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**Subject: 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**

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

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

Sincerely,

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

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-383, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 71 Related to ESBWR Design Certification Application*, October 10, 2006

Enclosures:

1. MFN 06-443 – Response to Portion of NRC Request for Additional Information Letter No. 71 Related to ESBWR Design Certification Application –ESBWR Human Factors Engineering NEDO-33268, Rev. 1, Human-System Interface Design Implementation Plan – RAI Numbers 18.8-1 through 18.8-49

cc: AE Cabbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0000-0060-8377

Enclosure 1

MFN 06-383

Response to Portion of NRC Request for

Additional Information Letter No. MFN 06-443

Related to ESBWR Design Certification Application

Human Factors Engineering

**NEDO-33268, Rev. 1, Human-System Interface Design
Implementation Plan**

RAI Numbers 18.8-1 through 18.8-49

NRC RAI 18.8-1

Much of the document is written in present tense. For example, NEDO-33268 page (p.) 62 states: "The requirements for operator interaction with the Video Display Unit (VDU) or Flat Panel Display Graphical User Interface (GUI) are identified in the Style Guide for Graphical User Interfaces."

Does the style guide currently exist and are the requirements currently in it?

Please, clarify what tasks have been accomplished already and what will be done in the future.

GE Response

The GE Design Control Document (DCD) Writers Guide has the following guidelines.

“Text should be in present active tense (i.e., make the subject do the action). Avoid the use of the future and past tenses.

Avoid using the word “will” because this denotes a licensing commitment that will be formally tracked to completion. “Will” should only be used to state a future commitment to the NRC. (This means that text should be written as if the plant/equipment already exists, as is being described.)

In licensing documents, the term “shall” specifies a requirement, “should” specifies a recommendation, and “may” specifies an option.”

When GE refers to an item that will be available or used when the ESBWR is certified, then we will use the present tense. Anything that must be done post-certification by the COL applicant or represents a commitment, then we will use term "will". Historical descriptions may be written in past tense. All licensing commitments that have not been presently completed will be written using the term “will”. These commitments will be placed in our HFEITS commitment tracking system. Commitment dates will be added after a scheduled completion date is established.

The use of present tense in NEDO-33268 Rev 0 can be in conflict with the present status of our design. In the future revisions we plan to use the term “will” in establishing future commitments. Therefore statements in the present tense do not imply a future commitment. Page 65 of NEDO-33268 contains the following example of this present tense conflict in a document that we plan to write.

The ESBWR Human Factors Guidance Manual is a combination style guide, equipment HFE requirements guide, and Control Room environmental requirements guide. The ESBWR Human Factors Guidance Manual will be a comprehensive, plant specific human factors guidance manual that includes the requirements of NUGEG-0700 and NUREG-0711 and will direct the design engineer to the appropriate sections of these manuals. Deviations from these two NUREGs will be documented and justified using the following guides, standards, simulator operation, tests, mockups, and/or operator surveys.

- NUREG-0700 Rev2, May 2002 *Human-System Interface Design Review Guidelines*
- NUREG-0711 Rev 2, February 2004 *Human Factors Engineering Program Review Model*
- FAA HFDS 2003 *Human Factors Design Standard*
- IEEE Std 1023-2004 *IEEE Recommended Practice for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations and Other Nuclear Facilities*
- MIL-STD-1472F August 1999 *Department of Defense Design Criteria Standard Human Factors Engineering*
- DOE-HDBK-1140-2001 *Human Factors/Ergonomics Handbook for the Design for Ease of Maintenance*
- NASA-STD-3000 Rev B 1995 *Man-Systems Integration Standards*

The referenced Standards and Handbooks listed in the present revision of NEDO-33268 are being deleted and replaced by the above Standards and Handbooks in NEDO-33268 Rev 2.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-2

An implementation plan should provide step-by-step, specific guidance on how to perform the HSI design. The current document stops short of providing step-by-step procedures. To illustrate, in Section 4.2.3, the plan advises its user to design the Man-Machine Interface Systems (MMIS) giving due consideration to the "centralized or local philosophy," but the philosophy for the ESBWR is not provided. Much of the plan identifies considerations for design without providing designers with the basis or procedures to make decisions based on the considerations. Another example is that the "Auditory environment of the HSI is designed considering a relevant database of human capabilities and characteristics" (p. 24). Absence of these types of specific procedural steps will make this document difficult for users and the intended methodology may be incorrectly and inconsistently applied.

Special attention should be made to ensuring that the methodology used to address the General Human Factors Engineering (HFE) Requirements described in NEDO-33268, Section 3.3.3 is presented. Section 3.3.3 follows closely the staff's review criteria for HSI Design. However, the high-level discussion in 3.3.3 does not provided the methodological details as to how these commitments are achieved. While some the considerations are addressed in later sections of the NEDO, others are not. For example, Section 3.3.2 discusses General Electric's commitment to develop a concept of operations. However, none of the subsequent plan material or documentation descriptions address concept of operations. Please, provide step-by-step, specific guidance on how to perform the HSI design.

GE Response

NEDO-33268 is not a step-by-step, specific guidance manual on how to perform the HSI design or evaluation. NEDO-33268 is being revised to provide the description of the implementation process that will develop the Human-System Interface Design for the ESBWR. This document will provide directions to develop the step-by-step, specific guidance manual referred to as the ESBWR Human Factors Guidance Manual. Neither NEDO-33268 Rev 2 nor the ESBWR Human Factors Guidance Manual has been written at present.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-3

Commitment to the Methodology - The methodology is presented in this document (NEDO-33268) as a recommended practice rather than a commitment. The purpose of an Implementation Plan review is to certify the methodology that will be used, rather than what might be used. Please clarify why the methodology is described as a recommendation only and not the actual plan that will be used to conduct that analysis.

GE Response

NEDO-33268 will be revised as a top-level implementation plan to develop the ESBWR Human Factors Guidance Manual and to develop an HSI process program for use in the design phase and for the COL applicant to commit to after the plant is in operation. The revised NEDO-33268 will commit to meeting the requirements of NUREG-0700 and NUREG-0711 in the development of the ESBWR Human Factors Guidance Manual. Deviations to these NUREGs will be documented and justified using the HFE design documents listed in RAI 18.8-1 or with tests and HFE evaluation techniques that will be more applicable for the operating philosophy and anticipated user population who will be operating the ESBWR plants.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-4

NEDO-33268 Sections 4, 5, and 6 provide high-level HSI guidance. As an example, Section 4.2.6.2, Item 1.c.v states (p. 26) that "For VDU display, the background color should be pure and free from noise patterning." Clarify why a background color was not specified and how is the guidance in Sections 4, 5, and 6 to be used by designers following the plan?

GE Response

NEDO-33268 is not a step-by-step, specific guidance manual on how to perform the HSI design. NEDO-33268 will be revised to provide directions to develop the step-by-step, specific guidance manual referred to as the ESBWR Human Factors Guidance Manual for the design engineers to perform the HSI design. This manual has not been written at present.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-5

NEDO-33268, page 10, states "The ESBWR HSI design implementation starts with the results of the operations analysis (system functional requirements analysis, allocation of functions, and task analysis) and with the existing design bases included in the Advanced Boiling Water Reactor (ABWR) Standard Safety Analysis Report (SSAR)." At the time of ABWR design certification, these analyses had not been completed and were a part of a certified process. Please clarify this statement.

GE Response

The GE Writers Guide dictates that the present tense is to be used when an item will be available or in operation when the ESBWR is certified. The use of "will" is for anything that must be done post-certification by the COL applicant post-certification or is a licensing commitment. Historical descriptions may be written in past tense. It is anticipated that the design bases included in the Advanced Boiling Water Reactor (ABWR) Standard Safety Analysis Report (SSAR) will be available before ESBWR certification. Therefore the present tense is used.

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 18.8-6

The introduction to NEDO-33268 and Table 1 both refer to RG 1.97, draft Revision 4 and IEEE Std 497-2002, but don't clearly state they will be followed. RG 1.97 Revision 4, which endorses IEEE 497 (with a few exceptions) has been issued as a final document and is being used for evaluating the ESBWR. Please clarify the commitment to these documents in NEDO-33268.

GE Response

NEDO-33268 will be revised and it will clearly state that the ESBWR HSI design will meet the criteria of RG 1.97 Rev 4 and IEEE 497-2002.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-7

The purpose of NEDO-33268 limits HSI design program to the main control room (MCR) and remote shutdown system (RSS), and the scope only addresses the MCR. Both the purpose and scope should include, the MCR, RSS, local control stations, the Technical Support Center (TSC) and the Emergency Offsite Facility (EOF). It is noted that the TSC and EOF are mentioned in Section 4.

NEDO-33268, Section 1.2, Scope, Item 3 States "Methods for comparing the consistency of the HSI human performance, equipment design and associated workplace factors with that modeled and evaluated through the task analysis." Please clarify scope and purpose.

GE Response

NEDO-33268 will be revised to make it clear that the MCR, RSS, Local Control Stations (LCSs) with a safety-related function or as defined by High Level Task Analysis, TSC, and EOF are included in the purpose and scope. NEDO-33268 will also be revised to clarify the scope statement in part 2 of the question as follows: "Methods to evaluate the HSI equipment design to support the human performance characteristics established in the task analysis and the workplace factors under which the operators will perform the associated tasks."

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-8

NEDO-33268, Section 2 has many references to old documents - many to the 1980s. What role do these documents play in the plan? Many of the versions of the documents referenced have been replaced by newer, updated material. For example, MIL-STD-1472D is referenced, while that document has been revised and is now in Revision F. Some of the old documents may contain outdated and potentially incorrect guidance. For example, EPRI-NP3701 on Computer-Generated Display System Guidelines was published in 1984. Technology and display development approaches have advanced so much since 1984 that the guidance is not fully applicable to today's systems. These documents have been replaced by a new generation of guidance documents. Clarify the use of old document versions.

GE Response

NEDO-33268 will be revised and it will reference the latest industry standards and references that are listed in RAI 18.8-1. The existing references will be deleted.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-9

NEDO-33268, Section 4.1 discusses the use of operating experience. Section 4.1.1 identifies existing plants for which Detailed Control Room Design Reviews (DCRDRs) were performed and who's Human Engineering Discrepancies (HEDs) will be evaluated for lessons learned. The plants listed do not include ABWRs (although operating experience of the ABWR is listed in the first sentence of Section 4.2), whose control rooms are like to be more similar to ESBWR than the plants listed. Also, no other "computer-based" control rooms are identified where similar technology may be used. Please clarify why more modern control rooms are not included in the Operational Experience Review (OER).

GE Response

NEDO-33268 will be revised to include experience from the BWR fleet of reactors, including available data from Kashiwazaki-Kariwa K6 and K7 and Lungmen Nuclear Power Plants. Also other new nuclear power plants both domestic and foreign design will be reviewed, as the data is available. The operating experience information is made available to design engineers to support development of design features that mitigate human error.

Likewise, positive features of previous designs are identified, evaluated, and retained. The baseline review record includes BWR experience related to the plant and systems of the ESBWR. In addition, the design process will include discussions and walkthrough analyses with personnel having operational experience and the use of a plant specific control room mockup or simulator.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-10

NEDO-33268, Section 4.1.1 references NEDE-33217 as a source of information on operating experience of previous designs. What document is this and is it available for staff review. NEDE-33217 led to a fairly extensive list of human factors principles identified in Appendix A. However, many of the principles would not seem to apply to a computer-based control room. Are these principles still to be used for portions of the ESBWR design?

GE Response

NEDO-33217 is the Licensing Topical Report *ESBWR Man-Machine Interface System and Human Factors Engineering Implementation Plan*. The purpose of this plan is to ensure through human-centered design, development and operational activities that the vital role personnel play in the safe efficient production of electric power at ESBWRs can be accomplished under normal and emergency conditions.

NEDO-33268 is being revised and the present Appendix A is being eliminated. The plan is to use NUREG-0700 and NUREG-0711 along with the Standards and Handbooks listed in RAI 18.8-1 to develop the ESBWR Human Factors Guidance Manual.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-11

Status of the Control Building General Arrangement Drawing - NEDO-33268, Section 4.2.1 lists standard features. Reference is made to the Control Building General Arrangement Drawing after item 18. What is the status of this drawing and how does it relate to Figure 18D-1 of the Tier 2 Design Control Document (DCD)?

GE Response

The Control Building General Arrangement is shown in the Nuclear Island General Arrangement Drawings (GE Drawing 105E3908 Sheet 3) previously transmitted to the NRC via MFN 05-164 and it was the same as Figure 18D-1 of the Tier 2 Design Control Document (DCD) Rev 1. However Figure 18D-1 is being removed from Chapter 18 in Tier 2 Design Control Document (DCD) Revision 2.

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 18.8-12

NEDO-33268, p. 29 states that the information processing functions should support "Expanding availability information to cover implicit data." Please clarify this statement.

GE Response

The phrase *"Expanding availability information to cover implicit data."* is being removed from NEDO-33268.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-13

NEDO-33268, p. 33 discusses critical parameters and references Section 18F. However, this section only identified the need for a Combined Operating License (COL) minimum inventory analysis and not the parameters. Please, clarify.

GE Response

The question refers to a statement in NEDO-33268 Rev 0. The current revision does not contain the reference to Section 18F. However, the Top-Down approach using the Task Analysis and the EOPs will develop a set of minimum and/or critical parameters that must be displayed to the operator at all times. NEDO-33268 will be revised to state that the critical parameter input list will be an output from the Task Analysis.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-14

NEDO-33268, p. 34 states that plant parameters that are to be displayed on the over mimic are defined on the WDP Arrangement drawings. How are these parameters determined and what is the status of the arrangement drawings?

GE Response

NEDO-33268 will be revised and it will provide guidance about the selection of parameters to be displayed and the method of display. The Top-Down approach using the Task Analysis and the EOPs will determine the parameters to be displayed and the method of display.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-15

NEDO-33268, p. 35 and Section 4.6.4.2, p. 62 reference this document. The language suggests this document already exists, e.g. "The requirements for operator interaction with the VDU or Flat Panel Display GUI are identified in the Style Guide for Graphical User Interfaces" (p. 61). What is its status of this document and how does it relate to the guidance presented in the NEDO?

GE Response

The use of present tense in NEDO-33268 can be in conflict with the present status of our design. The GE Design Control Document (DCD) Writers Guide dictates the use of present tense for the expected future status of the design documents at the issuance of the COL. The ESBWR GUI Style Guide does not exist at this time. NEDO-33268 will provide guidance to develop the ESBWR Human Factors Guidance Manual. This manual will include guidance to develop the VDU displays. The ESBWR Human Factors Guidance Manual will conform to the guidance of NUGEG-0700 and NUREG-0711.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-16

NEDO-33268, p. 38 discusses ARPS and computer-based aids. Will ESBWR have computer-based ARPs?

Alarms and corrective actions - NEDO-33268, p. 38 states that the display of alarms meets the following criteria. Criterion a. states "An alarm is annunciated where the operator has the necessary means for initiating corrective actions." Please clarify this statement, particularly as it applies to VDUs.

GE Response

On-line computer based procedures are planned. The Task Analysis and NUREG-0700, R2, Section 4 will be used to develop the required alarm requirements for the operator. NEDO-33268 will be revised to provide the implementation plan to produce the ESBWR Human Factors Guidance Manual to be used by the design engineers to develop the required alarming methodology. The details of these procedures and method of display will be developed using the guidance of NEDO 33268 and summarized in the HSI Design Summary Report.

NEDO-33268 will provide high-level guidance to provide displays (which includes alarms) in a close visual proximity to the controls that affect the parameters and functions monitored and controlled. The detailed guidance specifying control and display locations, visual characteristics and physical sizes will be provided in the ESBWR Human Factors Guidance Manual that will be developed under the guidance of NEDO-33268.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-17

NEDO-33268, p. 39 states "Mechanical characteristics of control elements, such as size, operating pressure of force, tactile feedback, etc., meet capabilities and characteristics specified in the anthropometric database." What database is referred to here?

GE Response

The ESBWR Human Factors Guidance Manual will use the anthropometric data for physical characteristics of equipment based on body size and dimensions of the user population found in NUGEG-0700. Deviations from NUGEG-0700 will be documented and justified using the:

- Guides and standards listed in RAI 18.8-1
- Simulator operation
- Tests
- Mockups and/or
- Operator surveys

The ability of the operators to efficiently function within their environment will be observed. Physical barriers or impediments to the ease with which they are able to perform their tasks will be resolved. This includes ergonomic issues such as reach, force, grasp, size, distance, etc

The statement in Section 4.2.8 of NEDO-33268 will be revised to clarify the anthropometric database will be specified in the ESBWR Human Factors Guidance Manual.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-18

NEDO-33268, p. 39, Item 2 - iii states "Placement of controls in keeping with their conformance to safety functions." Please clarify what this statement means.

Form of controls - NEDO-33268, p. 40 states "The form of control adopted is consistent with HSI requirements." Please clarify what this statement means.

GE Response

NEDO-33268 will be revised to refer to the ESBWR Human Factors Guidance Manual for the guidance concerning the placement of controls and displays on the consoles and control panels. The Top-Down approach using the Task Analysis and the operator procedures will determine the parameters to be displayed and the controls required. The design philosophy of the ESBWR encompasses a fully digitized and largely automated environment. However the placement of data on displays, touch screen control dimensions, and placement of control positions along with the placement of the VDUs all require detailed HFE guidance. The ESBWR Human Factors Guidance Manual discussed in RAI 18.8-1 will provide the detailed guidance for developing computerized displays and controls, including the format of controls appropriate for the HSI requirements established in the operations analysis phase.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-19

NEDO-33268, p. 44, states "The Motor Control Center (MCC) design does not contain fixed-position displays because the standard ESBWR design does not require them at the MCC. All fixed-position displays (FPD) are located at the WDP based, in part, on the rationale for fixed-position displays (such as diversity) and the relatively compact configuration of the MCC. The minimum set of controls, displays and alarms, based upon a review of the ESBWR Emergency Procedure Guidelines (EPGs), have been allocated to the MCC and WDP. "In Section 4.2.1, standard feature 4 states "The use of dedicated function switches on the control console." Is it feasible for a dedicated control to be located at the MCC while the associated display is at the WDP? What is the status of the minimum set of controls, displays and alarms?"

GE Response

The acronym MCC is referring to main control console and will be changed to this wording or MCR console so as not to be confused with motor control center (MCC) acronym. NEDO-33268 will be revised and it will provide guidance about developing criteria for the placement of controls and displays on the Main Control Room Panel (MCRP) and other control panels. Presently, controls and displays of all operations are computerized. However some fixed controls and displays will be required. These may be computer generated fixed positions on the VDUs or they may be hardwired discrete components. The Top-Down approach using the Task Analysis and the operator procedures will determine the minimum set of controls, displays, and alarms. The ESBWR Human Factors Guidance Manual discussed in RAI 18.8-1 will provide the detailed guidance for the placement of controls and displays.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-20

NEDO-33268, p. 45 references these drawings. What is their status?

GE Response

The use of present tense in NEDO-33268 can be in conflict with the present status of our design. The GE Design Control Document (DCD) Writers Guide dictates the use of present tense for the expected future status of the design documents at the issuance of the COL. The MCC Panel Arrangement drawings are not available at this time.

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 18.8-21

NEDO-33268, p. 49 lists critical parameters to be displayed on the WDP. How was this list determined and why are the pool levels (suppression pool, gravity-driven cooling system, isolation condenser, and passive containment cooling) not included?

GE Response

See response to RAI 18.8-13. Good human factors practice and regulatory requirements along with the information and control needs from the Task Analysis will be used to determine what parameters need to be displayed on the WDP and the format and type of display. The ESBWR Human Factors Guidance Manual based on NUREG-0700 will be used as the base criteria defining the display characteristics of the WDP.

NEDO-33268 will be revised to include the safety related pool level displays (suppression pool, gravity-driven cooling system, isolation condenser, and passive containment cooling) in the critical parameter list.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-22

NEDO-33268, p. 50-51 discusses approaches to alarm suppression. Are suppressed alarms available to operators should they want them?

GE Response

NEDO-33268 will be revised to refer to the ESBWR Human Factors Guidance Manual for guidance about alarming methodology. Suppression of misleading and nuisance alarms is an extremely useful HFE principle. The use of alarm suppression is anticipated in the design of the ESBWR control room indicators. The Top-Down approach using the Task Analysis and the operator procedures will determine the alarms required and the suppression needed. The ESBWR Human Factors Guidance Manual discussed in RAI 18.8-1 will provide the detailed guidance for the alarms.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-23

NEDO-33268, p. 53 notes that an analysis was performed that defined a minimum inventory of alarms, displays, and controls using the EPGs, Probabilistic Risk Assessment (PRA), and "other studies." Please explain how this analysis was conducted and provide the minimum inventory of displays, controls and alarms derived from the analysis for both the MCR and RSS. And, in accordance with SRP 14.3.9, Draft Rev. 0, April 1996, the minimum inventory list should be included in DCD Tier 1. Also this section states that the analysis used important operator actions identified in the PRA. Please provide this list of operator actions and explain how they were derived.

GE Response

The use of present tense in NEDO-33268 can be in conflict with the present status of our design. The GE Design Control Document (DCD) Writers Guide dictates the use of present tense for the expected future status of the design documents at the issuance of the COL. The ESBWR Human Factors Guidance Manual and the Task Analysis have not been done at this time.

See response to RAI 18.8-13. Criteria will be developed to provide guidance as what parameters are to be displayed in the MCR and RSS. The ESBWR Human Factors Guidance Manual will provide the hardware and software criteria for the minimum and/or critical parameters that must be available to the operator.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-24

NEDO-33268, p. 55 notes that "MCC profiles that are compatible with task requirements have been defined in DCD Chapter 18." Explain how is this possible if the task analysis has not been completed yet?

GE Response

See response to RAI 18.8-19.

The use of present tense in NEDO-33268 can be in conflict with the present status of our design. The GE Design Control Document (DCD) Writers Guide dictates the use of present tense for the expected future status of the design documents at the issuance of the COL. The ESBWR Human Factors Guidance Manual and the Task Analysis have not been done at this time. Therefore, the MCR console and panels for the ESBWR are not designed at present. The MCR console and panels for the ABWR are being used for planning purposes, but they do not represent the final MCP console and panels for the ESBWR.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-25

Explain what is the ESBWR Standard Plant Design Program referenced in NEDO-33268, p. 56.

GE Response

The reference does not refer to a specific document but to an ongoing ESBWR design process and its inputs. The statement could read, "The main control room panel system description presents the MCR, MCRP and the large display panel design based on the ESBWR DCD and the inputs from the standard plant design process.

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 18.8-26

NEDO-33268, p. 59 notes that "The annunciator philosophy for the ESBWR design, and the annunciator warning system, is based on the concepts presented in the ESBWR DCD." Explain where in the DCD is this philosophy articulated.

GE Response

The ESBWR DCD Tier 2 Chapter 18 Rev 1 Section 18.1.4.1.14 provides a statement about the alarms. However the ESBWR DCD Tier 2 Chapter 18 Rev 2 has deleted this statement. The detailed annunciator philosophy for the ESBWR design has not been developed at present.

NEDO-33268 will be revised to delete the reference to philosophy contained in the DCD Tier 2 Rev 1.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-27

Conceptual design allocation of function - NEDO-33268, p. 60 states "Perform Preliminary allocation of primary and backup mode operation to operator or machine for the following functions" How does this relate to the allocation of function process described in that implementation plan (NEDO-33220)?

GE Response

NEDO-33268 will be revised to state that the conceptual design is based on information from plant and process flow diagrams and the preliminary allocation of primary and backup mode operation to operator or machine from the allocation of function activity for the following functions.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-28

NEDO-33268, p. 61 identifies plant-specific display design constraints. The list includes: demands of operator and industry standards and guidelines. Explain why these factors are considered constraints in the context of a new plant design.

GE Response

In the next revision to NEDO-33268, the word “constraints” will be corrected to “design considerations”. Industry standards, industry guidelines, operator expectations, operator capabilities, maintenance requirements will all be considered as design considerations or criteria in the revised document.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-29

NEDO-33268, Section 4.6.4.2, p. 62, references a Display Primitives Design Specification. What is the status of this document?

GE Response

The Display Primitives Design Specification is in development. This document will be complete after the ESBWR Human Factors Guidance Manual has been written, after the task analysis, and before the DCIS is programmed.

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 18.8-30

NEDO-33268, p. 65, identifies "Demonstrated by use of dynamic displays, simulator, etc." as a criterion for selecting HFE techniques. How is this used as a criterion?

GE Response

The item in question refers to GE's approach to HSI design. The HSIs will be developed using simulated platforms prior to the final equipment design and construction. Various HFE techniques could be applied to the simulated platforms and if they prove useful, may be selected as criteria for the final evaluation.

DCD Impact/LTR Impact

No DCD Tier #2 changes will be made in response to this RAI.

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

NRC RAI 18.8-31

NEDO-33268, p. 64 contains a section 4.7.1, "Criteria Used in Selecting HFE/HSI Design and Evaluation Tools." The section discusses tools and techniques and presents a list of seven procedures appropriate to HSI evaluation in item 1. Item 2 goes on to provide criteria for selecting techniques. Section 4.7.2 is entitled "Definition of the Design/Evaluation Tools for the HSI Design Analysis." The introductory paragraph in this section addresses techniques. The section goes on to define four "techniques," including: checklists, drawings, mock-ups, and questionnaires/interviews. Two of these are the same as those identified in the listing of procedures in the previous section. Section 4.7.1 references Figures 4 & 5. Figure 4 identifies methods of data collection that are the same as the seven procedures listed on p. 64. Figure 5 identifies five methods of design evaluation, that include things like full-scope simulator. Please clarify the terms used and provide a consistent discussion in these sections of the NEDO.

GE Response

Procedures are meant as techniques, methods, tests, or evaluation options. Section 4.7.1 serves as an introduction and lists some of the various evaluative techniques that are likely to be employed to evaluate the HSI.

Section 4.7.2 provides a discussion of several of these design and evaluation tools for the HSI design analysis. Figures 4 and 5 are graphic representations to illustrate data collection methods and usefulness of the HFE design and evaluation tools. NEDO-33268 will be revised to replace the term "procedures" with "design evaluation tools", and a consistent discussion of the design and evaluation tools for the HSI design analysis will be incorporated into the document.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-32

NEDO-33268, p. 65, states "Considering the criteria listed in Section 3, Criteria to be used in selecting HFE/HSI Design and Evaluation Tools, the following techniques are used in the conduct of the HSI design analyses." How is the Section 3 material used for this purpose? Why are the criteria provided in Section 4.7.1 (including Figs 4 and 5) not used?

GE Response

Figures 4 and 5 are referred to in each section 3 and 4. Section 3 is a higher-level overview. Section 4 delineates further details. There are no discrepancies between the two.

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 18.8-33

Figure 4 clarification - NEDO-33268, p. 95, Figure 4 lists HFE activities across the top of the matrix. Why were these activities chosen? What is meant by performance models? How are MMI Evaluation and Evaluation of Alternative Designs different? How were the ratings in the cells of the table determined?

GE Response

These are standard activities that are evaluation tools within the profession of human factors engineering that were used in the evaluation of the Lungmen human-computer interface design. However newer procedures and evaluation tools have been developed that GE plans to use in the design of the ESBWR plant such as:

- PRA accident scenarios
- Task Analysis actions and procedures to define scenarios
- Simulator or mockup studies to gage effectiveness of design
- Tag out process studies
- Use of observers who are experienced with models of human error
- Documentation formats that help identify areas to enhance interface design

NEDO-33268 will be revised and this table will be eliminated. GE will provide descriptions of the procedures and evaluation tools used to design the HSI features of the ESBWR.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-34

NEDO-33268, p. 96, Figure 5 - What is the basis for the evaluations? Full-scope simulators and in-plant evaluations are always identified as "inefficient." How is efficiency defined. What is the meaning of the underline for some cell entries?

GE Response

This table is derived from the work done in the nuclear and other hazardous process control industries (see pertinent NRC, EPRI, and INPO guidance). These methods of evaluation were used in the Lungmen human-computer interface design. However GE plans to review and select the methods of evaluation that are available today and proven effective in the design of the ESBWR.

NEDO-33268 will be revised and this table will be eliminated. GE will provide descriptions of the methods of evaluation used to design the HSI features of the ESBWR. Also see RAI 18.8-33.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-35

NEDO-33268, Section 4.7.2.5.2, Methods of Evaluation, lists three such methods. However, the actual methods are not described. For example, the first item listed is "Electronic Evaluation." The section does not describe how a user of the document conducts this evaluation. Also, why have several of the methods (listed in Figure 5 and shown on Fig 7) been omitted from this section, e.g., full-scope simulator?

GE Response

Other evaluation methods will be considered in addition to those listed and discussed in NEDO-33268.

The instructions and procedures in question are common to the discipline of human factors engineering. The methods and results of the selected techniques will be summarized in the results summary report.

Other types of evaluations to be considered and their merit and conduct, including the simulator, will be further discussed in the next revision.

DCD Impact/LTR Impact

DCD Tier #2, Section 18.8 will be revised as appropriate.

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-36

NEDO-33268, Section 5 provides a HSI description and Section 6 provides software guidelines. How do these descriptions and guidelines relate to those provided in earlier section and those in the documents referenced in this NEDO, such as the HSI style guide?

GE Response

The contents of both section 5 and section 6 were derived from those documents listed in RAI 18.8.1. They are all related. The complexity of HSI entails all features and functions of the controlling and display mechanisms as well as software content and presentation.

The ESBWR Human Factors Guidance Manual when written will encompass the most current HFE guidance and/or direction to such guidance for the software, usability, and HSI specialists to design and develop the HSIs. The purpose of the evaluations and testing is to give rise to an indication of the goodness of fit of the integration of leading edge technology and the current design concepts (safe, standardized, and simple interfaces using the concepts of automation and passive control).

NEDO-33268 will be revised to include the preparation of the ESBWR Human Factors Guidance Manual.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-37

NEDO-33268, Section 6, p. 74, identified the "HSI report." What report is being identified here?

GE Response

The HSI report (more correctly HSI Results Summary Report) will contain the summary of findings, interpretation, and meaning associated with the HSI tests and evaluations as delineated.

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 18.8-38

NEDO-33268, Section 6, p. 74, states "The look and feel of each display is governed by the requirements of NUREG-0700R2 ..." This should be modified since NUREG-0700 does not contain "requirements."

GE Response

NEDO-33268 will be modified to replace "requirements" with "guidance".

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-39

NEDO-33268, p. 86, indicates that the ESBWR style guide will be based on "applicable excerpts from NUREG-0700R2." Much of the guidance in NUREG-0700 is fairly general due to its application (review of different HSI designs). Will the guidance in the style guide be more specific to how general guidance is tailored and made more specific for the ESBWR application?

GE Response

See response to RAI 18.8-1.

The guidance in the ESBWR Human Factors Guidance Manual and/or direction to accepted human factors best practices will be tailored and made specific to ESBWR applications.

NEDO-33268 will be revised to include the preparation of the ESBWR Human Factors Guidance Manual.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-40

NEDO-33268, Figure 1 states "All HSIs conform to HFE Guidelines" under HSI Task Support Verification. The same statement appears under HFE Design Verification. This statement appears to accurately characterize the latter, but not the former. Please clarify.

NEDO-33268, Figure 1 states "Dynamic Display" under HFE Design Verification, yet the types of mockups listed would not seem to support an evaluation of dynamic displays. Please explain.

GE Response

Task Support Verification (TSV) is a check that the inventory of HSI components (i.e., controls, displays, alarms, etc.) is consistent with HFE analyses, and that the HSI accommodates operator tasks as defined by Task Analysis, emergency operating procedure analysis, and critical actions of PRA/HRA. Detailed TSV confirms that HSI component characteristics (e.g., units of measure, accuracy, precision, dynamic response time) meet end-user operability requirements (task execution and information access needs).

HFE Design Verification is a broader verification than TSV. It is evaluation of the HSI with respect to a particular end user population, and not an evaluation of the end users. Individual HSI components are checked against plant engineering criteria, human engineering criteria, and operating and functional requirements. The verification is performed in accordance with QA requirements that include requirements for independent verification. HFE Design Verification verifies that each HSI component design meets personnel task requirements and operational considerations, and reflects HFE guidelines, standards, and principles.

Both activities apply HFE guidelines.

Figure 1 will be modified to include a simulator in the list of HFE Design Verification Tools. The dynamic displays will be verified using the simulator.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-41

NEDO-33268, Figure 2 lists a number of design inputs. Questions related to some of them are:

Where are the general human factors requirements listed?

What does HSI technology refer to?

Describe how is the minimum displays, controls and alarms list an input.

What does operating crew refer to?

GE Response

These questions clearly inquire about the contents of the first box in Figure 2. Human factors engineering takes a systems approach to the evaluation of tasks, situations, interfaces, or environment. Thus these are standard commonly known elements or contributing variables of systems, particularly related to the nuclear industry. These elements all bare information regarding the human in the system and each lends information about that system and the persons within the system.

Where are the general human factors requirements listed?

See RAI 18.8-1

What does HSI technology refer to?

HSI technology refers to conventional HSI, the predominant means for providing control input via hard-wired, spatially dedicated control devices that have fixed functions, and advanced HSI, the predominant means for providing control input via digital technology. GE will use NUREG-0700 for guidance of conventional HSI and NUREG/CR-6635 for guidance of advanced HSI. NUREG/CR-6635 provides guidance for:

- Soft Controls
- Computer-based procedures
- Information (display) design and organization
- Design analysis, evaluation, and implementation of hybrid HSIs
- Maintenance of digital systems

NEDO-33268 will be revised to establish the preparation of the ESBWR Human Factors Guidance Manual to include the above guidance for HSI design.

Describe how is the minimum displays, controls and alarms list an input.

Those items are elements with which the operating crew interfaces to work within the system and are derived from the operations analysis (See RAI 18.8-42).

What does operating crew refer to?

The preliminary staffing assumption for ESBWR crew for control and monitoring will consist of the following assignments:

<u>Quantity</u>	<u>Qualification</u>	<u>Assignment</u>
1	Control Room Supervisor ¹	Provides overall supervision of control room operations
2	Reactor Operators ²	First operator is assigned to normal control actions at MCR HSI. Second operator is assigned to control of testing, surveillance and maintenance activities, including blocking and tagging permits.
1	Senior Reactor Operator (Shift Manager) ¹	Assigned to shift but not necessarily in the Main Control Room (MCR). Acts as manager of and relief for shift supervisor.
2	Auxiliary Operators ³	Qualified to operate equipment in the plant.

¹Licensed by the NRC as a Senior Reactor Operator (SRO)

²Licensed by the NRC

³Non-licensed, often called Auxiliary Equipment Operators (AEOs)

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-42

NEDO-33268, p. 94. Please explain "Information and Control Requirements Definition Synthesis" as used on Figure 3.

GE Response

Information and control requirements are obtained from the operations analysis. Taking that information into account, the type and number of display types (that is, information presentation techniques) used for each information requirement are determined.

In addition, the information techniques appropriate to the information conveyed are selected.

The techniques used to control the display system are determined and include:

- Methods for accessing display pages
- Changing display parameters
- Responding to alarms
- Changing the controller state (for example, on/off, open/closed)
- Method of configuration control
- Restriction of system use to authorized personnel

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 18.8-43

NUREG-0711 Section 8.5 references several other regulatory documents that specify HSI-related systems in the control room or other control facilities for the power plant. Please describe the ESBWR-specific implementation of HSI for the following six key aspects of the plant HSI:

- 1. Provision for periodic testing of protection systems actuation functions, as described in Regulatory Guide 1.22.*
- 2. Bypassed and inoperable status indication for NPP safety systems, as described in Regulatory Guide 1.47.*
- 3. Manual initiation of protective actions, as described in Regulatory Guide 1.62.*
- 4. Instrumentation for light-water-cooled nuclear power plants to access plant and environmental conditions during and following an accident, as described in Regulatory Guide 1.97.*
- 5. Instrumentation setpoints, as described in Regulatory Guide 1.105.*
- 6. HSIs for the emergency response facilities (TSC & EOF), as described in NUREG-0696.*

GE Response

These six key aspects of the plant HSI are in the design phase and as development and implementation unfolds such questions can be answered. These provisions will be added as pre-operational testing requirements in NEDO-33268 to be addressed in the activity and the methodology and results will be summarized in the results summary report.

DCD Impact/LTR Impact

DCD changes will be revised as appropriate.

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-44

NEDO-33268 discusses the Safety Parameter Display System (SPDS) for ESBWR and compares it to NUREG-0737, not the more recent set of criteria in NUREG-1342, 1989 and NUREG-0700, Revision 2, Section 5, 2002. Please provide information on how the proposed implementation of SPDS for ESBWR compares to the criteria of NUREG-0700, Revision 2, Section 5.

GE Response

As the SPDS design evolves, the regulatory guidance will be met as appropriate and will follow the most current relevant criteria as set forth in NUREGs and other industry-specific documents. These most recent criteria identified in the question will be added in NEDO-33268.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-45

NEDO-33268 states that the SPDS "may" be provided in the TSC and "optionally" in the EOF. However, NUREG-0696, Section 8, Emergency Response Facility Integration, specifies that the variables displayed by SPDS and the RG 1.97 Type A, B, C, D, & E variables shall be available for use in the TSC and the EOF. Please update the document to address this or provide justification as to why your proposal is acceptable.

GE Response

The words "may" and "optionally" will be deleted in the revision to NEDO-33268. The SPDS variables that are displayed in the MCR will be available in the TSC and EOF.

DCD Impact/LTR Impact

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

LTR NEDO-33268 Rev. 2 will include a revision as described above.

NRC RAI 18.8-46

IEEE Std 497 in Section 6.6 calls for the Type A, B, and C variables to be powered by Class 1E power. The SPDS parameters are typically a complete subset of these variables, yet Section 4.3.5.1 (2) of NEDO-33268 appears to state that SPDS will receive non-1E power. Please clarify.

GE Response

Type A, B, and C variable instrumentation will be powered by Class 1E power in compliance with IEEE Std 497. These instruments will supply signals to the Essential Distributed Control and Information System (E-DCIS), which is also powered by Class 1E power. The type A, B, and C variable signals will be propagated through isolators to the Non-Essential Distributed Control and Information System (NE-DCIS). The type D and E variable instrumentation may be powered by either Class 1E power or non-Class 1E power and these instruments will supply signals to the NE-DCIS. The SPDS is a subsystem of the NE-DCIS and displays RG 1.97 Type A, B, C, D, and E variables plus additional variables and requirements that are required by NUREG-0737 Supplement 1.

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

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 18.8-48

Item 9.a. states "HSI Design Implementation Plan is developed which establishes the methods and criteria for Human System Interface (HSI) equipment ..." This plan has already been completed and is being reviewed as part of design certification of the ESBWR. Therefore 9.a does not belong in the ITAAC. Item 9.b relates to the implementation of the HSI Design Plan and is appropriate, but should be modified to follow the guidance on SRP section 14.3.

GE Response

DCD Tier 1, Table 3.3-1, Item 9.a

All of the HFE implementation plans identified in Table 3.3-1 have been submitted for NRC review. DCD, Tier 1 Table 3.3-1, Section 9.a entries will be deleted at the next revision.

DCD Tier 1, Table 3.3-1, Item 9.b

The ITAAC Item 9.b will be modified accordingly.

DCD Impact/LTR Impact

DCD Tier 1 Rev. 2 include the revisions described above.

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

NRC RAI 18.8-49

The description of the standard features is not exactly the same when comparing the Tier 2 DCD and the HSI Design Implementation Plan. Please reconcile inconsistencies.

GE Response

These documents are under review and revision. All in-consistencies will be reconciled.

DCD Impact/LTR Impact

DCD Tier 2 changes will be made, if necessary, in Rev.3 to resolve inconsistencies between the DCD and the LTR NEDO-33268.

LTR NEDO-33268 Rev. 2 will include a revision that resolves discrepancies between it and the DCD Tier 2.