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Subject: **Submittal of Response to NRC Request Related to ESBWR Design Certification Application Chapter 18 - Human Factors Engineering - RAI Number 18.8-47 S02**

The purpose of this letter is to submit a response to Nuclear Regulatory Commission (NRC) Request Additional Information (RAI) 18.8-47 S02. Please note that this RAI was not formally submitted to GEH, but rather was discussed verbally with NRC regarding the response to Supplement 1.

The response to RAI 18.8-47 S01 was provided in Reference 1 as requested by NRC in Reference 2. The original response to RAI 18.8-47 was provided via Reference 3 in response to NRC request (Reference 4).

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

D068
NRO

References:

1. MFN 07-334 - Submittal of *"ESBWR DCD Chapter 18, Human Factors Engineering - RAI to DCD Roadmap Document"* dated June 27, 2007
2. Transmittal from AE Cubbage to DL Lewis, *List of Chapter 18 RAIs for Roadmap Request*, dated 5/18/07
3. MFN 06-443 - *Response to Portion of NRC Request for Additional Information Letter No. 71 – ESBWR Human Factors Engineering NEDO-33268, Rev. 1, Human-System Interface Design Implementation Plan – RAI Numbers 18.8-1 through 18.8-49*, dated November, 20, 2006
4. MFN 06-383 – Letter from Nuclear Regulatory Commission to David H. Hinds (GEH) *"Request for Additional Information Letter No. 71 Related to ESBWR Design Certification Application"*, dated October 10, 2006

Enclosure:

1. MFN 08-859 – Submittal of Response to NRC Request Related to ESBWR Design Certification Application Chapter 18 - Human Factors Engineering - RAI Number 18.8-47 S02

cc:

AE Cubbage	USNRC (with enclosure)
RE Brown	GEH/Wilmington (with enclosure)
DH Hinds	GEH/Wilmington (with enclosure)
eDRF	0000-0092-9323

Enclosure 1

MFN 08-859

Submittal of Response to NRC Request Related to ESBWR Design Certification Application Chapter 18 Human Factors Engineering RAI Number 18.8-47 S02

For historical purposes, the original text of RAI 18.8-47 and any previous supplemental text and GE/GEH responses are included preceding each supplemental response. Any original attachments or DCD mark-ups are not included to prevent confusion.

NRC RAI 18.8-47

As part of the general resolution of the issue pertaining to lack of control room detail, the staff has requested that applicants for design certification identify a minimum group of fixed-position controls, displays, and alarms (CDAs) that are required for transient and accident mitigation. Also, the minimum inventory for safe shutdown from the remote shutdown panel should be specified (but not necessarily be fixed-position at the remote panel). The NRC review criteria for the minimum inventory are given in Standard Review Plan (SRP) Chapter 14.3.9. Sections 4.3.3, 4.3.5.1, and 4.3.6 of NEDO-33268 briefly discuss fixed-position dedicated CDAs, but do not specify the CDAs or provide the criteria used to select all of them. Many of the criteria given in SRP 14.3.9, such as risk, are not mentioned. Also Section 4.4.3 addresses minimum controls, displays and alarms but does not mention fixed-position. Further, it is not clear if the intent is to use criteria in IEEE Std 497 discussed elsewhere in NEDO-33268 for fixed displays. Please provide information relative to the selection criteria and selection process for minimum inventory for ESBWR as it is described in SRP 14.3.9.

GE Response

These evaluations and assessments are ongoing and are part of the design process. As details emerge, they will be documented accordingly. Regulatory requirements will be met and guidance will be followed as appropriate. ESBWR philosophies in conjunction with completion of task analysis, function allocation and similar endeavors will give rise to the information pertinent to the inventory of controls and displays.

DCD Impact/LTR Impact

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

No LTR NEDO-33268 changes will be made in response to this RAI.

NRC RAI 18.8-47 S01

Note: The following is an excerpt from MFN 07-334, Enclosure 1 (Reference 1).

Chapter 18 Roadmap Document								
RAI NO	SEC	#	NRC Supplemental	DocName/ Question	Resolved	Plan	Section	Resolution Description
18.8-47	8	47	Y	Minimum Inventory	From GE response	33268 DCD 2	5.1 18.1.3.2	The NEDO plan commits to "a list of instruments that complies with RG 1.97 and supporting analysis". The DCD chap 18 states that the operations analysis defines a minimum set of controls, displays, and alarms that allow the operators to perform the actions specified in the EOPs and the important operator actions identified in the PRA. As the staff is aware, the concept of "minimum inventory" is a question the industry is still trying to define. GE will comply with the guidance from the outcomes of the NRC and NEI on-going discussions.

NRC RAI 18.8-47 S02

The response states that no changes will be made to the NEDO. However, the NEDO does not currently contain all the information requested by the RAI. The NEDO should be updated to incorporate this information.

GEH Response

Response Background and Context

In the time that has passed since the GEH response to RAI 18.8-47 (S01) was submitted to the NRC, a significant amount of industry and NRC discussion relating to minimum inventory has taken place. The primary vehicle for this interaction has been the NEI/NRC Task Working Group 5, which has been working on an industry document designed to provide a consistent process to develop minimum inventory.

Participation in the September 15, 2008 NRC TWG 5 public meeting at the NRC White Flint offices made it apparent that the industry minimum inventory process document would not be available in the near term and that the NRC required an ESBWR minimum inventory list in support of the plant design certification. As a result, GEH has determined that the previous RAI response, "GE will comply with the guidance from the outcomes of the NRC and NEI on-going discussions" must be revised.

Prior to certification, GEH will define 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). The process used to develop the minimum inventory list is described below. This process is consistent with the current industry process as discussed with the Staff in NEI/NRC TWG 5 meetings. The next revision to this RAI will include the minimum inventory list and the associated proposed procedure changes to include this list and its development process description.

Regulatory Overview and Interrelationships

Background: Applicable portions of SECY 92-053, RG 1.97 Rev 4, NUREG 0800 Rev 0, and NUREG 0711 Rev 2 and how they are addressed:

1. SECY 92-053 provides for the use of Design Acceptance Criteria (DAC) during 10 CFR Part 52 design certification reviews. One of the areas of DAC usage addressed is control room design. The SECY allows for plant

design certification to take place without a completed control room design, so long as a minimum inventory of alarms, displays, and controls is included in the design certification. 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" is established via the minimum inventory development process presented in this document. "The second part of the staff's review will utilize DAC to ensure the implementation of a systematic approach to the incorporation of human factors principles in completing the design of operator workstations in the control room" and will be completed in accordance with the processes presented in ESBWR Design Control Document (DCD) Chapter 18. It should be noted that inclusion in the MI list does not supplant Chapter 18 processes for a given human-system interface (HSI). All ESBWR control room, remote shutdown system (RSS), and risk important local control stations' HSIs are subject to the human factors engineering (HFE) processes documented in DCD Chapter 18.

2. Regulatory Guide 1.97 Revision 4 and the IEEE Std 497-2002 it endorses (subject to some regulatory positions) are post accident monitoring guidance documents. These documents provide guidance for selecting, categorizing, and assigning design requirements to key accident monitoring variables.

   IEEE Std 497-2002 Introduction states that: "Accident monitoring variable selection must be consistent with the plant specific emergency operating procedures (EOPs) and abnormal operating procedures (AOPs). The variables selected from these procedures need to be the minimum set to assess that safety-related functions are performed and safety systems operate acceptably. Also, instrumentation for shutdown from outside the main control room (i.e., remote shutdown) is outside the scope of this standard."

   Information characteristics guidance implemented during detailed design includes:

   - Selection criteria defining 5 variable types ultimately used to assign design characteristics. "Type A is accident specific and needed for preplanned operator action, Type B and Type C allow a supervisory overview approach to accident monitoring by allowing a review of critical high level safety functions, Type C additionally allows extended range monitoring of defense-in-depth variables. Type D and Type E allow monitoring of performance of appropriate safety and radiation monitoring systems."

- "The basis for display characteristics for accident monitoring variables shall include the results of an analysis of the system functions required to respond to an accident and analysis of the tasks required of the operator to implement those functions during design basis events. Display characteristics shall be identified that include, as a minimum; range, instrument accuracy, precision, display format (e.g., status, value, or trend), units, and response time."

Regulatory Guide 1.97's focus is fundamentally different from that of SECY 92-053 in that it focuses on the execution of the detailed control room design process. The Regulatory Guide specifies accident monitoring instrument selection criteria and assigns design requirements that the detailed design process must accommodate. By contrast, the SECY 92-053 minimum inventory precedes the detailed design process. The two concepts significantly overlap in the area of variable selection but SECY 92-053 minimum inventory culminates in design certification while Regulatory Guide 1.97 and IEEE 497 guide the detailed design process and culminate in final design.

3. NUREG 0800 Revision 0 Section 14.3.9 (March, 2007 revision) and Chapter 18 provide the review requirement that DCD "Tier 1 includes a minimum inventory of displays, controls, and alarms that are necessary to carry out the vendor's emergency procedure guidelines (i.e., Owners' Groups Generic Technical Guidelines) and critical actions identified from the applicant's PRA and task analysis of operator actions." These review requirements establish the scope of the minimum inventory development process presented in this document.

4. NUREG 0711 Revision 2 provides guidance intended to ensure that applicant's detailed design processes are conducted in accordance with accepted HFE practices and guidelines. Aspects of 0711 Rev 2 relevant to the process presented in this document include:

   - "The task analysis results should be used to define a minimum inventory of alarms, displays, and controls necessary to perform crew tasks based on both task and instrumentation and control requirements."

     The minimum inventory development process presented in this document governs the function and task analysis performed to define the ESBWR minimum inventory of alarms, displays, and controls. The process performs function / task analysis of the ESBWR Design Comparison to BWROG EPG (For information regarding this document refer to discussion below titled: "ESBWR

Design Comparison to BWROG EPG - Functional Analysis") and the risk important human actions identified in the ESBWR PRA. Analysis of these tasks and the information and controls required to successfully complete them determines the alarms, displays, and controls to be included in the ESBWR minimum inventory list.

- "The HFE aspects of the plant should be developed, designed, and evaluated based on the basis of a structured analysis using accepted HFE principles." This top-down process is a fundamental part of the ESBWR design process as described in ESBWR DCD Rev 5 Chapter 18. As was stated above: all ESBWR control room, remote shutdown system (RSS), and risk important local control stations' HSIs are subject to the human factors engineering (HFE) processes. During detailed design, all applicable HSIs (including those within the scope of SECY 92-053 and Regulatory Guide 1.97 Rev 4) will be subject to this rigorous analysis.
  The top-down HFE analysis process works in conjunction with all other applicable guidance and regulatory requirements to specify the content, layout, function, and other detailed design requirements of the HSI analyzed.

In summary, the selection of the minimum inventory of HSIs and their designation as alarm, display, or control is completed prior to, and in support of, design certification (consistent with SECY 92-053). Content, presentation, and level of detail will be in keeping with precedent as documented in the minimum inventory listings contained in the DCDs of the ABWR, AP-1000, and System 80+. Detailed analysis and design (performed in accordance with the ESBWR DCD and applicable regulatory guidance and requirements, including NUREG 0711) formally categorizes HSIs within the scope of Regulatory Guide 1.97 and assigns the detailed design requirements to all HSIs. Completion of these detailed design requirements is reviewed by the Staff in accordance with NUREG 0800.

Minimum Inventory Development Process Description

Note: For the purposes of the following discussion, "Element" is defined as a discrete task, action, or function that is ultimately task analyzed for determination of minimum inventory HSI requirements.

The following paragraphs describe the 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" (SECY 92-053) are broken down into elements. Also presented is the process by which these elements are analyzed through task analysis to determine what HSIs (alarms, displays, controls) need be present to provide for their successful completion.

ESBWR Design Comparison to BWROG EPG - Functional Analysis:

The EPG portion of the BWROG EPG/SAG Rev 2 strategies, steps, and actions are evaluated in the context of the ESBWR plant and systems design as documented in ESBWR DCD Rev 5. This analysis culminates in the development of the ESBWR Design Comparison to BWROG EPG which demonstrates how EPG strategies can be implemented in the ESBWR. This document is at the parameter level; no set points or decision point values will be included.

Where the ESBWR design is similar to the designs that formed the basis for the BWROG EPG/SAG Rev 2, the BWROG guidance is implemented as recommended (some minor wording or system name changes may be made). Where the ESBWR design or operating philosophy differs from the EPG/SAG Rev 2 bases reactors, needed system, strategy, and step text changes are documented. In both of these cases, a comparison between the BWROG guidance and ESBWR implementation, and the discussion of any differences, is presented.

Every step and caution in the EPG portion of the BWROG EPG/SAG Rev 2 is addressed such that the ESBWR Design Comparison to BWROG EPG constitutes a complete picture (sufficient for the purpose of minimum inventory derivation) of how operators will implement the emergency operating procedures. Because of this completeness, the ESBWR Design Comparison to BWROG EPG constitutes a valid analytical tool for the derivation of the ESBWR minimum inventory.

The process used to develop the ESBWR Design Comparison to BWROG EPG is a functional analysis linking the strategy and task guidance contained in the EPG portion of the BWROG document with the design specifics and system capabilities of the ESBWR. The ESBWR Design Comparison to BWROG EPG produced from this analysis describes each of the elements for which task analysis will determine minimum inventory HSI requirements.

Note: The ESBWR Design Comparison to BWROG EPG is written at a higher level (contains less detail) than will exist in the complete ESBWR EPGs (to be developed as a part of detailed design). The ESBWR Design Comparison to BWROG EPG is at the parameter level; no calculations, basis descriptions, set points, or decision point values will be included.

PRA Risk Important Human Action - Functional Analysis:

Using the analytical approach presented in ESBWR DCD Rev 5 Chapter 19, design basis accidents, event strategies, sequences, steps, and actions are evaluated. Any human actions included in these sequences are analyzed to

determine error probabilities and consequences. Using the ranking methodologies and cutoff criteria risk important human actions are identified.

The process used to identify risk important human actions is an analytical functional analysis linking the ESBWR operating and accident mitigation strategies with the design specifics 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/Detailed Review and HSI Requirements Determination

Task analysis is performed on each of the elements identified during functional analysis of the ESBWR Design Comparison to BWROG EPG and the PRA (risk important human actions).

Each element is analyzed in the context of the EPG strategy or PRA event sequence of which it is part. Analyzing the element in the context of its action sequence aids in determination of minimum inventory HSIs needed to ensure success. 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.

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 performance of safety-related functions to respond to design basis events for which there is no automatic control (Corresponds to RG 1.97 variable selection criteria)
- HSIs that provide for assessing, accomplishing, or maintaining critical safety functions and safe shutdown conditions (Corresponds to RG 1.97 variable selection criteria)
- HSIs that provide for the performance of risk important human actions as identified in the ESBWR PRA
- HSIs that provide dedicated safety system actuation such as reactor scram, MSIV isolation, and ATWS response initiation

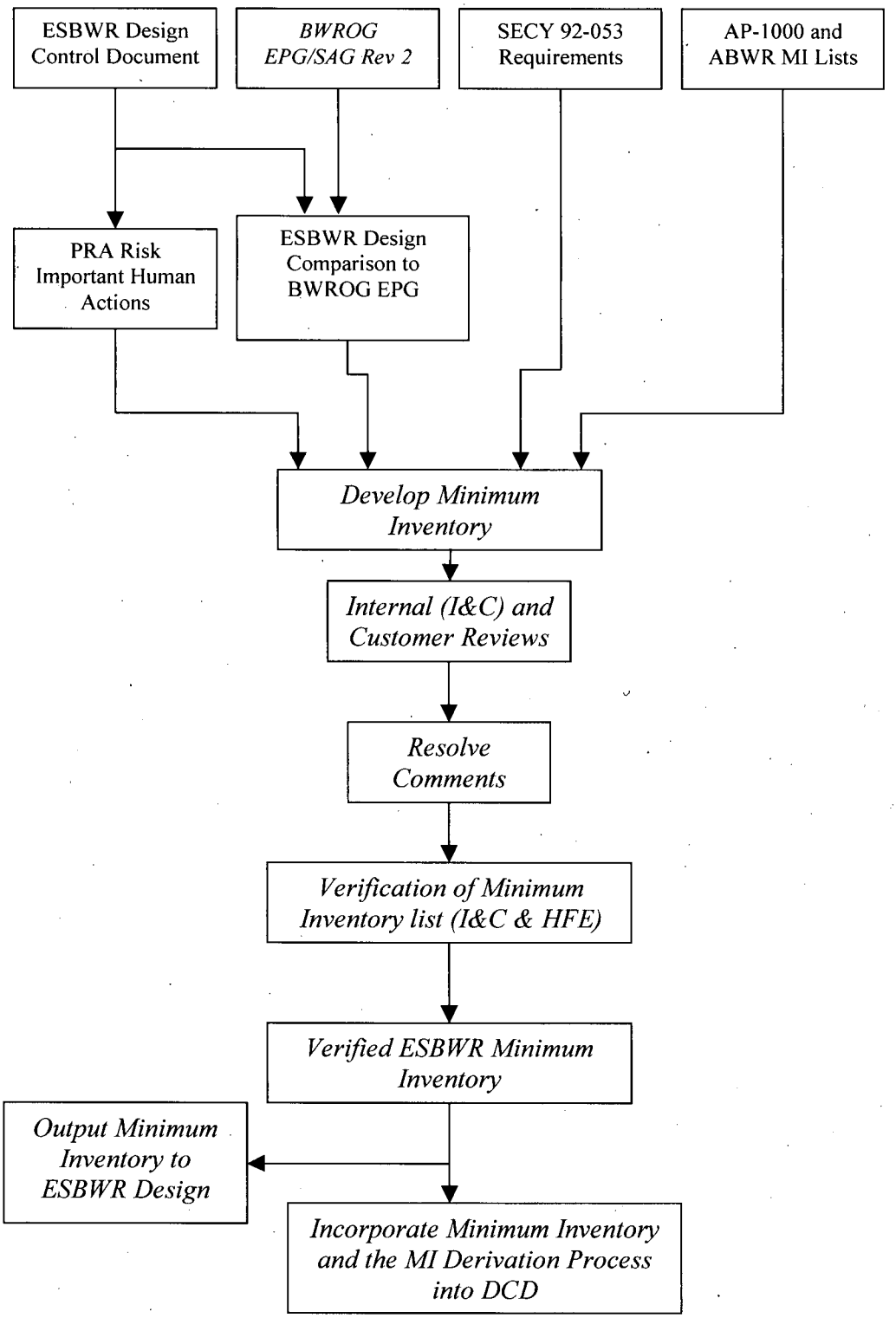
ESBWR minimum inventory HSIs are documented in a table that lists the parameter and whether the associated HSI consists of an alarm, display, and/or control.

Verification Process Description

The ESBWR minimum inventory final draft will undergo internal and customer reviews followed by formal verification in accordance with GEH internal engineering department verification procedures. Verifiers in both the I&C and

HFE branches of the ESBWR engineering department will verify the content and correctness of the ESBWR MI list. Verifiers will use the verified ESBWR Design Comparison to BWROG EPG, the ESBWR design as documented in ESBWR DCD Rev 5, and PRA analysis results (specifically, the risk important human actions identified) as basis documents. Using these basis documents, verifiers will ensure that the ESBWR minimum inventory verified document correctly identifies the complete list of minimum inventory HSIs as described in SECY 92-053.

ESBWR Minimum Inventory Development Process



DCD/LTR Impact

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

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