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Subject: **Submission of Response to NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification - RAI Number 18.5-41**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC letter No. 355, dated September 16, 2009 (Reference 1).

Reference 2 provided an earlier GEH response concerning the subject of this RAI and included an Attachment A (detailed process used to develop the ESBWR minimum inventory) and Enclosure 3 (Tier 2 DCD markups) that are amended in this RAI response.

Enclosure 1 provides the GEH response to the subject RAI as requested in Reference 1 and includes the revised Attachment A from Reference 2. Enclosure 2 contains the DCD changes to Tier 2 as a result of GEH's response to this RAI. Verified changes to the DCD associated with this RAI response are identified in the enclosed markups by enclosing the text within a black box.

If you have any questions or require additional information, please contact me.

Sincerely,

Richard E. Kingston
Vice President, ESBWR Licensing

References:

1. MFN 09-600 - Letter from U.S. Nuclear Regulatory Commission to Jerald G. Head, Request For Additional Information Letter No. 355 Related To ESBWR Design Certification Application, dated September 16, 2009
2. MFN 09-024 – Submittal of Response to NRC Request Related to ESBWR Design Certification Application Chapter 18 – Human Factors Engineering - RAI Number 18.8-47 S03, dated January 26, 2009

Enclosures:

1. MFN 09-636 – Response to NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application - RAI Number 18.5-41
2. MFN 09-636 – Response to NRC Request for Additional Information Letter No. 355 Related to ESBWR Design Certification Application - RAI Number 18.5-41 – DCD Markups

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Enclosure 1

MFN 09-636

**Response to Portion of NRC Request for
Additional Information Letter No. 355
Related to ESBWR Design Certification Application
RAI Number 18.5-41**

NRC RAI 18.5-41

Following the staff review of the responses to RAIs 18.5-34 (MFN 09-328), 18.5-35 to 18.5-40 (MFN 09-264), and 18.7-7 S05 (MFN 09-297), the staff determined that the description of the process to develop the minimum inventory of controls, displays, and alarms (CDAs) in the response to RAI 18.8-47 S03 (MFN 09-24) and possibly the DCD could be interpreted in multiple ways and thus needs clarification. Since RAI 18.8-47 S03 was previously closed, this is being issued as a new RAI for clarity of tracking.

For example, the overview in Attachment A of MFN 09-024 states that the minimum inventory of CDAs encompasses those Human System Interfaces (HSIs) that are needed to implement the ESBWR Emergency Operating Procedures (EOPs). However, other language in MFN 09-024 implies that minimum inventory only encompasses a subset of the EOPs.

During 9/2/2009 teleconference, GEH clarified how the identification of minimum inventory was conducted, which appeared to be acceptable to the staff. Please document this methodology clarification. This may require revision to the DCD and/or the response in MFN 09-024 and its various Appendices (including the "Delta" document).

In particular, the staff requests the following specific areas be addressed:

1. On page 6 of 14 of the response to RAI 18.8-47 S03 (MFN 09-024), in App. A, and in the DCD Tier 2, Section 18.5.1, there is the following statement:

"Where appropriate, analysts combine alarms, displays, and controls at high levels while still meeting HSI needs identified during task analysis." Our understanding is that the MI method addresses all design basis analysis (DBA) credited actions (as contained in the Emergency Planning Guidelines (EPGs)/Delta document) and probabilistic risk assessment (PRA) critical actions. Further we understood that all related CDAs are included and not rolled-up to a higher level. Please provide additional description of how and when the roll-up concept was applied, and correct that statement in the documents as applicable.

2. Provide clarification about which EOP actions were evaluated for inclusion of related CDAs. Areas discussed during the call included: primary and alternate actions; credited and preferred actions; automatic and manual actions; and actions manipulating safety related and non-safety-related equipment. Clarify that the MI is not limited to safety-related activities and equipment.

GEH Response

Response to Area #1

The process to determine the ESBWR minimum inventory of controls, displays, and alarms (CDAs) provided as Attachment A of RAI 18.8-47 S03 (MFN-09-024) addressed each step of the EPG (as presented in ESBWR Design Comparison To BWROG EPG/SAG Revision 2) and those “human actions shown to be important from the PRA”. As stated in the process assumptions, the ESBWR design basis analysis provides the events used to determine the minimum inventory of CDAs. A clarification that this assumption is used to determine the applicability of EOP steps will be added to both the minimum inventory process document and DCD Section 18.5. As noted in DCD Table 1.11-1, for design basis accidents, the ESBWR design requires no operator action in the first 72-hour time period.

Based on the staff’s request during a teleconference, that was followed with written notes by e-mail dated 10/22/2009, additional clarification of the specific criteria used to determine the PRA human actions considered for the minimum inventory is being provided by this response. For minimum inventory, the “human actions shown to be important from the PRA” are those operator actions that would contribute greater than or equal to 10% of the NRC Safety Goals (e.g., CDF 1E-4/year, LRF 1E-6/year) if not completed successfully. These human actions are included in Table 19.2-3 and are preceded by “The following operator actions have the highest risk importance”. For DCD Revision 6, these actions are included in row 15 of Table 19.2-3. These operator actions were determined to be important based on a risk importance analysis, which is documented in NEDO-33201 Rev. 4 Section 17.1.

Further, DCD Table 19.2-3 contains the ESBWR PRA assumptions that need to be incorporated into design or operational processes. The threshold for the assumptions in Table 19.2-3 is a contribution of greater than or equal to 1% of the NRC Safety Goals if the assumption is not met in the as-built and as-operated design. Other than the specified “human actions shown to be important from the PRA” described in the paragraph above, the operational programs and operator actions that are discussed either implicitly or explicitly in Table 19.2-3 do not meet the criteria for minimum inventory that is defined in the paragraph above. Clarification of the specific criteria for “human actions shown to be important from the PRA” will be added to DCD Section 18.5 and the minimum inventory process document.

The statement “Where appropriate, analysts combine alarms, displays, and controls at high levels while still meeting HSI needs identified during task analysis” was included in the process to facilitate reviewer understanding of why some associated system level parameters may not be included in the minimum inventory. Many steps of the EPG focus the operator on monitoring and maintaining the high level EPG symptom. If the step called for the operator to use this parameter as the measure of task success or the basis for decision-making, the analysts designated the higher-level parameter for the minimum inventory. This approach, referred to as “roll-up” in the staff’s request, provides the operator the direct information needed for the task rather than making it necessary to derive the equivalent information from lower-level parameters.

For example, in the task “Restore and Maintain reactor water level [using one or more the following injection systems]”, analysts specified reactor water level indication as minimum inventory CDAs in lieu of individual flow indications for each injection system. Reactor water level is the parameter the operator monitors to perform the task. As described above, “roll-up” to the EPG symptom being monitored and controlled was performed for the ESBWR minimum inventory. Where system level parameters were necessary to prompt action, support any decision-making imbedded in the action, perform the action, or monitor plant response to the action, they were included in the minimum inventory.

In response to the staff’s comments during a teleconference, that was followed with written notes by e-mail dated 10/22/2009, the minimum inventory process criteria were reviewed for statements such as “consideration is given” which could be viewed as non-specific criteria. These statements will be revised in DCD Section 18.5 and the minimum inventory process document to be specific as applied during the minimum inventory development. Additionally, as the sentence “Where appropriate, analysts combine alarms, displays, and controls at high levels while still meeting HSI needs identified during task analysis” was non-specific, and the process contains the necessary steps and criteria to ensure that HSIs needed to support the tasks are sufficiently identified, it will be deleted from DCD Section 18.5 and the minimum inventory process document.

The minimum inventory process was also reviewed for additional items that required clarification or improvement. The paragraph in the process document that begins “Minimum inventory HSIs may be identified in any of the following areas of EOP implementation, PRA risk important human actions, or remote shutdown manual actions” served only as a description of the type of CDAs that could be part of the final minimum inventory and did not represent selection criteria. As this paragraph and associated bullets were not needed for minimum inventory determination, they will be deleted from the minimum inventory process document to improve process clarity.

Response to Area #2

The process to determine the ESBWR minimum inventory provided as Attachment A of RAI 18.8-47 S03 (MFN-09-024) addressed each step of the EPG (as presented in ESBWR Design Comparison To BWROG EPG/SAG Revision 2). As described in Attachment A, the process involved the identification of HSIs needed to support operator tasks in completion of the EPG steps. For this purpose, HSIs are comprised of those needed to prompt action, support decision-making, support plant manipulations, and support monitoring of task success criteria.

The evaluation of the EPG steps for plant manipulations involved the application of criteria in an order that provides a preference for safety systems. The criterion “HSIs that provide dedicated safety system actuation such as reactor scram, MSIV isolation, and ATWS initiation” is applied first. If support for the step is provided by this criterion, the second criterion is not applied. For the second criterion, “HSIs that provide for assessing, accomplishing, or maintaining safety functions and safe shutdown

conditions”, support for manual manipulation is provided if the ESBWR design does not provide automatic control for a required function. Application of the criteria in this order results in “primary” mitigating function(s) being selected for steps that contain multiple options. Changes will be made to the minimum inventory process document and DCD Section 18.5 to clarify this approach.

Additionally, during the process review for this response, the criterion “HSIs that provide for the performance of safety-related functions to respond to design basis events for which there is no automatic control” was found to be enveloped by the criterion “HSIs that provide dedicated safety system actuation such as reactor scram, MSIV isolation, and ATWS response initiation” and was deleted. Also, though included in the text, “HSIs needed to prompt action” was not included in the subsection that included the minimum inventory selection steps and was added for completeness.

The minimum inventory provides support for monitoring the EPG symptoms that serve as a measure of the mitigating affects of functions regardless of the control (e.g., automatic or manual), classification (e.g., safety-related), or category (e.g., primary, alternate, preferred) of these functions. The ESBWR minimum inventory determination process includes selection criteria for HSIs that provide for assessing, accomplishing, or maintaining safety functions and safe shutdown conditions and for HSIs that provide for the performance of human actions shown to be important from the PRA. These criteria do not specify the safety classification of the equipment associated with the task or require that the operator actions be credited in the plant safety analysis.

DCD Impact

The revised minimum inventory process document is provided as Attachment A of this response. The document revision includes the change discussed above. This revision also includes an update of the “Overview” and updates to the revision of referenced documents.

DCD Tier 2, Section 18.5 will be revised as noted in the attached markup. Rectangular boxes mark the related document changes.

Attachment A

OVERVIEW

In support of ESBWR design certification, GEH submits the “minimum inventory of fixed alarms, displays, and controls necessary for the operators to implement the emergency operating procedures, and to carry out those human actions shown to be important from the applicant’s PRA”(SECY 92-053). This process document was last submitted in response to RAI 18.8-47 S03 (MFN 09-024) and is being updated with submittal of RAI 18.5-41. This document presents the methodology used to determine minimum inventory Human System Interfaces (HSIs) for the Main Control Room (MCR) and Remote Shutdown System (RSS).

The minimum inventory of alarms, displays, and controls encompasses those Human System Interfaces (HSIs) that are needed to:

- Implement the ESBWR Emergency Operating Procedures (EOPs)
- Perform the risk important human actions specified in the ESBWR Probabilistic Risk Assessment (PRA)

The minimum inventory task analysis, identification, and documentation process is performed independent of the operational analysis process presented in NED-33217, “ESBWR Man-Machine Interface System And Human Factors Engineering Implementation Plan” Rev 5. Additional design details and requirements are assigned to the minimum inventory HSIs during the Task Analysis Process presented in NED-33221, “ESBWR Human Factors Engineering Task Analysis Implementation Plan” Rev 3.

Attachment A

ESBWR Minimum Inventory

The HFE design team applies the criteria and logic presented in this plan during the minimum inventory development process to select minimum inventory HSIs.

Assumptions

ESBWR minimum inventory development process assumptions include:

- Minimum Inventory HSI is defined as the fixed alarms, displays, and controls necessary for the operators to implement the emergency operating procedures, and to carry out those human actions shown to be important from the PRA.
- The minimum inventory development team, with the support of other engineering staff, performs the analysis and documentation activities described in this plan, and manages the activity through verification. The minimum inventory development team is comprised of personnel with experience in at least the following areas:
 - Plant operations
 - Plant procedure development and implementation
 - EOP/SAG development and implementation

The duties of the minimum inventory development team are to establish and perform the activities as defined in this plan

- The ESBWR design basis provides the events used to determine the applicability of EOP steps for the minimum inventory of alarms, displays, and controls
- The ESBWR is designed to operate with a high degree of automation so as to minimize the need for operator action in response to design basis events. All ESBWR automatic actions function as designed
- The majority of operator actions in both the MCR and the RSS employ software based alarms, displays, and controls
- Fixed position alarms, displays, and controls are available at a fixed location (or locations) but are not necessarily continuously displayed
- Fixed position alarms, displays, and controls that are not continuously displayed are quickly and easily retrievable, typically accessible by one operator action (“one touch accessible”)
- An alarm is a visual or audible cue designed to capture an operator’s attention and communicate information of a cautionary or warning nature that alerts the operator to the need to take manual actions or verify automatic actions. ESBWR minimum inventory alarms may consist of a visual cue, audible cue, or both

Attachment A

- An event resulting in the evacuation of the MCR is not expected to occur in conjunction with any other design basis event. The RSS provides the capability to achieve and maintain safe, stable shutdown conditions with the ESBWR systems functioning as designed
- The ESBWR can be maintained in safe, stable shutdown for an indefinite period using passive safety systems. ESBWR technical specifications recognize “Stable Shutdown Mode” as an acceptable safe shutdown condition with plant temperatures at or below 215.6 degrees C (420 degrees F)
- For the purpose of determining the RSS minimum inventory, operators successfully scram the reactor prior to leaving the MCR (ESBWR Design Control Document (DCD) Chapter 15 MCR evacuation analysis).

Inputs

ESBWR minimum inventory inputs include:

- BWROG EPG/SAG Rev 2 (*BWROG EPG*)
- ESBWR Design Control Document Rev 6 (*ESBWR DCD*)
- ESBWR Design Comparison to BWROG EPG/SAG Revision 2 (*ESBWR delta doc*)
- AP-1000 and ABWR minimum inventory lists as presented in their DCDs
- The ESBWR PRA revision 4, operator actions having the highest risk importance as documented in *ESBWR DCD* Chapter 19, Table 19.2-3

Process

The following paragraphs describe the detailed and comprehensive process by which the functions and tasks “necessary for the operators to implement the emergency operating procedures, and to carry out those human actions shown to be important from the applicant’s PRA” are broken down into elements (discrete task, action, or function). Also presented is the process by which these elements are analyzed through task analysis to determine what HSIs (alarms, displays, and controls) need be present to provide for their successful completion.

The ESBWR HFE operational analysis process described in *ESBWR DCD* Chapter 18 is designed to be a multi-step process that implements the guidance contained in NUREG 0711, Rev 2. The ESBWR minimum inventory development process steps presented below carry out a similar analysis but do so using different mechanisms and focus upon HSI variables at the parameter level; no set points or decision point values are specified. In general, the process steps below take credit for the functional analysis, allocations, and task sequence determinations performed or specified during the performance of the ESBWR PRA and the development of the *ESBWR delta doc*.

Attachment A

Functional Requirements Analysis**ESBWR delta doc- Functional Analysis:**

Substantial industry functional and task analysis over many years has gone into the creation of the *BWROG EPG* document. This analysis has resulted in the high level emergency operating procedure guidelines that are applied by industry BWRs.

The detailed plant design required to draft an ESBWR specific EPG was not complete at the time minimum inventory HSI was to be specified. Because of this, the *BWROG EPG* strategies, steps, and actions were evaluated in the context of the ESBWR plant and systems design and operating strategies as documented in the *ESBWR DCD*. This analysis culminated in the development of the *ESBWR delta doc* that demonstrates (at a high level) how EPG strategies will be implemented in the ESBWR. This document is at the parameter level; no set points or decision point values are included.

Within each section, *BWROG EPG* steps are replicated, and the differences between the *BWROG EPG*'s and ESBWR design are discussed in a paragraph associated with the step. Where the ESBWR design and operating strategies are similar to the designs that formed the basis for the *BWROG EPG*, the *BWROG* guidance was implemented as recommended. Where the ESBWR design or operating philosophy differs from the *BWROG EPG* basis reactors, a comparison between the *BWROG* guidance and ESBWR implementation was performed and the basis for any differences is presented. The SAG strategies are not required for the development of minimum inventory, and were not encompassed by this document.

Every step and caution in the *BWROG EPG* was addressed such that the *ESBWR delta doc* constitutes a complete picture of how ESBWR specific EPGs and the ESBWR Emergency Operating Procedures will ultimately be written. Because of this completeness, the *ESBWR delta doc* constitutes a valid analytical tool for the derivation of the ESBWR minimum inventory.

The process used to develop the *ESBWR delta doc* is a functional analysis linking the strategy and task guidance contained in the *BWROG* document with the design specifics and system capabilities of the ESBWR.

The *ESBWR delta doc* produced from this analysis describes each of the elements for which task analysis will determine minimum inventory HSI requirements.

PRA Risk Important Human Action - Functional Analysis:

Using the analytical approach presented in *ESBWR DCD* Chapter 19, design basis accidents, event strategies, sequences, steps, and actions were evaluated. Any human actions included in these sequences were analyzed in the context of the ESBWR plant and systems design and operating strategies to determine error probabilities and consequences. Using the ranking methodologies and cutoff criteria presented in Chapter 19, risk important human actions were identified. The human actions that are considered "important from the PRA" and that apply to minimum inventory are those operator actions that would contribute greater than or equal to 10% of the NRC Safety Goals (e.g., CDF 1E-4/year, LRF 1E-6/year) if not completed successfully. These

Attachment A

actions are identified as the operator actions having the highest risk importance in *ESBWR DCD*, Table 19.2-3.

The process used to identify risk important human actions is an analytical functional analysis linking the ESBWR operating and accident mitigation strategies with the specific design and system capabilities of the ESBWR. Those human actions determined to be risk important constitute the elements for which task analysis will determine minimum inventory HSI requirements.

Task Analysis and HSI Requirements Determination

Task analysis processes the function and task elements assigned to operators (input into this process in the form of the *ESBWR delta doc* and the ESBWR PRA risk important human actions) to determine what alarms, displays, and controls are needed to meet plant design goals and requirements.

Analysts evaluate operator MCR actions within the context of the *ESBWR delta doc* and PRA identified risk important human actions to identify, prioritize, and organize plant and system tasks. RSS operator actions are evaluated within the context of the design basis MCR evacuation scenario and assumptions contained in the *ESBWR DCD*. The analysis context attributes provided by these documents include:

- System function priorities
- Direction for user focus
- Plant and system task sequences
- Task conditions, priorities, sequences, and initiation relationships
- Successful task completion criteria

Through analysis team review, each element is analyzed in the context of the strategy or event sequence of which it is part. The purpose of the sequence containing an element provides the context within which an element is performed. Analysts use this context to help determine the HSIs needed to ensure successful completion of the element. Differing combinations of alarms, displays, and/or controls may be assigned depending upon whether the analyzed element's emphasis is upon alerting, monitoring, diagnosing, and/or operating equipment in response to an event.

Attachment A

During the task analysis of the elements described above, minimum inventory HSIs are designated if they meet the following selection criteria:

- HSIs that provide for the implementation of the Emergency Operating Procedures (as presented in the *ESBWR delta doc*). When evaluating the need for plant manipulations, the criteria of the sub-bullets below are applied in the order provided. If support for the step is provided by the first criterion, then the second criterion is not applied. This method results in the “primary” mitigating function(s) being selected for steps that contain multiple options.
 1. HSIs that provide dedicated safety system actuation such as reactor scram, MSIV isolation, and ATWS response initiation.
 2. HSIs that provide for assessing, accomplishing, or maintaining safety functions and safe shutdown conditions. For this criterion, HSIs to support plant manipulations are provided only if there is no automatic control.
- HSIs that provide for the performance of risk important human actions as identified in the ESBWR PRA
- HSIs that provide for achieving and maintaining safe, stable shutdown from the RSS following a design basis MCR evacuation event.

Using the *ESBWR delta doc*, analysts evaluate each human action within the context of the task sequence containing it (for example: an implementation action analysis considers the goals of the strategy being implemented and any preceding steps). During the analysis HSIs needed to prompt action, support any decision-making imbedded in the action, perform the action, and monitor plant response to the action are identified.

Attachment A

Minimum inventory is compiled for:

- HSIs needed to prompt action
 - Determine if action prompting is needed
 - Determine the minimum inventory HSIs for prompting action
- HSIs needed to support decision making
 - Determine if there are any imbedded decisions
 - Determine the type of decision required and the data to be analyzed to make the decision
 - Determine what supporting information is needed
 - Determine the minimum inventory information required for the performance of each decision task
- HSIs needed to support plant manipulations
 - Determine what plant manipulation tasks are required.
 - Determine the minimum inventory HSI required for performing the task
- HSIs needed to support monitoring task success criteria
 - Determine what criterion demonstrates the successful completion of the task
 - Identify the alarms, displays, and/or controls that must be present to provide the information operators will measure against the criteria
 - Determine the minimum inventory information required for monitoring the success of each task

For the HSIs identified above, assign one or more of the following types of minimum inventory:

- Alarms
 - Determine what alarms associated with the task being analyzed need to be incorporated into minimum inventory HSIs to support performance or identify system and plant parameters operating outside expected range using the following criteria:
 - Alarms should be used to alert the operator regarding abnormal or degrading conditions that require the operator response
 - Document any minimum inventory alarms needed to supply the operator alerts required for each task

Attachment A

- Displays
 - Determine what information is necessary during task performance
 - Determine what abort criteria is applicable to the task (if any) and what information is needed to assess task performance against the abort criteria
 - Determine the parameters or conditions that would indicate that the end state (or objective) of the task has been accomplished and is functioning as intended
 - Determine the parameters or conditions that would indicate that the end state (or objective) of this activity is achieving the desired results
 - Determine the parameters or conditions that would indicate that the end state (or objective) of this activity is no longer needed and can be terminated
 - Document any minimum inventory displays needed to supply the plant information required for each task
- Controls
 - Determine what controls are necessary for task performance
 - Determine how the above control is provided (specific component control, high level system control, etc)
 - Document any minimum inventory controls needed to perform each task

ESBWR minimum inventory HSIs are documented in a table that lists the parameter and whether the associated HSI consists of an alarm, display, and/or control.

Attachment A

Comparison With Industry Precedent for Scope and Level of Detail

The HSI list created using the process above is compared to the minimum inventory lists contained in the public DCDs of the AP-1000 and ABWR. This analysis compares the HSI list with specific industry precedent to identify differences in scope and level of detail. This comparison ensures that the ESBWR minimum inventory listing captures a similar general scope and level of detail as is contained in the DCDs for the two comparison certified designs.

Item by item comparison is not undertaken due to physical design differences between the reactors (PWR vs BWR, Active BWR vs Passive BWR, etc) and their operating strategies (event based versus symptom based EOPs, etc).

Internal Instrumentation & Controls and Customer Review

Engineering product reviews are conducted in accordance with internal GEH engineering procedures and the following discussion is intended to provide insight into this process rather than override or supplant it.

Reviews are formal adequacy evaluations that are performed by knowledgeable persons other than those directly responsible and accountable for the engineering product.

The Instrumentation and Controls (I&C) and customer reviews of this document are used to evaluate the following for adequacy:

- ESBWR minimum inventory development process
- Minimum inventory selection criteria and compliance with regulatory requirements
- Consistency with industry precedent
- ESBWR minimum inventory list

Additionally, the ESBWR minimum inventory review is used to verify that the product and associated documentation meets customer requirements.

The ESBWR minimum inventory list and associated documentation is judged to be adequate when at least the following criteria have been met:

- The EBSWR minimum inventory list is complete and final
- The MCR minimum inventory HSIs meet the requirement to support both EOP implementation and successful completion of PRA risk important human actions
- The RSS minimum inventory HSIs meet the requirement to support achieving and maintaining safe, stable shutdown following a MCR evacuation

Attachment A

Resolution of Comments

Minimum inventory development analysts incorporate changes, as necessary, to the ESBWR minimum inventory based on feedback and comments from the review team members. The analysts resolve any questions and/or concerns with adequate resolution.

Verification of Minimum Inventory List

The ESBWR minimum inventory undergoes formal verification in accordance with GEH internal engineering department verification procedures and the following discussion is intended to provide insight into this process rather than override or supplant it. Verifiers in both the I&C and HFE branches of the ESBWR engineering department verify the content and correctness of the ESBWR minimum inventory list. Verifiers use the *ESBWR delta doc*, the ESBWR design as documented in *ESBWR DCD*, and PRA analysis results (specifically, the operator actions having the highest risk importance identified in the *ESBWR DCD* Table 19.2-3) as basis documents. Using these basis documents, verifiers ensure that the ESBWR minimum inventory correctly identifies the minimum inventory HSIs as described in SECY 92-053.

Items requiring verification include, but are not limited to:

- Design output
 - The minimum inventory HSIs meet the requirement to support both EOP implementation and successful completion of PRA risk important human actions
 - The RSS minimum inventory HSIs meet the requirement to support achieving and maintaining safe, stable shutdown following a MCR evacuation
- Documents
 - ESBWR minimum inventory development process
 - ESBWR minimum inventory list is complete and final

Attachment A

Outputs

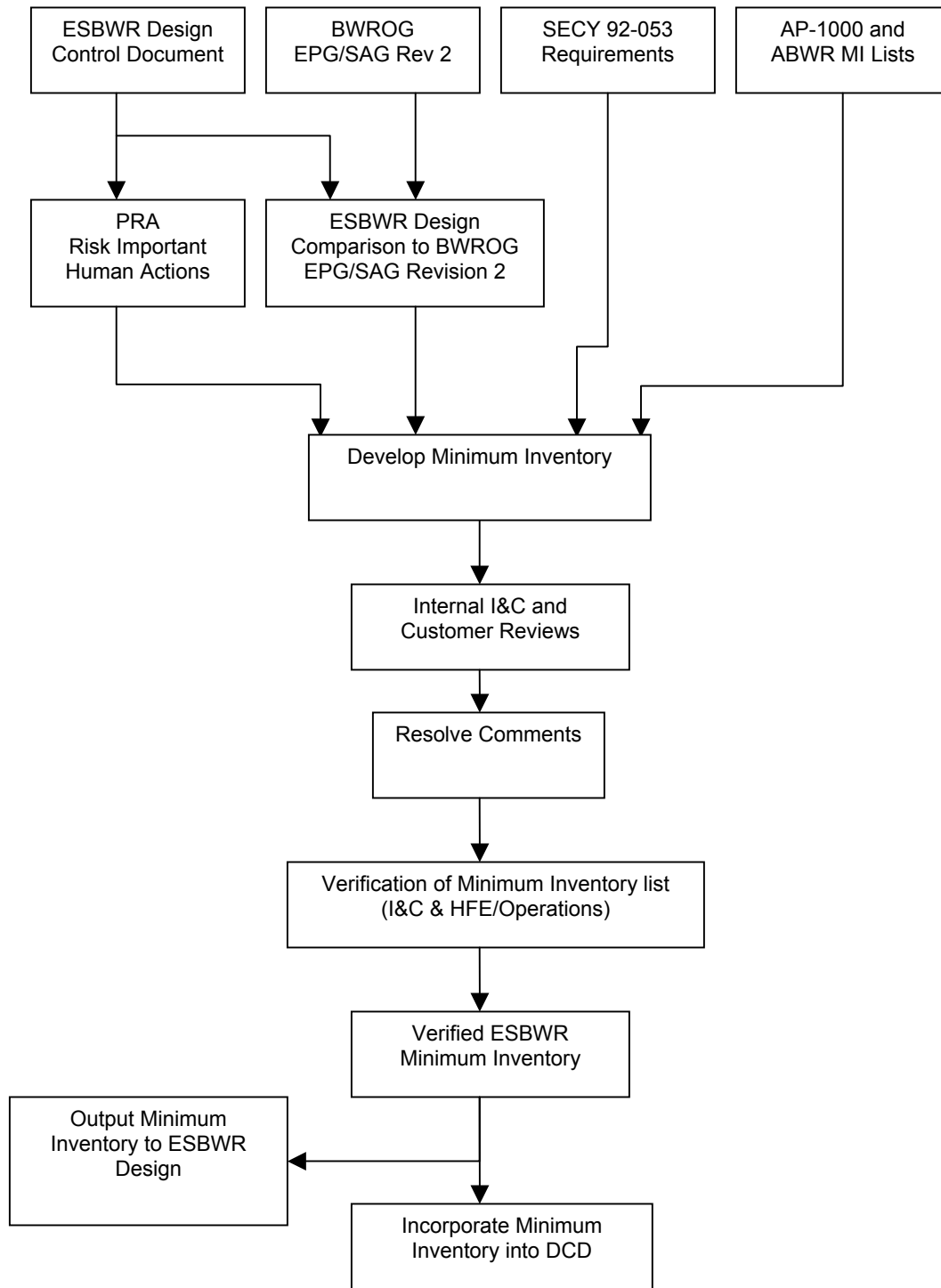
The ESBWR minimum inventory development process produces the ESBWR minimum inventory of alarms, displays, and controls document.

ESBWR Minimum Inventory of Fixed Alarms, Displays, and Controls

This document presents the ESBWR “minimum inventory of fixed alarms, displays, and controls necessary for the operators to implement the emergency operating procedures, and to carry out those human actions shown to be important from the applicant’s PRA”(SECY 92-053). Additionally, it presents the minimum inventory of alarms, displays, and controls that must be incorporated into the RSS to support achieving and maintaining safe, stable shutdown following design basis MCR evacuation. The document is presented in a table format and provides a brief descriptor for each variable and identifies if an alarm, display, and/or control is required.

Attachment A

Figure 1: ESBWR Minimum Inventory Development Process



Enclosure 2

MFN 09-636

**Response to NRC Request for
Additional Information Letter No. 355
Related to ESBWR Design Certification Application**

RAI Number 18.5-41

DCD Markups

18.5 TASK ANALYSIS

Task analysis is performed in two segments:

- MCR and RSS minimum inventory HSI determination (complete); and
- Detailed Design (including the design, detailed, and economic phases of task analysis).

MCR and RSS minimum inventory HSI determination task analysis was performed as described in Subsection 18.5.1.

The task analysis process for detailed HSI design is conducted in accordance with References 18.5-1 and 18.5-2.

18.5.1 MCR and RSS Minimum Inventory HSI Determination

The following paragraphs describe the detailed and comprehensive process by which the functions and tasks necessary for the operators to implement the emergency operating procedures, and to carry out those human actions shown to be important from the PRA was broken down into elements (discrete task, action, or function). Also presented is the process by which these elements were analyzed through task analysis to determine what HSIs (alarms, displays, and controls) must be present to provide for their successful completion.

18.5.1.1 Assumptions

ESBWR minimum inventory development process assumptions include:

- Minimum inventory HSI is defined as the fixed alarms, displays, and controls necessary for the operators to implement the emergency operating procedures, and to carry out those human actions shown to be important from the PRA.
- The minimum inventory development team, with the support of other engineering staff, performs the analysis and documentation activities described in this plan, and manages the activity through verification. The minimum inventory development team is comprised of personnel with experience in at least the following areas:
 - Plant operations;
 - Plant procedure development and implementation; and
 - Emergency operating procedure/severe accident guideline (EOP/SAG) development and implementation.
- The ESBWR design basis provides the events used to determine the [applicability of EOP steps for the](#) minimum inventory of alarms, displays, and controls.
- The ESBWR is designed to operate with a high degree of automation so as to minimize the need for operator action in response to design basis events. All ESBWR automatic actions function as designed.
- The majority of operator actions in both the MCR and the RSS employ software based alarms, displays, and controls.

- Fixed position alarms, displays, and controls are available at a fixed location (or locations) but are not necessarily continuously displayed.
- Fixed position alarms, displays, and controls that are not continuously displayed are quickly and easily retrievable, typically accessible by one operator action (one touch accessible).
- An alarm is a visual or audible cue designed to capture an operator's attention and communicate information of a cautionary or warning nature that alerts the operator to the need to take manual actions or verify automatic actions. ESBWR minimum inventory alarms may consist of a visual cue, audible cue, or both.
- An event resulting in the evacuation of the MCR is not expected to occur in conjunction with any other design basis event. The RSS provides the capability to achieve and maintain safe stable shutdown conditions with the ESBWR systems functioning as designed.
- The ESBWR can be maintained in safe, stable shutdown for an indefinite period using passive safety systems. ESBWR technical specifications recognize "Stable Shutdown Mode" as an acceptable stable, safe shutdown condition with plant temperatures at or below 215.6°C (420°F).
- For the purpose of determining the RSS minimum inventory, operators successfully scram the reactor prior to leaving the MCR (ESBWR Design Control Document Chapter 15 MCR evacuation analysis).

18.5.1.2 Process

Functional Analysis

Substantial industry functional and task analysis over many years has gone into the creation of the BWR Owners' Group Emergency Procedure and Severe Accident Guidelines, Revision 2 (Reference 18.5-3) document. This analysis has resulted in the high level emergency operating procedure guidelines that are applied by industry BWRs.

The detailed plant design required to draft an ESBWR specific EPG was not complete at the time minimum inventory HSIs were specified. Because of this, the strategies, steps, and actions of Reference 18.5-3 were evaluated in the context of the ESBWR plant and systems design and operating strategies. Where the ESBWR design and operating strategies were similar to the designs that formed the basis of Reference 18.5-3, the guidance was implemented as recommended. Where the ESBWR design or operating philosophy differed from the Reference 18.5-3 basis reactors, a comparison between the Boiling Water Reactor Owners Group (BWROG) guidance and ESBWR implementation was performed. The SAG strategies are not required for the development of minimum inventory.

This process is a functional analysis linking the strategy and task guidance contained in the BWROG document with the design specifics and system capabilities of the ESBWR.

Using the analytical approach presented in Chapter 19, design basis accident, event strategies, sequences, steps, and actions were evaluated. Any human actions included in these sequences were analyzed in the context of the ESBWR plant and systems design and operating strategies to determine error probabilities and consequences and risk-important human actions were

identified. The human actions that were analyzed for minimum inventory support are those operator actions that would contribute greater than or equal to 10% of the NRC Safety Goals (e.g., CDF 1E-4/year, LRF 1E-6/year) if not completed successfully. These actions are identified as the operator actions having the highest risk importance as determined by the ESBWR PRA are documented in the Table 19.2-3.

The process used to identify risk-important human actions for the minimum inventory was an analytical functional analysis linking the ESBWR operating and accident mitigation strategies with the specific design and system capabilities of the ESBWR. Those human actions determined to be risk-important constitute the elements for which task analysis determined minimum inventory HSI requirements.

Task Analysis and HSI Requirements Determination

Task analysis processed the function and task elements assigned to operators to determine the alarms, displays, and controls needed to meet plant design goals and requirements.

Analysts evaluated operator MCR actions within the scope of the minimum inventory process and identified, prioritized, and organized plant and system tasks. RSS operator actions were evaluated within the context of the design basis MCR evacuation scenario and assumptions. The analysis context attributes provided by these documents include:

- System function priorities;
- Direction for user focus;
- Plant and system task sequences;
- Task conditions, priorities, sequences, and initiation relationships; and
- Successful task completion criteria.

Differing combinations of alarms, displays, and/or controls were assigned depending upon whether the analyzed element's emphasis was upon alerting, monitoring, diagnosing, and/or operating equipment in response to an event.

During the task analysis of the elements described above, minimum inventory HSIs were designated if they met the following selection criteria:

- HSIs that provide for the implementation of the Emergency Operating Procedures. When evaluating the need for plant manipulations, the criteria of the sub-bullets below were applied in the order provided. If support for the step was provided by the first criterion, then the second criterion was not applied. This method resulted in the "primary" mitigating function(s) being selected for steps that contain multiple options.
- ~~• HSIs that provide for the performance of safety-related functions to respond to design basis events for which there is no automatic control;~~
- ~~1.~~ 1. HSIs that provide dedicated safety system actuation such as reactor scram, main steam isolation valve isolation, and ATWS response initiation.
- ~~2.~~ 2. HSIs that provide for assessing, accomplishing, or maintaining safety functions and safe shutdown conditions. For this criterion, HSIs to support plant manipulations were provided only if there was no automatic control.

- HSIs that provide for the performance of risk-important human actions as identified in the ESBWR PRA.
- HSIs that provide for achieving and maintaining safe, stable shutdown from the RSS following a design basis MCR evacuation event.

Analysts evaluated each human action within the context of the task sequence containing it (for example: an implementation action analysis considers the goals of the strategy being implemented and any preceding steps). ~~During the analysis consideration was given to HSIs needed to prompt action, support any decision-making imbedded in the action, perform the action, and monitor plant response to the action.~~

~~Where appropriate, analysts combined alarms, displays, and controls at high levels while still meeting HSI needs identified during task analysis.~~

Minimum inventory was complied for~~analysts considered:~~

- HSIs needed to prompt action;
- HSIs needed to support decision making;
- HSIs needed to support plant manipulations; and
- HSIs needed to support monitoring task success criteria.

For the HSIs identified, ~~A~~analysts ~~considered what HSIs were needed to successfully complete each task and~~ assigned one or more of the following types of minimum inventory HSIs:

- Alarms – Alert the operator regarding abnormal or degrading conditions that require operator response.
- Displays – Provide information necessary during task performance.
- Controls – Provide the means to change the state of plant equipment.

The design requirement for the minimum inventory HSIs is that they be accessible by one operator action (one touch accessible). Minimum inventory HSIs that are continuously displayed meet the one touch accessible design requirement. The one touch accessible design requirement for the minimum inventory HSIs is acceptable because of the passive nature of the ESBWR safety systems and the resultant required operator response times. DCD Chapter 15 Design Basis Events require operator response times ranging from 30 minutes to, more typically, no operator response required or an operator response is not credited for 72 hours.

The result of this analysis is the ESBWR MCR and RSS minimum inventory of HSIs documented in Tables 18.1-1a and 18.1-1b.

18.5.2 Task Analysis Implementation Plan - Detailed Design

The TA implementation plan, Reference 18.5-2, establishes a task analysis process that conforms to ESBWR plans and applicable regulatory requirements. The process includes the design, detailed, and economic phases of task analysis as described in the plan. The system-level and plant-level functions are systematically analyzed. The relationships and interaction between human and machine tasks are examined through several iterations of analysis. TA considers all functions identified by the FRA and allocated to human, machine, or shared ownership.