types of measures identified in the criterion. However, it is not clear that a full range of measures will be included. Please provide additional information on the performance measures to be used in validation. Specific questions are identified below:

A. *Plant/system level measures - measures of plant and system performance were not addressed. Please, justify.*

B. *Operator task measures - NEDO-33276, p. 14 lists the performance measures used to determine the validity of the MCR, RSS, and LCS designs. Operator task performance is not included in the list, yet it is included in list of measures on page 45. However, while the term "task performance" is included in the title of Section 4.3.4.4.1, it does not address what measures will be taken and how they will be determined. Section 4.3.4.7.1 identifies a list of task related measures; however, the tasks for which these measures will be taken are not identified. Please identify the tasks that will be evaluated during integrated system validation.*

C. *Situation awareness - Section 4.3.4.4.3 describes the evaluation of situation awareness. The section indicates that the Situation Awareness Control Room Inventory (SACRI) method will be used. However, in Section 4.3.4.7.3, the measurement of situation awareness is discussed. This section indicates that situation awareness is subjectively evaluated on the basis of correctness to test subject responses to questions asked during the test scenarios. Is this statement referring to SACRI method identified in the earlier section? The latter section also describes many other indications of situation awareness. How will all these methods be combined to assess overall situation awareness? If the SACRI method is used, additional details about its implementation should be provided. Please indicate how questions will be developed for each scenario used in the evaluation and what criteria will be used to judge whether or not, the level of situational awareness is acceptable?*

D. *Operator workload - Section 4.3.4.4.4 discusses the assessment of operator workload. This section provides a cross reference to the task analysis implementation plan for a discussion of workload assessment methods. In Section 4.3.4.7.4 performance measures for workload are discussed. It indicates that workload will be assessed using a rating scale method and actual operator performance during test scenarios. The rating scale method identified is the NASA TLX. In addition, a list of activities to evaluate is provided. The list includes evaluating navigation, evaluating information gathering, evaluating plant conditions, alarm interaction, analyzing information needed to assess plant situation, and analyzing the memory demands to perform operational tasks. How will each of these be evaluated? And how will they be integrated, along with rating scale evaluations, to determine the acceptability of workload?*

E. *Crew communication and coordination - Section 4.3.4.4.5 indicates that crew, communication and coordination will be subjectively evaluated on the basis of the crew's demonstrated performance during training exercises. Please explain why training exercises*

are being used for this evaluation and not integrated system validation trials? In Section 4.3.4.7.5, it states that crew communication and coordination are subjectively evaluated on the basis of how well crews exhibited a number of characteristics related to teamwork, such as effective leadership, well defined roles and responsibilities, teamwork, open dialogue, etc. Please indicate how the nine items listed in this section will be measured and how they will be evaluated?

GE Response

A. In the case of plant/system level measures the impact of transients such as loss of electrical power have little impact on the ESBWR core damage frequency because of the natural circulation and passive cooling features of the plant. Thus temperature changes to the core are calculated to be very slow for all but a very few hypothetical accidents. The main issue for operators' use of the MMIS is to monitor the plant state and backup automatic actions if necessary. The MMIS should permit the operators to control key plant parameters and maintain them within allowed conditions. Such parameters include power level (neutron flux), turbine generator status, isolation, relief and safety valve positions, control rod positions, pump states, feedwater flow, core flow rates and isolation condenser heat transfer.

B. The scope listed in 3.1.1 and 4.3.4.1 will be reconciled. The first sentence in Section 4.3.4.1 will be modified to "Simulations will be used by plant personnel to demonstrate successful task performance on operational events to validate the ability of operators to use the MMIS to support safe plant operations."

The operator tasks that will be evaluated during integrated system validation are those that are defined through the operational analysis, through the PRA/HRA as risk important actions, and those directly called out in the procedures.

C. The first paragraph in Section 4.3.4.7.3, will be changed to:

"The ability of the MMIS to support situational awareness is subjectively evaluated by analysis of one or more of the following measures at different phases of the V&V.

- timing of operator cues and operator actions,
- appropriateness of operator actions
- consequence (good or bad) of operator actions,
- observation of operator actions, procedure use and communications,
- freezing the simulator after an operator cue has been simulated and querying the operator about plant status, and/or
- post scenario video reviews and interviews."

If more than one operator with suitable training can not take appropriate corrective actions within an appropriate time window, the observation will be considered for documentation as an HED on the MMIS.

D The workload rating scales will be used to qualitatively assess high or low or not applicable ratings in each area. The ratings will be integrated by converting the workload ratings to a fraction of the time involved over the simulated event time. Then the workload formula in section 4.3.4.6.4 will be applied.

E. The objective here is to verify that the MMIS promotes good communication and coordination of the crew as part of the integrated system evaluation. Of the nine good communication principles five relate to the MMIS. Section 4.3.4.4.5 will be modified to indicate how the five items listed in this section will be measured and evaluated as follows:

"MMIS support for crew communication and coordination are subjectively evaluated on the basis of how well crews exhibit the following:

1. MMIS supports well-defined roles and responsibilities are executable from the assigned station (simulated transients require infrequent movement from the control station).

2. MMIS supports crew teamwork by providing information needed by the individual team members working as a team.

3. MMIS permits two operators to use the same information (e.g., displays, alarms, procedures) at the same time so that operators are able to identify, analyze, plan and implement responses based on information from the work station displays.

4. MMIS permits proactive monitoring and observation (to enhance situation awareness and progress assessment monitoring is from the local workstation).

5. MMIS is organized for efficient movement between information pages, panels and control screens at workstations (only use several screen maneuvering actions to adjust screens to find information during a simulated event)."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-25

Three additional areas of evaluation are discussed and performance measures are identified: automation, procedures, and displays. It is not clear that these represent three areas of performance measurement or three aspects of the design that will be evaluated. In either event, the following additional information is requested.

A. *Automation - NEDO-33276, Section 4.3.4.7.7 provides a list of performance measures for automation, such as operator cognition. Please indicate how these items will actually be measured.*

B. *Procedures - NEDO-33276, Section 4.3.4.4.8 discusses the validation of operating procedures. The section indicates that the validation is completed during operator training phases. What training phases are being referred to in this statement? Section 4.3.4.7.8 on performance measures for operating procedures, states "refer to operate a performance measures regarding situation awareness." Please explain this statement. Based on the earlier discussion of situation awareness, the questions asked of operators appear to relate to awareness of plant status. How then can they be used to validate procedures?*

C. *Displays - NEDO-33276, Section 4.3.4.7.9 states that there are no performance measures for graphical displays. Please explain.*

GE Response

A. The following statement will be added to NEDO-33276, Section 4.3.4.7.7, "Observers will measure operator cognition and monitoring of automated states as indicated by the MMIS by observation of when the operators acknowledge changes in operational mode, by release of automation break points, or by debrief of the operators at the end of the simulation response session."

B. The training phases are those shown in Figure 2 of NEDO-33276. They consist of using the three types of simulation interfaces (e.g., GETS mockups for simulation of system operation (SOPs), BS for simulation of alarms (AOPs) and FSS for all others.

Validation of procedures confirms that the procedures such as EOP flowcharts effectively integrate with the MCR MMIS arrangement and work environment. The methods used in the situational awareness based on the MMIS information will be applied to determine position in the procedures. In addition the procedure validation addresses usability of layout space in the MCR and that procedure names and symbol match the names and symbols in the MMIS.

C. The word "human" will be inserted after "no" in the 1st line of 4.3.4.7.9. The following paragraph will be added to NEDO-33276, Section 4.3.4.7.9:

> "However, the graphical displays on the MMIS provide situational awareness to the operators. Therefore, display cues and navigation must support timely operator actions. The performance measures for graphical displays are that the

status of valves and pumps is known during all phases of a control interaction. Color changes and symbol changes that represent the system configuration are consistent throughout the VDUs. Each stage of a control action is clearly observable through MMIS (e.g., selection of a controlled element, defining the action to take, sending the signal, feedback on the change and verification of the position during the change period, and the final new state)."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-26

Acceptance criteria for performance measures are discussed in NEDO-33276,Section 4.3.4.6. However, the statements contained in this section for each of the performance measures, do not provide actual criteria for acceptability. For example, Section 4.3.4.6.1 provides the following acceptance criteria for operational safety and task performance: "Acceptable human performance is based, in part, on success with the measures for operational safety and task performance." Such a statement would not provide clear criteria for determining the acceptability of observed task performance. And without clear performance criteria, how will HEDs be identified. Please provide specific criteria for the proposed measures and indicate which are to be used in deciding that the design is validated.

GE Response

Section 4.3.4.6.1 of NEDO-33276 will be replaced with the following:

"Human performance during simulated event scenarios provides a framework for demonstrating acceptable margin based on the face validity determined by the knowledgeable observers. The qualitative factors that support the observations are:

- High degree of situational awareness from the MMIS
- Effective use of procedures to guide actions
- Effective use of time during the simulated event
- Consistency of actions between different operators and crews on repeated simulations
- The overall integrated response results in an acceptable plant state (e.g., passive cooling of decay heat load)."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-27

NEDO-33276 does not provide detailed information on test design. Please provide descriptions of the methodology used for the following aspect of test design:

- *presentation of scenarios to crews*
- *test procedures*
- *training of test conductors*
- *training of test participants*
- *pilot studies.*

GE Response

NEDO-33276 will add a section on test design in the next revision to address the issues identified:

A. Presentation of scenarios to crews

A discussion prior to the simulations will be conducted to describe the overall objective of the testing process which is to validate the MMIS and for operating team to consider difficulties and issues they have in using the MMIS for the planned scenarios (e.g., normal operational startups, shutdowns, accidents from full power or partial power, and management of outage conditions). A shift turnover process will be used to define the plant status including possible equipment tagouts. The use of the simulation freeze capability for questions about situational awareness is discussed.

B. Test procedures

A simulation scenario known to the observers is selected from at least five different ones.

The simulation start will be announced.

The initial condition will last for several minutes before any new malfunction is introduced.

Recording of plant alarms, screen changes, control actions and key parameter traces is maintained throughout the simulator training interface.

The timing for each malfunction will be entered from a preset file that permits each simulation to be repeated for other crews.

The simulation continues until the planned actions are completed and the plant reaches a stable state.

Records of the simulation from the simulation are saved in an electronic file for future use.

The operators are debriefed after the simulation to obtain information that made control tasks difficult.

c. Training of test conductors

The test conductors include the simulator operator, training instructors, and observers with control room and simulator observation experience. The training of the this team can be performed by setting up scenarios with set malfunctions, or by running through existing scenarios to define possible and expected responses based on procedures and general operating rules. Also, protocols such as how to interact with the crew during the simulation, non-intrusive locations, use of recording devices, development of the information check list for taking notes during the simulation, and focus on the MMIS, procedure or tasks of importance for the specific simulation.

D. Training of test participants

The test participants should have had basic operator training on ESBWR technology, use and meaning of the screen protocols and MMIS interaction processes, have completed training on each procedure to be used, and have training on potential human errors (e.g., STAR).

E. Pilot studies.

Initial pilot studies on use of the MMIS by the designers and the HFEs can be used to test out scenarios and interactions on computers that provide simulation capability. The pilot studies address resolution of issues identified early in the process.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-28

NEDO-33276, Section 4.3.4 .4.1 states that "Operator crews are subjected to a set of test scenarios run on the simulator. The test scenarios have predefined initial conditions, applicable symptoms, and expected system responses and plant behavior. Each crew is subjected to a given scenario at least twice. Each crew is also subjected to the same set of scenarios for purposes of comparing crew performance under similar uses, and conditions, of the HSI." If a crew is subject to the same scenario twice, what will prevent it from simply being recognized. Once recognized, any data collected for the rest of the scenario may not be valid. Please clarify.

GE Response

The following paragraph will be inserted into section 4.3.4.4.1.

> "Crews may be subjected to a given scenario twice prior to the final V&V process. The reuse of a scenario for the same crew for MMIS validation is used to capture the improvement in the use of the MMIS. The data is not being collected to evaluate crew capabilities, but rather to validate that the MMIS can be used to effectively manage the normal operation and accident situations. If information is available to the crew and it is not understood initially, then the second run provides a second look at the MMIS. If the same issue continues, then improvements to the MMIS are considered and an HED is initiated as appropriate. Data from the second session are not used to support HRA evaluations."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-29

NEDO-33276 provides little detailed information on data analysis and interpretation. Please describe:

- *what methods will be used to analyze data and to assess performance criteria*
- *how HEDs will be identified*
- *how consistency across different measures will be evaluated*
- *how data analysis will be verified for correctness*

GE Response

The following paragraphs and reference will be added to NEDO-33276.

> "The methods for analyzing the simulation results will draw from experience in EPRI OER program as summarized in EPRI NP-6560L, which provides estimates of the median response time and the standard deviation associated with different types of cue response as measures of consistency between crews and individuals. Acceptability of the MMIS clarity is that standard deviation falls within the ranges of responses demonstrated in existing plant simulations for multiple crews. For larger deviations between crews an examination of the MMIS for improvement is documented in an HED.
>
> The analysis inputs will be verified by comparing observer inputs and comparison with the computer generated event logs. The observer inputs include qualitative assessments of influencing factors such as lighting level, noise level, communication clarity, MMIS information clarity, and other factors that influence detection, analysis, planning and implementation of actions.
>
> EPRI NP-6560-L. "A Human Reliability Analysis Approach Using Measurements for Individual Plant Examination," 1990"

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-30

NEDO-33276, Section 4.3.4.9 addresses documentation and integration of results. However this section does not address the evaluation of conclusions from integrated system validation. Please describe the documentation of validation conclusions including the bases for determining that the performance of the integrated system is acceptable and how potential limitations to the validation will be assessed.

GE Response

The following paragraphs will be added to NEDO-33276.

> "The documentation provides the basis for verification and validation that the MMIS in the MCR, the RSS, and LCSs provide the information for monitoring automatic actions that change the state of the plant. The MMIS provides cues for human actions that are identified through operational analysis, the PRA/HRA, OER, and in procedures. The MMIS names match the procedures. The MMIS screen maneuvering and information displays support planning of control actions. The MMIS provides for easy implementation while protecting from inadvertent actions. The MMIS provides timely feedback on actions taken and permits monitoring of the entire plant status including equipment under testing and surveillance and tagged out for maintenance and repair.
>
> The validation conclusions also address potential limitations to the MMIS validation that include HEDs that have been resolved on the basis of risk priority, engineering judgment and management decision."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-31

NEDO-33276, Sections 4.2.5 and 4.3.5 discuss human factors issue resolution verification. However, this type of verification was identified in earlier versions of NUREG 0711 and referred to verifying that issues identified in the tracking system were resolved. While Section 4.2.5 seems to clearly indicate that this verification pertains to the HEDs identified throughout the V&V process, Section 4.3.5.1 identifies the scope as "The verification applies principally to significant issues in the HFEITS requiring resolution (i.e., those with potential for risk-significant human error and adverse impact on plant safety or performance)." The latter seems to be a broader scope that HED resolution. Please clarify the intended scope. An additional suggestion is to change the name of this activity to HED resolution in order to avoid any potential for confusion for COLs who may be familiar with the original issue resolution, verification process.

GE Response

Section 4.3.5 will be modified as follows in the next revision to NEDO-33276.

The first sentence of section 4.3.5.1 will be modified by changing "issues" to "HEDs."

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-32

A methodology for the evaluation and resolution of HEDs identified as part of the V&V process is not fully described. NEDO-33276 states "Significance Category is a temporary field for potentially future HED compilation, ranking and screening purposes. It is a methodology to rank or prioritize new and unresolved issues in terms of their significance and potential impact on plant safety and performance. The intent is to facilitate evaluation and resolution of HEDs in a manner consistent with the guidelines of NUREG-0700 and NUREG 0711. The Significance Category methodology is depicted in Figure 3." Figure 3 provides an outline of a categorization methodology, but it does not stand alone.

A. While the staff agrees on the importance of ranking and prioritizing HEDs, the method by which this valuation will take place should be described in order for the staff to determine whether or not, the methodology is consistent with the review criteria in NUREG 0711.

B. Regarding Figure 3, what is the significance of an HED being classified into the different category levels, that is, what are the design implications of the various categories?

GE Response

Figure 3 will be modified as follows:

A. The process in Figure 3 will be revised to address the safety and risk significance of each HED as outlined in NUREG-0711R2. In this case the HEDs are classified by safety significance rather than error potential. The design implications are that the MMIS will be prioritized to address the human actions which most impact safety and risk and are required for operation.

B. Figure 3 of NEDO-33276 shows how the HEDs can be screened for their potential impact on human error which is not necessarily linked to risk and safety significance. Thus, from a human performance monitoring viewpoint Figure 3 provides a link between the HFEITS HED data set and the human performance monitoring implementation plan. It is expected that resolution of HEDs by enhanced MMIS display and features will reduce the human error probability for the key actions, the human performance monitoring system will benefit from a listing of actions whose MMIS has been improved as a basis for selecting the action. Moreover, the human performance monitoring task will be able to demonstrate the enhanced impact of the MMIS features used in resolution of HEDs.

DCD/LTR Impact

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

LTR NEDO-33276, Rev 0 will be revised as described above at the next revision.

NRC RAI 18.11-33

Please clarify the following statement (DCD Tier 2, Revision 1, Section 18.11.1,item f): "COL Holder's final plant HFE/HSI Design Verification completion is performed and documented as a basis to human performance monitoring."

GE Response

Completion of the final plant design verification (per NEDO-33278) is followed by initiation of the human performance monitoring (HPM) program in the operational phase of the ESBWR.

DCD/LTR Impact

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

No changes to the LTR NEDO-33276, Rev 0 will be made in response to this RAI.