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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 79 Related to ESBWR Design Certification Application – Reliability Assurance Program – RAI Numbers 17.4-13 through 17.4-16**

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

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

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-393, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 79 Related to ESBWR Design Certification Application,* October 11, 2006

Enclosure:

1. MFN 06-486 – Response to Portion of NRC Request for Additional Information Letter No. 79 Related to ESBWR Design Certification Application – Reliability Assurance Program – RAI Numbers 17.4-13 through 17.4-16

cc: AE Cubbage USNRC (with enclosures)
GB Stramback GE/San Jose (with enclosures)
eDRF 0061-5451

ENCLOSURE 1

MFN 06-486

Response to Portion of NRC Request for

Additional Information Letter No. 79

Related to ESBWR Design Certification Application

Reliability Assurance Program

RAI Numbers 17.4-13 through 17.4-16

NRC RAI 17.4-13

SECY 95-132, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety System (RTNSS) in Passive Plant Designs (SECY 94-084)," Item E, Reliability Assurance Program, states in part, that "the NRC disapproved the staff's proposal that an O-RAP be continued for the life of the COL. The staff should assure that the objectives of O-RAP are incorporated into existing programs for maintenance and quality assurance." Thus, in SECY 95-132 and SRP Section 17.4, Revision 0, the staff incorporated the O-RAP process into existing programs to implement the maintenance rule and the quality assurance program.

The applicant should state in DCD Tier 2, Section 17.4.9, "Operational Reliability Assurance Activities," whether, and if so, how, O-RAP process will be implemented through existing operational programs, including the maintenance and surveillance program(s), the quality assurance program, and the Maintenance Rule program. The applicant should also add a reference to SECY 95-132 in DCD Tier 2, Section 17.4.14,References.

GE Response:

Design Control Document Tier 2, Section 17.4.9 will be revised to state that the O-RAP will be implemented through the COL holder's maintenance and surveillance programs, quality assurance program, and Maintenance Rule program. Also, a reference to SECY 95-132 will be added to Section 17.4.14, "References."

DCD Impact

DCD Tier 2, Section 17.4 will be revised in Revision 3 as noted in the response to RAI 17.4-13.

NRC RAI 17.4-14

The applicant should include reliability monitoring information collected from Technical Specification (TS) surveillance test data, from other relevant testing and from industry Operating Data (IOE) for safety-related equipment as available. This information can be used in determining ORAP/Maintenance Rule reliability goals or performance criteria. The applicant should also include similar reliability data for RTNSS structures, systems, or components (SSCs) which are within the scope of the RAP as available. This information can also be collected from reliability estimates used in basic event fault trees for risk-significant (i.e., high-safety-significant) systems and components modeled in ESBWR PRA. A reference to these sources for reliability estimates and monitoring information should be added to DCD Tier 2, Section 17.4.9, "Operational Reliability Assurance Activities."

GE Response:

A statement regarding the use of TS surveillance test data and industry operating data for safety-related equipment, when available, as sources for reliability estimates and monitoring information will be added to DCD Tier 2, Section 17.4.9, "Operational Reliability Assurance Activities."

DCD Impact

DCD Tier 2, Section 17.4 will be revised in Revision 3 as noted in the response to RAI 17.4-14.

NRC RAI 17.4-15

The staff determined that a COL applicant referencing the ESBWR should reference the guidance documents used to implement its O-RAP in DCD Tier 2, Section 17.4.9, "Operational Reliability Assurance Activities." For the Maintenance Rule element of the O-RAP, these documents include RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, "which endorses NUMARC 93-01, "Industry Guidance for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." In addition, if still effective at the time of the COL application, RG 1.182, "Assessing and Managing the Risk Before Maintenance at Nuclear Power Plants," which endorsed the revised NUMARC 93-01, Section 11,"Assessment of Risk Resulting from the Performance of Maintenance Activities, "should be referenced. This information should also be added to DCD Tier 2,Section 17.4.14, 'References."

GE Response:

RG 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," NUMARC 93-01, "Industry Guidance for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," RG 1.182, "Assessing and Managing the Risk Before Maintenance at Nuclear Power Plants," the revised NUMARC 93-01, Section 11, "Assessment of Risk Resulting from the Performance of Maintenance Activities, "will be referenced in DCD Tier 2, Section 17.4.9.

DCD Impact

DCD Tier 2, Section 17.4 will be revised in Revision 3 as noted in the response to RAI 17.4-15.

NRC RAI 17.4-16

The staff determined that the following COL action items should be added to DCD Tier 2, Section 17.4.13:

- *The COL applicant is responsible for integrating the objectives of O-RAP into the QA program developed to implement 10 CFR 50, Appendix B. This program should also address failures of non-safety-related, risk-significant SSCs that result from design and operational errors in accordance with SECY 95-132, Item E.*
- *The COL applicant is responsible for performing the tasks necessary to maintain the reliability of risk-significant SSCs as identified in the D-RAP. The applicant may cite, for example, cost-effective maintenance enhancements, such as condition monitoring and using condition-directed maintenance as well as time directed or planned periodic maintenance.*
- *The COL applicant's Maintenance Rule (10 CFR 50.65) program is required for monitoring the effectiveness of the COL applicant's maintenance activities needed for operational reliability assurance. As such it is an important element of O-RAP.*
- *If the COL applicant proposes to use its Maintenance Rule program in O-RAP implementation, the SSCs in the scope of the Maintenance Rule program that are classified as high-safety-significant (HSS) should encompass all SSCs in the scope of the D-RAP.*
- *In addition to the specific tasks necessary to maintain SSC reliability at its required level cited above, the O-RAP activities should include:*
  - Reliability data base - Historical data on equipment performance as available. The compilation and reduction of this data provides the plant with source of component reliability information. Data used in PRA fault-tree analyses may also be a viable initial source.
  - Surveillance and testing-establishes the level of performance or condition being maintained for SSCs within the scope of the RAP and identifies declining trends in between surveillances prior to performance or condition degrading to unacceptable levels undetected (or failure) to the extent possible.
  -Maintenance Plan - This plan describes the nature and frequency of maintenance activities to be performed on plant equipment. The plan includes the selected SSCs identified in the D-RAP.

GE Response:

COL Information Item 17.4-2:
The Combined License holder is responsible for integrating the objectives of O-RAP into the Quality Assurance Program developed to implement 10 CFR 50, Appendix B. This program will also address failures of non-safety-related, risk-significant SSCs that result from design and operational errors in accordance with SECY 95-132, Item E.

COL Information Item 17.4-3:
The Combined License holder is responsible for performing the tasks necessary to maintain the reliability of risk-significant SSCs as identified in the D-RAP. The applicant may cite, for example, cost-effective maintenance enhancements, such as condition

monitoring and using condition-directed maintenance as well as time directed or planned periodic maintenance.

COL Information Item 17.4-4:
The Combined License holder's Maintenance Rule (10 CFR 50.65) program is required for monitoring the effectiveness of the COL applicant's maintenance activities needed for operational reliability assurance.

COL Information Item 17.4-5:
The Combined License holder shall consider all SSCs that are in the scope of the D-RAP as high-safety-significant (HSS) within the scope of the Maintenance Rule program, or provide Expert Panel justification for any exceptions.

Note: The Expert Panel, in accordance with common industry practice and guidance in NUMARC 93-01, develops the final list of risk significant SSCs from various inputs, including the PRA risk importance calculations and industry operating experience. It is prudent for the Expert Panel to include all SSCs that are in the scope of the D-RAP to be within the scope of the Maintenance Rule. However, risk importance calculations and other factors may change the risk significance of certain SSCs that were previously determined to be risk-significant within the bounds of the D-RAP. Therefore, exceptions between the D-RAP and O-RAP risk significance may exist, and should be evaluated and justified by the Expert Panel.

COL Information Item 17.4-6:
The Combined License holder O-RAP activities should include:

- Reliability Database - Historical data on equipment performance as available. The compilation and reduction of this data provides the plant with source of component reliability information. Data used in PRA fault-tree analyses may also be a viable initial source.
- Surveillance and Testing - Establishes the level of performance or condition being maintained for SSCs within the scope of the RAP and identifies declining trends in between surveillances prior to performance or condition degrading to unacceptable levels undetected (or failure) to the extent possible.
- Maintenance Plan - This plan describes the nature and frequency of maintenance activities to be performed on plant equipment. The plan includes the selected SSCs identified in the D-RAP.

COL Information Items 17.4-1 through 17.4-6 shall be available prior to fuel load for NRC inspection to confirm that they meet NRC regulations and guidance.

DCD Impact:

DCD Tier 2, Section 17.4 will be revised in Revision 3 as noted in the response to RAI 17.4-16.

developing its O-RAP to assure that such SSCs function reliably when challenged throughout plant life with reliability consistent with that assumed in the PRA.

17.4.5 GE Organization for D-RAP

The GE ESBWR Engineering Section is an integrated design and engineering organization that is responsible for formulating and implementing the D-RAP. The Manager, ESBWR Engineering is responsible for the design and licensing of the ESBWR, and for development of the D-RAP. The COL applicant is responsible for implementing the operations phase of the RAP.

The ESBWR Engineering organization is responsible for the design analysis and PRA engineering that is necessary to support the development of the D-RAP. ~~PRA personnel and design engineering personnel report to the Manager of ESBWR Engineering. As such, the~~ PRA personnel are directly involved with the design organization and keep the design staff cognizant of risk-significant items, program needs, and project status. PRA personnel participate in the design change control process, which includes providing D-RAP related inputs in the design process.

GE ESBWR engineering design procedural controls are applied to the D-RAP. Specific procedures provide guidance on the design process, control of design changes, and storage and retrieval controls.

The design control procedure defines the process for performing, documenting, and verifying design activities. This includes developing or modifying the design of systems, engineering evaluations, analyses, calculations and document preparation, (e.g., specifications, drawings, reports.)

The procedure for design change control defines the process for evaluating design changes in engineering controlled documents to ensure that the total effect is considered before a change is approved, and the affected documents are identified and changed accordingly. The procedure identifies interfaces and organizations responsible for these interfaces, including PRA review. If a proposed change could affect the safety, availability or capacity factor of the ESBWR plant, system reliability is analyzed.

Several design control procedures provide guidance for developing a high quality process for reliability assurance. The documentation procedure establishes the requirements and responsibilities for the preparation, approval, and issue of documents controlled by the engineering design organizations. The quality assurance records procedure provides requirements for quality assurance record retention. The self-assessment, corrective action and audits procedure specify the responsibilities for performing self-assessments; internal audits of the engineering organization; and prompt identification, documentation, and corrective actions on conditions that are adverse to quality.

In addition to the standard engineering design processes and quality controls, specific guidance is used to define and implement an effective RAP. Reference 17.4-1 describes the RAP processes for identifying and prioritizing risk significance, implementing reliability assurance strategies, and monitoring program effectiveness. It is used to incorporate reliability assurance into each aspect of the design, construction, testing, and operation of the ESBWR.

engineering controlled documents to ensure that the total effect is considered before a change is approved, and the affected documents are identified and changed accordingly.

A design reliability assessment is a process in which the design engineer builds quality and reliability into the SSC, while ensuring that the basis for SSC design is properly modeled in the PRA. Due to the preliminary nature of the PRA model during the design phase, the model relies on generic information, bounding assumptions, or design requirements as a basis for model development. This design assessment can be performed for changes that occur during the plant design phase, as well as during normal plant operations. It is a systematic method to evaluate the proposed design details with respect to PRA insights. The assessment considers reliability concepts, such as redundancy, diversity, human factors, spatial interactions, external events, etc., to enhance the system design, and considers PRA insights and assumptions. If the assessment reveals that the proposed design could conflict with results and insights calculated in the PRA, or could cause significant unavailability of a safety function, then a design change is pursued.

Proposed design changes are processed by the design change control procedure, which requires PRA review. If a design change affects the PRA model, then it is revised in accordance with the PRA update process described in the PRA procedure.

17.4.8 Defining Failure Modes

The determination of dominant failure modes of risk-significant SSCs includes historical information, analytical models and existing requirements. Many BWR systems and components have compiled a significant historical record, so an evaluation of that record is performed. For those SSCs for which there is not an adequate historical basis to identify critical failure modes, an analytical approach is necessary.

Inputs may include PRA importance analysis, root cause analysis, failure modes and effects analysis, and review of operating experience. In addition, equipment performance information, including vendor manuals, ASME Section XI, technical specifications, Regulatory Treatment of Non-Safety Systems (RTNSS), and other regulatory requirements are reviewed to identify important safety functions.

The design engineer analyzes this information to identify dominant failure modes, such as single failures, latent failures not detected by routine monitoring, common cause failures, or failures that could cascade into more significant safety functional failures.

17.4.9 Operational Reliability Assurance Activities

Once the dominant failure modes are determined for risk-significant SSCs, an assessment is performed to identify O-RAP activities that assure acceptable performance during plant life. Such activities may consist of periodic surveillance inspections or tests, monitoring of SSC performance, and/or periodic preventive maintenance. Some SSCs may require a combination of activities to assure that their performance is consistent with that assumed in the PRA.

The O-RAP will be implemented through the COL applicant or holder's maintenance and surveillance programs, quality assurance program, and Maintenance Rule program. Section 17.4.13 lists specific COL Action Items pertaining to implementing the O-RAP. Guidance documents used to implement the O-RAP include: Reg Guide 1.160, "Monitoring the

Effectiveness of Maintenance at Nuclear Power Plants," NUMARC 93-01, "Industry Guidance for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," and, if still effective at the time of the COL application, RG 1.182, "Assessing and Managing the Risk Before Maintenance at Nuclear Power Plants."

Periodic testing of SSCs may include startup of standby systems, surveillance testing of instrument circuits to assure that they respond to appropriate signals, and inspection of SSCs (such as tanks and pipes) to show that they are available to perform as designed. Performance monitoring, including condition monitoring, can consist of measurement of output (such as pump flow rate or heat exchanger temperatures), measurement of magnitude of an important variable (such as vibration or temperature), and testing for abnormal conditions (such as oil degradation or local hot spots).

Periodic preventive maintenance is an activity performed at regular intervals to preclude problems that could occur before the next preventive maintenance (PM) interval. This could be regular oil changes, replacement of seals and gaskets, or refurbishment of equipment subject to wear or age related degradation.

Planned maintenance activities will be integrated with the regular operating plans so that they do not disrupt normal operation. Maintenance that is performed more frequently than refueling outages must be planned so as to not disrupt operation or be likely to cause reactor scram, engineered safety feature actuation or AOOs. Maintenance planned for performance during refueling outages must be conducted in such a way that it has little or no effect on plant safety, outage length or other maintenance work.

Reliability monitoring information is collected from sources such as Technical Specification surveillance test data and industry operating data, if applicable. Similar reliability data is collected for RTNSS SSCs which are within the scope of the O-RAP. Reliability estimates are also developed from basic event fault trees for risk-significant (i.e., high-safety-significant) systems and components modeled in ESBWR PRA.

The COL ~~applicant~~ holder shall ~~provide~~ have a complete O-RAP, ~~to be reviewed~~available for review by the NRC. See Subsection 17.4.13 for COL applicant information.

17.4.10 Owner/Operator's Reliability Assurance Program

~~The~~The O-RAP is prepared and implemented by the ESBWR owner/operator, and uses the information provided by GE. This information should help the owner/operator determine activities that should be included in the O-RAP. ~~Examples of elements that might be~~Elements included in an O-RAP are as follows:

- **Problem Prioritization:** Identification, for each of the risk-significant SSCs, of the importance of that item as a contributor to its system unavailability and assignment of priorities to problems that are detected with such equipment.
- **Corrective Action Implementation:** Carrying out identified corrective action on risk-significant equipment to restore equipment to its intended function in such a way that plant safety is not compromised during work.

- **Plant Aging:** Some of the risk-significant equipment is expected to undergo age related degradation and require equipment replacement or refurbishment.
- **Programmatic Interfaces:** Reliability assurance interfaces related to the work of the several organizations and personnel groups working on risk-significant SSCs.
- **Maintenance Rule Program:** A procedure is developed by the COL holder to implement a Maintenance Rule program with the following scope:
  - Selection of SSCs for inclusion.
  - Establishing and applying safety significant criteria.
  - Setting performance monitoring criteria.
  - Trending the performance of applicable SSCs to demonstrate the effectiveness of maintenance activities.
  - Taking corrective action when SSC performance degrades.
  - Periodically assessing program performance.
  - Identifying documentation that is required to support the program.
  - Maintenance Rule (a)(4) assessment of real-time risk profile

The plant owner/operator's O-RAP addresses the interfaces with construction, startup testing, operations, maintenance, engineering, safety, licensing, quality assurance and procurement of initial and replacement equipment.

17.4.11 D-RAP Implementation

The following example is based upon design and PRA details of the Isolation Condenser System (ICS) that were available during the design phase. It is used for illustration purposes only, and therefore is not updated if design or PRA details of the ICS change.

17.4.11.1 Example: Isolation Condenser System

The ICS is used as an example to demonstrate how the reliability assurance processes are used to identify, analyze, and develop effective reliability assurance strategies. ICS is a safety-related system that removes reactor decay heat following events involving reactor shutdown and containment isolation. It also prevents unnecessary reactor depressurization, and precludes the need for operation of other Engineered Safety Features to bring the reactor to a safe and stable condition. In the event of a LOCA, ICS provides additional liquid inventory by opening the condensate return valves to actuate the system. ICS also assists with initial depressurization of the reactor before ADS in event of loss of feed water, so that the automatic depressurization can take place from a lower pressure.

The ICS consists of four totally independent trains, each containing an isolation condenser that condenses steam on the tube side and transfers heat to the IC/PCC pool, which is vented to the atmosphere. The isolation condensers are connected by piping to the reactor pressure vessel, and are placed at an elevation above the source of steam (i.e., vessel). When the steam is condensed, the condensate is returned to the vessel via a condensate return line. A detailed description of ICS is located in DCD Tier 2 Subsection 5.4.6.

17.4.12 Glossary of Terms

Design Reliability Assurance Program — Performed by the plant designer to assure the plant is designed so that it can be operated and maintained in such a way that the reliability assumptions of the probabilistic risk assessment apply throughout plant life.

Fussell-Vesely Importance — A measure of the component contribution to core damage frequency. Numerically, the percentage contribution of the component to CDF.

Owner/Operator — The utility or other organization that owns and operates the ESBWR following construction.

Operational Reliability Assurance Program — Performed by the plant owner/operator to assure the plant is operated and maintained safely and in such a way that the reliability assumptions of the PRA apply throughout plant life.

Regulatory Treatment of Non-Safety Systems (RTNSS) – A process to determine whether regulatory oversight for certain nonsafety-related systems is needed, and to determine an appropriate level of regulatory oversight commensurate with their risk significance.

Risk-Significant — Those structures, systems and components that are identified as contributing significantly to the core damage frequency.

17.4.13 COL Information

17.4.13.1 ~~Provision for O-RAP~~COL Information Item 17.4-1

The COL ~~applicant~~/holder will ~~provide~~ have a complete O-RAP, available for review ~~to be reviewed~~ by the NRC (Subsection 17.4.9).

17.4.13.2 COL Information Item 17.4-2

The Combined License holder is responsible for integrating the objectives of O-RAP into the Quality Assurance Program developed to implement 10 CFR 50, Appendix B. This program will also address failures of non-safety-related, risk-significant SSCs that result from design and operational errors in accordance with SECY 95-132, Item E.

17.4.13.3 COL Information Item 17.4-3

The Combined License holder is responsible for performing the tasks necessary to maintain the reliability of risk-significant SSCs as identified in the D-RAP. The applicant may cite, for example, cost-effective maintenance enhancements, such as condition monitoring and using condition-directed maintenance as well as time directed or planned periodic maintenance.

17.4.13.4 COL Information Item 17.4-4

The Combined License holder's Maintenance Rule (10 CFR 50.65) program is required for monitoring the effectiveness of the COL applicant's maintenance activities needed for operational reliability assurance.

17.4.13.5 COL Information Item 17.4-5

The Combined License holder shall consider all SSCs that are in the scope of the D-RAP as high-safety-significant (HSS) within the scope of the Maintenance Rule program, or provide Expert Panel justification for any exceptions.

17.4.13.6 COL Information Item 17.4-6

The Combined License holder O-RAP activities should include:

- Reliability Database - Historical data on equipment performance as available. The compilation and reduction of this data provides the plant with source of component reliability information. Data used in PRA fault-tree analyses may also be a viable initial source.
- Surveillance and Testing - Establishes the level of performance or condition being maintained for SSCs within the scope of the RAP and identifies declining trends in between surveillances prior to performance or condition degrading to unacceptable levels undetected (or failure) to the extent possible.
- Maintenance Plan - This plan describes the nature and frequency of maintenance activities to be performed on plant equipment. The plan includes the selected SSCs identified in the D-RAP.

COL Information Items 17.4-1 through 17.4-6 shall be available prior to fuel load for NRC inspection to confirm that they meet NRC regulations and guidance.

17.4.14 References

17.4-1 GE Nuclear Energy, "Reliability Assurance Program Plan", NEDO-33289, October 2006~~.~~

17.4-2 US Nuclear Regulatory Commission, "Policy and Technical Issues Associated With the Regulatory Treatment of Non-Safety Systems (RTNSS) in Passive Plant Designs (SECY-94-084)", SECY-95-132, May 1995

17.4-3 US Nuclear Regulatory Commission, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," Reg Guide 1.160, March 1997

17.4-4 US Nuclear Regulatory Commission, "Assessing and Managing the Risk Before Maintenance at Nuclear Power Plants," Reg Guide 1.182, May 2000

17.4-5 NEI, "Industry Guidance for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," NUMARC 93-01 April 1996