GE Energy

James C. Kinsey
Project Manager, ESBWR Licensing

PO Box 780 M/C J-70
Wilmington, NC 28402-0780
USA

T 910 675 5057
F 910 362 5057
jim.kinsey@ge.com

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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 86 – Human Factors Engineering – RAI Numbers 18.9-12 through 18.9-26**

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

The enclosed DCD Chapter 18.9 RAI responses reflect the top-down methodology for developing Emergency Procedure and Severe Accident Guidelines (EPG/SAGs) values and limits. The top-down process necessitates that analyses be performed prior to publishing EPG/SAG values and limits. These values and limits are calculated based on ESBWR standard plant design and (like the standard technical specifications) included in the ESBWR design certification.

The process for developing procedures, including Emergency Operating Procedures (EOPs), is required to be part of the overall top-down process employed by the ESBWR HFE program described in DCD Section 18.9. Prerequisites for developing procedures include completion of the HRA/PRA, the operational analysis, and the design of the Human System Interface (HSI).

General Electric Company (GE) discussed the revision and submission schedule for ESBWR Licensing Topical Reports (LTRs) (between January 31 and March 31) during the recent NRC's ESBWR Human Factors Engineering (HFE) Audit. NEDO-33274, ESBWR Procedure Development Implementation Plan, is included in these revisions. As

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revised, NEDO-33274 methodologies reflect the ESBWR HFE top-down design philosophy outlined during the audit.

Instead of providing "best guess" EPGs, the process for developing the EPG/SAGs is described in detail in the NEDO-33274, ESBWR Procedure Development Implementation Plan. The ESBWR EPG/SAGs will comply with 10 CFR 50.34(f)(2), DG-1145, SRP 13.5, SRP 18, NUREG-0711 Rev. 2, NUREG-0899, August 1982 and NEI 94-01, Revision 1, December 1994, Section 5, Severe Accident Issue Closing Guidelines. ESBWR Specific EPG/SAGs and will be provided for NRC review and approval in a manner similar to that used for operating plants and in a timely fashion to support HFE Verification and Validation (V&V) of procedures, operator training and the licensing of plant operators.

The design specific bases and definitions for variables applicable to the ESBWR are located in NEDO-33274 Appendix A (submitted via MFN 07-075 dated March 15, 2007).

If you have any questions or require additional detail regarding the information provided here, please contact me.

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

Reference:

1. MFN 06-518, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 86 Related to the ESBWR Design Certification Application*, December 11, 2006

Enclosures:

1. MFN 07-181– Response to Portion of NRC Request for Additional Information Letter No. 86 – RAI Numbers 18.9.12 through 18.9-26

cc: AE Cubbage USNRC (with enclosures)
RE Brown GE/Wilmington (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF: 0000-0063-9291, Revision 1

Enclosure 1

MFN 06-181

Response to Portion of NRC Request for

Additional Information Letter No. 86

Related to ESBWR Design Certification Application

DCD Chapter 18, Tier 2, Rev 2

Human Factors Engineering

RAI Numbers 18.9-12 through 18.9-26

Enclosure 1

NRC RAI 18.9-12:

The ESBWR DCD Tier 2, Section 18A.1, page 18A-2, 4th paragraph, states that "The basis and calculational for these limits are defined in the BWROG Emergency Procedure and Severe Accident Guidelines, revision 2, appendices B and C, respectively."
There is a significant design evolution from operating BWRs to ESBWR including a taller reactor pressure vessel (RPV) and primary containment, natural circulation flow through the reactor core, and a passive safety system approach to emergency and severe accident mitigation. The changes from operating BWR to the ESBWR design exceeds the differences from BWR/2 to BWR/6, and from operating BWRs to ABWR. Consequently, the ESBWR EPG/SAG methodology and bases should be analyzed and documented, rather than referencing the BWROG EPG/SAG Appendices. ESBWR-Specific appendices would provide the COL applicant EOP authors with sound technical bases and methodology, with potentially less reliance on engineering judgement and less opportunity for errors and misinterpretations.
Further, providing the methodology and bases for ESBWR EPG/SAG values and limits could reduce the potential for operator uncertainty in emergency and accident solutions. In this regard please provide:
(1) ESBWR design specific bases for each step in the EPG/SAG including appendices equivalent to those in the BWROG EPG/SAG but specific to the ESBWR design, in particular, information provided in appendix B, and
(2) ESBWR-Specific definitions for all variables applicable to the ESBWR EPG/SAG. Note that there are 32 valuables in the current EPG/SAG, Appendix B.
The staff recognizes some may not be applicable to ESBWR.

GE Response:

The ESBWR EPGSAG will primarily follow the guidance and methodology of the BWR Owners Group EPG/SAG Revision 2.

(1) The ESBWR design specific bases for each step in the ESBWR EPG/SAG will be based on either;
   a. BWROG EPG/SAG, Rev. 2 basis,
      or
   b. ESBWR specific design basis.

   The ESBWR design specific bases will be documented in an ESBWR EPG/SAG Basis document, which will be generated following completion of the detailed plant design.

(2) ESBWR specific definitions for all variables applicable to the ESBWR EPG/SAG will be provided through the HFE implementation plans and safety analyses. The ESBWR specific definitions for all variables will be documented in the Emergency Procedure and Severe Accident Guideline Calculations, (equivalent to the BWROG Appendix C: Calculations), the ESBWR EPG/SAG Basis documentation, and the ESBWR EPG/SAGs.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-13

Many of the values and limits in the EPG/SAGs are written in brackets with the intent of requiring licenses to perform calculations based on plant specific configurations. However, because the ESBWR is a standard plant design, these calculations should be completed on a generic basis to the extent possible and the resulting values and limits should be included in the EPG-SAGs. Note that the ESBWR standard technical specifications include ESBWR specific parameters. The same approach should be used for the EPG-SAGs. Document the calculation methods for the steps and specify the limits in the appendix to ESBWR DCD Tier 2, Chapter 18, Similar to the information provided in Appendix B and C of the BWROG EPG SAG.

GE Response:

The ESBWR EPG/SAG specific calculation (also called the Appendix C: Calculation), derives the parameter values and limit curves which are to be used in the plant emergency procedures and will be developed on a generic basis to the extent possible. This calculation will be based on the methodology of the BWR Owners Group EPG/SAG Rev. 2, Appendix C: Calculation or ESBWR specific methodology based on plant design, analysis results, sensitivity studies, PRA input, and other criteria.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-14:

Update introduction to include discussion about contingencies and reference to NUREG-0737, Item 1.C.1. DCD Section 18A1, Page 18A-1 Add discussion about the contingencies in the Introduction section. Also, add reference to NUREG-0737 Item 1.C.1 in the Introduction since the regulatory requirement for the EPG is based on this item.

GE Response:

The EPGs/SAGs will include introductory discussion on contingencies and will reference NUREG-0737, Item 1.C.1, as well as NEI 91-04, Section 5. In addition, the Procedures Development Implementation Plan, NEDO-33274 Rev. 2, specifically makes reference to NUREG-737 requirements for development of EPGs.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

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NRC RAI 18.9-15

Provide metric units DCD Section 18A.2, Page 18A-4: English units used in Caution 1. Metric units used in Caution 3. In other sections of Section 18, both English and Metric unit values are given. Provide both units to maintain consistency.

GE Response

For the EPG/SAG and associated emergency procedures, the parameter units will be displayed in a consistent manner. The ESBWR HFE style guide, will define the units displayed in procedures and HSI displays. The units displayed in the plant Man Machine Interface shall be SI. The primary system of units shall be the International System of Units, SI and the secondary system of units will be the U.S. Customary units (i.e., English or inch-pound units).

DCD Impact

No Impact to DCD Tier 2, Chapter 18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

NRC RAI 18.9-16

Update DCD Section 18A.2 with current ESBWR data. DCD Section 18A.2, Page 18A-4, Caution 1 has a table with sets of data points. Those sets of data are identical to EPG/SAG Rev 2. Confirm that the numerical values given are correct for ESBWR and update the table with the current ESBWR data. In addition, shutdown range is not enclosed in brackets [ ]. Does that mean that these values are not plant unique setpoints?

GE Response:

ESBWR specific RPV instrument ranges will be provided per NEDO 33274 Rev. 2 "Procedure Development Implementation Plan" as the plant detailed design becomes finalized.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-17:

Update Table 18B-1 to include ESBWR specific values DCD Section 18A.3, page 18A-6. Data points for RPV level, pressure, drywell pressure are different than the EPG/SAG Rev. 2 and they are not listed in Section 18C, the values are different than the values in same section from EPG/SAG Rev 2. Provide reference for those new data points and list these differences in Table 18B-1.

GE Response:

ESBWR specific data values for Limiting Condition for Operation (LCO) / Technical Specification Limits and nominal trip setpoints are derived and documented in an Instrument Setpoint Methodology document to be transferred to the EPG/SAGs. These setpoints are developed as the plant design and instrument procurements become finalized.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.
Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-18:

Clarify ECCS initiation in DCD section 15A.3 DCD 18A.3, Pages 18A-7 and 8. RC/L-1 states:"RC/L-1 Initiate each of the following which should have initiated but did not: ... " ECCS ..."

"ECCS in ESBWR includes GDCS, ICS, SLCS and ADS. Initially only ICS should be initiated. RPV blowdown should be the last resort. Clarify why ECCS initiation is included in this step.

GE Response:

The reference to ECCS, in the cited section, is a direct application of the BWR Owners Group EPGs equivalent guideline step. In the BWR Owners Group EPG/SAG Rev. 2, Appendix B: Bases, Reactor Control, the following is stated regarding ECCS in guideline step RC/L-1;

"Initiation of ECCS aligns sources of makeup water and starts pumps for injecting water into the RPV. More detailed instructions regarding the operation of these systems to establish and maintain control of RPV water level are provided in subsequent steps of the EPGs."

Reactor Control Level is entered because of an entry condition such as RPV water level below the low water level scram setpoint. Since RPV water level has decreased to at least the low water level scram setpoint or lower water level, because of the transient, then those ECCS that should have initiated, such as GDCS, ICS, SLCS, and ADS would be initiated if those systems did not initiate.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3. Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-19:

Define basis for excluding SLCS from list of alternate injection systems. DCD Section 18A.3, page 18A-7 RC/L-2. Why is SLCS initiation (specifically, the passive injection feature) not included in the new level control list? Provide the basis for excluding SLCS from the list of alternate injection systems.

GE Response:

The analyses to determine the alternate injections systems such as SLCS have not been completed. Therefore, the inclusion of SLCS is beyond the level of detail provided in DCD Tier 2. The basis for including or excluding the Standby Liquid Control System from the list of alternate injection systems would be documented in an ESBWR EPG/SAG Basis document.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-20:

Provide basis for why GDCS is not listed in step RC/L-3. DCD Section 18A.3, page 18A-8 RC/L-3. Step RC/L-3 lists systems to restore RPV water level after emergency RPV depressurization. Provide the basis for why GDCS is not listed in this step.

GE Response:

The analyses to determine the alternate injections systems such as GDCS have not been completed. Therefore, the inclusion of GDCS is beyond the level of detail provided in DCD Tier 2. The basis for including or excluding GDCS from the list of systems to restore RPV water level, would be documented in an ESBWR EPG/SAG Basis document.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-21:

Describe the Alternate Shutdown Cooling DCD Section 18A.3, page 18A-10, RC/P-2 The override in the middle of the page discusses initiation of Alternate Shutdown Cooling Procedure. Describe the Alternate Shutdown Cooling procedure.

GE Response:

An override describing an Alternate Shutdown Cooling Procedure was created in the ESBWR EPG, because original BWROG EPG/SAG Rev. 2 step RC/P-4 was modified for the case of if shutdown cooling could not be established. Since the RWCU/SDC system can operate over a full range of reactor pressures, an alternate shutdown cooling procedure concept was introduced and to be used if necessary. The basis for including or excluding an Alternate Shutdown Procedure, in the EPG Reactor Pressure Control strategy would be documented in an ESBWR EPG/SAG Basis document. An actual Alternate Shutdown Cooling procedure, if generated, would become an EOP emergency support procedure.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-22:

Update Table 18B-1 to list the difference regarding the automatic initiation of ADS DCD Section 18A, Page 18A-11 ESBWR Step RC/Q-3 is equivalent to step RC-Q-6 of BWROG EPG/SAG, Rev.2 and includes ADS inhibit. But ESBWR Step RC/Q-3 does not include the statement "and prevent automatic initiation of ADS," which is included in Step RL-Q-6 of the BWR06 EPG/SAG, Rev. 2. This difference is not listed in Table 18B-1, page 18B-10. Add the difference in the Table.

GE Response:

GE concurs that differences between BWROG EPG/SAG Rev. 2 and the ESBWR EPG/SAGs will be documented in an ESBWR EPG/SAG Basis document.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-23:

Why Minimum Steam Cooling Pressure is presented in step C2-1.3?DCD Section 18A.8, page 18A-30, Contingency #2 and #3 Step C2-1.3 used Minimum Steam Cooling Pressure. However, in DCD Section 18B.2.2, it is stated that steam cooling is not appropriate for the ESBWR. Why is Minimum Steam Cooling Pressure presented in this step?

GE Response:

The BWROG Steam Cooling strategy, employed to prolong the time that adequate core cooling is assured with no RPV injection source available, is not used in the ESBWR design. From a PRA standpoint, there does not appear to be a significant benefit without further analysis. The basis to include or exclude a Steam Cooling strategy will be documented in an ESBWR EPG/SAG Basis document.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-24:

If the RPV level decreases to Level 1, can the ADS and GDCS activate? DCD Section 18A.9, Page 18A-34, Contingency # 3. Step C3-3 States: "Lower RPV water level, irrespective of any reactor power or RPV water level oscillations, by terminating and preventing all injection into the RPV except from boron injection systems and CRD purge flow, defeating interlocks if necessary, until either: "ADS inhibit is in effect when the RPV level reaches L2 in combination with APRM upscale. If the RPV level decreases to Level 1, can the ADS and GDCS activate? If the ADS and GDCS are activated how would the operators prevent GDCS from injecting?

GE Response:

The analyses to determine ADS and GDCS parameters and methods that are prescribed by the EPG/SAG have not been completed. Therefore, the inclusion of GDCS is beyond the level of detail provided in DCD Tier 2. The basis for a strategy for GDCS operations during EPG conditions will be documented in an ESBWR EPG/SAG Basis document.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3. Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.

NRC RAI 18.9-25:

Provide plans for simulating transients and validating the proposed ESBWR EPG/SAG. Describe the plans for simulating the transients specifically for ESBWR using a ESBWR simulator and for validating the proposed ESBWR EPG/SAG using the ESBWR simulation.

GE Response:

The ESBWR Emergency Operating Procedures (EOPs) and Severe Accident Guidelines (SAGs) are validated against the Part-Task Simulator and Full Scope Simulator that meets ANSI/ANS-3.5-1998, Nuclear Power Plant Simulators for Use in Operator Training and Examination.

The EOP/SAG procedure validation process confirms that the procedures;

- Are consistent with the HSI in terms of controls, displays, alarms, and data processing
- Contains correct references to HSI components
- Are useable
- Function as intended in the integrated HSI design.

DCD Impact:

No impact to DCD Tier 2, Chapter18.

NRC RAI 18.9-26:

Address the reliability of the automatic ADS inhibit function DCD Tier 2, Rev 2, Section 18B.1.4 "ATWS Mitigation Systems," states that "ESBWR has an automatic ADS inhibit feature in contrast to earlier BWRs where manual action is required to inhibit, if needed. In contrast, ESBWR has no manual inhibit feature. "The ADS inhibit function is necessary for ATWS mitigation (DCD Tier 2, Rev 2,Section 15.5.4.3.4, "ATWS Logic and Setpoints"). Since the ESBWR design does not provide manual ADS inhibit capability, please address the reliability of the automatic function. Please address operator actions in the event of failure of the automatic inhibit function (i.e., backup or alternate means).

GE Response:

The reliability of the ADS inhibit function is described in Chapter 19. There are no required human actions during the first 72 hours of an event.

The present design of automatic ADS inhibit function is highly reliable. The decision to automate ADS inhibit during ATWS was based on operator action time studies. For operating plants inhibit was a critical action, just on the edge of what operators could be reliably expected to be performed. Note also in DCD Tier 2, Chapter 7, Subsection 7.8.1.1.2, manual inhibit of the ADS under ATWS conditions is described. The basis for a strategy for ADS operations during EPG conditions will be documented in an ESBWR EPG/SAG Basis document.

DCD Impact:

No impact to DCD Tier 2, Chapter18. Appendices A, B and C are not appropriate for inclusion in Chapter 18 and were removed from DCD Tier 2, Chapter 18 Revision 3.

Appendix A "Summary of Emergency Operating Procedures and Severe Accident Management Guidelines" was added to the NEDO-33274 Rev. 2, Procedures Development Implementation Plan to address EPGs/SAGs.