

January 31, 2006

Mr. David Hinds, Manager, ESBWR
General Electric Company
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Wilmington, NC 28402-0780

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 6 RELATED TO
ESBWR DESIGN CERTIFICATION APPLICATION

Dear Mr. Hinds:

By letter dated August 24, 2005, General Electric Company (GE) submitted an application for final design approval and standard design certification of the economic simplified boiling water reactor (ESBWR) standard plant design pursuant to 10 CFR Part 52. The Nuclear Regulatory Commission (NRC) staff is performing a detailed review of this application to enable the staff to reach a conclusion on the safety of the proposed design.

The NRC staff has identified that additional information is needed to continue portions of the review. The staff's request for additional information (RAI) is contained in the enclosure to this letter. This RAI concerns the Instrumentation and Control Systems, specifically Chapters 7 and 9 of Tier 2 of the ESBWR design control document (DCD) and Tier 1 of the DCD. This RAI was sent to you via electronic mail on December 6, 2005, and was discussed with you during a telecon on December 14, 2005. On January 17, 2006, you agreed to respond to these RAIs on the following schedule:

February 28, 2006: 7.2-3, 14.3-2, 14.3-3;
March 10, 2006: 7.7-1, 9.5-1;
March 31, 2006: 7.1-1, 7.1-2, 7.1-3, 7.1-5, 7.4-1;
April 6, 2006: 7.1-4, 7.2-2, 7.8-1;
April 28, 2006: 7.0-1, 7.0-2, 7.2-1, 7.2-4, 7.9-1, 9.5-2, 14.3-4;
June 30, 2006: 14.3-1.

D. Hinds

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If you have any questions or comments concerning this matter, you may contact me at (301) 415-42875 or aec@nrc.gov, Lauren Quinones at (301) 415-2007 or lnq@nrc.gov, or Lawrence Rossbach at (301) 415-2863 or lwr@nrc.gov.

Sincerely,

/RA L. Rossbach for:/

Amy E. Cubbage, Senior Project Manager
New Reactor Licensing Branch
Division of New Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 52-0010

Enclosure: As stated

cc: See next page

D. Hinds

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Request for Additional Information - ESBWR DCD Chapter 7

RAI number	Reviewer	Question Summary	Full Text
7.1-1	Beacom / Li	Describe the resolution of USIs and GSIs applicable to I&C systems. (BTP HICB-16, Sect. B.3.2)	With respect to level of detail for design certification application under 10 CFR Part 52, Section B.3.2 of BTP HICB-16 describes material that should be provided in addition to that identified by Reg. Guide 1.70. In DCD Section 7.1, describe the resolution of unresolved and generic safety issues applicable to the instrumentation and control (I&C) systems.
7.1-2	Beacom/ Li	Identify and describe the validation of innovative means of accomplishing I&C system safety functions. (BTP HICB-16, Sect. B.3.2)	With respect to level of detail for design certification application under 10 CFR Part 52, Section B.3.2 of BTP HICB-16 describes material that should be provided in addition to that identified by Reg. Guide 1.70. In DCD Section 7.1, identify and describe the validation of innovative means of accomplishing I&C system safety functions.
7.1-3	Beacom/ Li	Describe the computer system development process when the application proposes using digital I&C systems. (BTP HICB-16, Sect. B.3.2)	With respect to level of detail for design certification application under 10 CFR Part 52, Section B.3.2 of BTP HICB-16 describes material that should be provided in addition to that identified by Reg. Guide 1.70. In DCD Section 7.1, describe the computer system development process when the application proposes using digital I&C systems.
7.1-4	Beacom/ Li	Provide a defense-in-depth analysis for the I&C system design. (BTP HICB-16, Sect. B.3.2)	With respect to level of detail for design certification application under 10 CFR Part 52, Section B.3.2 of BTP HICB-16 describes material that should be provided in addition to that identified by Reg. Guide 1.70. In DCD Section 7.1, provide a defense-in-depth analysis for the I&C system design. BTP HICB-19 describes the characteristics of such analyses.

RAI number	Reviewer	Question Summary	Full Text
7.1-5	Beacom / Li	Demonstrate how the ESBWR safety-related protection systems meet the requirements of IEEE Std. 603-1991 and correction sheet dated January 30, 1995.	Demonstrate how the ESBWR safety-related protection systems meet the requirements of IEEE Std. 603-1991 and correction sheet dated January 30, 1995. The staff needs detailed information how these protection systems meet each of the sections of IEEE Std. 603-1991 with applicable correction sheet.

RAI number	Reviewer	Question Summary	Full Text
7.2-1	Beacom / Li	Provide the ESBWR safety system design basis as outlined in IEEE Std. 7-4.3.2.	<p>In order for staff to confirm the ESBWR is in full compliance with IEEE Std. 7-4.3.2 requirements, please provide the ESBWR safety system design basis as outlined in IEEE Std. 7-4.3.2. (Note: The Reg. Guide 1.152, Rev. 2 which endorses IEEE Std. 7-4.3.2-2003 and includes requirements for cyber security is in the process of being issued. This latest version of RG 1.152 will be used in the review of ESBWR.) Demonstrate each requirement per the standard and beyond IEEE Std. 603 is met per the following items identified in IEEE Std. 7-4.3.2:</p> <p>5.3 Quality - The following requirements are necessary in order to meet the quality criterion:</p> <ul style="list-style-type: none"> a. Software development including Software quality metrics b. Software tools c. Verification and validation d. Independent V&V (IV&V) requirements e. Software configuration management f. Software project risk management <p>5.4 Equipment qualification - Equipment qualification testing shall be performed with the computer functioning with software and diagnostics that are representative of those used in the actual operation. This includes, as appropriate, exercising and monitoring the memory, the CPU, inputs and outputs, display functions, diagnostic, associated components, communication paths, and interfaces. Testing shall demonstrate that the design basis performance requirements have been met.</p>

RAI number	Reviewer	Question Summary	Full Text
7.2-1 (cont.)	Beacom / Li	Provide the ESBWR safety system design basis as outlined in IEEE Std. 7-4.3.2. (Continued)	<p>5.5 System Integrity - In addition to the requirements of IEEE Std. 603, the design for computer integrity, test and calibration and fault detection and self-diagnostics shall be addressed.</p> <p>5.6 Independence - Data communication between safety channels or between safety and nonsafety systems shall not inhibit the performance of the safety function. Identify barrier requirements to provide adequate confidence that the nonsafety portions cannot interfere with performance of the safety portion of the software or firmware.</p> <p>5.11 Identification - The following identification requirements specific to software systems shall be met; a) Firmware and software identification shall be used to assure the correct software is installed in the correct hardware component. b) Means included in the software such that the identification may be retrieved from the firmware using software maintenance tools. c) Physical identification requirements per IEEE 603-1998.</p> <p>5.15 Reliability - In addition to requirements of IEEE 603-1998, when reliability goals are identified, the proof of meeting the goals shall include software. (Note: As stated in RG 1.152 and SRP Chapter 7, the NRC staff does not endorse the concept of quantitative reliability goals as a sole means of meeting the requirements for reliability of safety systems. Quantitative reliability determination, using a combination of analysis, testing, and operating experience, can provide an added level of confidence in the reliable performance of safety I&C systems.)</p>

RAI number	Reviewer	Question Summary	Full Text
7.2-2	Beacom / Li	Provide detailed interface information for each of the systems which interface with the reactor protection system (RPS).	<p>Please provide detailed interface information for each of these systems, listed in Section 7.2.1.2.1, including logic diagrams to indicate signal paths, physical, electrical, and communication independence, channel separation, isolation between safety-related and nonsafety-related portions of the various systems as listed in the DCD:</p> <ul style="list-style-type: none"> C Essential Distributed Control and Information System (E-DCIS) C Safety System Logic and Control (SSLC) C Neutron Monitoring System (NMS) C Nuclear Boiler System (NBS) C Control Rod Drive System (CRDS) C Containment Monitoring System C Suppression Pool Temperature Monitoring (SPTM) function C Rod Control and Information System (RC&IS) C Leak Detection and Isolation System (LDIS) C Isolation Condenser System (ICS) C Steam Bypass and Pressure Control (SBPC) C Plant Automation System (PAS) C Main Control Room Panel C Non-Essential DCIS (NE-DCIS) C Uninterruptible AC Power Supply C Instrumentation and Control Power Supply C DC Power Supply C Raceway System
7.2-3	Beacom / Li	Provide detailed information and design basis on the RPS bypass provisions.	The DCD states that the RPS includes two possible operator controlled bypasses. These are independently controlled by separate fiber optic "joystick" switches. Provide detailed information and the design basis of these bypass provisions.

RAI number	Reviewer	Question Summary	Full Text
7.2-4	Beacom / Li	Provide information related to each system, per the criteria identified by BTP HICB-16, Section B.3.3.	<p>With respect to level of detail for design certification application under 10 CFR Part 52, Section B.3.3 of BTP HICB-16 describes material that should be provided in addition to the material identified by Reg. Guide 1.70. Please provide the following: (1) system features provided to meet the requirements of 10 CFR 50.34(f), "TMI related requirements," (2) a description of the overall system architecture and the functional block diagrams for each system, (3) the computer-based I&C system characteristics that the self-diagnostics and on-line testing will detect to indicate computer system failures, (4) the interconnections of test and diagnostics with the system functional hardware and software, and (5) the mechanisms available to modify software in the installed systems. The material identified above should be discussed in sufficient detail to allow staff determination that the design will meet requirements related to postulated single failures, common-mode failures, and appropriate signal isolation. Additional detail for the items requested above is provided by BTP HICB16, Section B.3.3.</p>
7.4-1	Beacom / Li	Provide remote shutdown system (RSS) visual display unit (VDU) control capabilities and demonstrate separation/ isolation between safety and nonsafety.	<p>The DCD states that the remote shutdown system (RSS) has two redundant and independent panels, each contain a safety related digital visual display unit (VDU), and a nonsafety related VDU. From these VDUs it is possible to control both safety-related and nonsafety-related systems. Please provide detailed information of RSS control capabilities and provide drawings to demonstrate the separation/isolation between safety and nonsafety systems. Also provide the design basis to qualify the VDU for safety related application.</p>

RAI number	Reviewer	Question Summary	Full Text
7.7-1	Beacom / Li	Address concerns and provide detailed information for the major design considerations identified in SRP 7.7, Control Systems, for each of the control systems NOT listed in Section 7.7.0 of the DCD.	<p>Address concerns of SRP Section 7.7, Section II. Acceptance Criteria, and provide detailed information for the major design considerations identified in Section III of SRP 7.7, for each of the control systems NOT listed in 7.7.0 of the DCD. Those Control Systems are:</p> <ul style="list-style-type: none"> C Containment / drywall cooling system controls C Heating, ventilating, and air conditioning controls C Atmospheric control system controls C Reactor water cleanup system controls C Service water system controls C Chilled water system controls C Make-up water system controls C Instrument air system controls
7.8-1	Beacom / Li	Describe diverse I&C system characteristics and which accidents (refer to DCD Chapter 15 analyses) are covered as the backup protection to the primary protection system.	In DCD section 7.8, describe the diverse I&C system characteristics such as diverse hardware and software, different designer, diverse actuation methods, different power source etc. The DCD also should identify which accidents (refer to DCD Chapter 15 analyses) are covered by the diverse I&C systems as the backup protection to the primary protection system (systems described in DCD 7.2 and 7.3).

RAI number	Reviewer	Question Summary	Full Text
7.9-1	Beacom / Li	Provide sufficient detail of the design of the Essential Distributed Control and Information System (E-DCIS).	<p>In DCD section 7.9, provide sufficient detail of the design of the Essential Distributed Control and Information System (E-DCIS). Major design considerations include:</p> <ul style="list-style-type: none"> C Quality of components and modules C Software quality C Performance requirement C Reliability C Control of access C Single failure criterion C Independence C Failure modes C System testing and inoperable surveillance C EMI/RFI susceptibility C Defense-in-depth and diversity analysis C Exposure to seismic hazard

RAI number	Reviewer	Question Summary	Full Text
7.0-1	Beacom / Li	Confirmation that development of software for safety system functions within RPS and SSLC conforms to guidance of BTP HICB-14. Provide the software lifecycle process.	<p>The DCD states that development of software for the safety system functions within RPS and SSLC conforms to the guidance of BTP HICB-14. DCD Section 7B listed the following software development documents:</p> <ul style="list-style-type: none"> CSoftware Quality Assurance CSoftware Management Plan CSoftware Development Project Plan CSoftware Configuration Management Plan CVerification and Validation Plan CSoftware Safety Plan (SSP) CSoftware Test Plan (SVTP) COperations and Maintenance Manual <p>Three of these documents have been submitted for review: the Software Management Plan, Software Development Plan and Software Configuration Management Plan. The staff's acceptance of software for safety system functions is based on (1) confirmation that the software was developed in accordance with acceptable software development plans, (2) evidence that the plans were followed in an acceptable software life cycle, and (3) evidence that the process produced acceptable design outputs. The staff will follow the BTP HICB-14 step by step to perform the ESBWR design review. Please submit the Software Test Plan for staff review.</p>

RAI number	Reviewer	Question Summary	Full Text
7.0-2	Beacom / Li	Provide information, sufficiently detailed per 10 CFR 52.47(a)(2), for any ESBWR application software developed by GE for software life-cycle documents	<p>10 CFR 52.47(a)(2) requires that the information submitted for a design certification must include performance requirements and design information sufficiently detailed to permit the preparation of acceptance and inspection requirements by the NRC, and procurement specifications and construction and installation specifications by an applicant. For any ESBWR application software developed by GE, and described in DCD Appendix 7B, please provide the following software life-cycle documents:</p> <p>C Requirements Definition C Integration Plan C Test Plan</p>
9.5-1	Zografos/ Beacom	Provide information regarding the location of secondary power supply systems for non-portable communication equipment.	<p>10 CFR 73.55(e) requires that on site secondary power supply systems for non-portable communication equipment be located in vital areas. The DCD Tier 2 mentions in section 13.6.1 that all vital equipment are located in vital areas to which access is monitored and controlled. However, appropriate clarification is needed, in order to determine if the secondary power supply systems for the non portable communication equipment are considered as vital. Provide information regarding the location of secondary power supply systems for non-portable communication equipment.</p>

RAI number	Reviewer	Question Summary	Full Text
9.5-2	Zografos / Beacom	Regarding the communication systems described in DCD 9.5.2, demonstrate their capability of providing effective communications under conditions described in SRP 9.5.2.	<p>According to the SRP 9.5.2 demonstration of effective communication is required for:</p> <ul style="list-style-type: none"> • Communication among personnel using protective equipment e.g. respirators. • Communication among personnel in vital areas under maximum plant noise levels and worst-case EMI/RFI conditions. <p>Regarding the communication systems described in DCD 9.5.2, demonstrate their capability of providing effective communications under conditions described in SRP 9.5.2.</p>

RAI number	Reviewer	Question Summary	Full Text
14.3-1	Beacom / Li	Provide DCD, Tier 1, ITAAC commitments which include the attributes of the system and its components.	<p>Provide DCD, Tier 1, ITAAC commitments which include the attributes of the system and its components. This would include not only operational tests, currently listed, of the systems and components but also each of these separate ITAACs and their associated design basis accident conditions :</p> <ul style="list-style-type: none"> • Seismic capability of all Category I equipment • SWC, EMI, RFI and ESD capability of Class 1E equipment • Environmental capability of Class 1E equipment including room ambient temperature, humidity, pressure and vibration conditions • Class 1E equipment is powered from its respective Class 1E source • Separation is provided between Class 1E divisions, between Class 1E divisions & non-Class 1E systems. • The system initiates automatic initiation of ESF and / or RPS as identified when plant process signals reach identified limits. • Data communication between safety and nonsafety systems do not inhibit the performance of the safety function. <p>The inspections tests or analyses, for many of the qualification attributes would be confirmation that a report exists and concludes the particular function is provided.</p>

RAI number	Reviewer	Question Summary	Full Text
14.3-2	Beacom / Li	Requirements to be addressed by DCD Tier 1, Section 2.2.1, Rod Control and Information System (RCIS).	<p>DCD Tier 1 Section 2.2.1, Rod Control and Information System, should address but not be limited to the follow requirements:</p> <ul style="list-style-type: none"> C Isolation provision between safety and non-safety systems. (System interface examples, but not limited to: RPS, NMS and CRDS) C The three means to control movements of the control rods (manual, semi-automatic, and automatic) need to be defined in this section. C The test methodology for items 3, 4, 5, 6, 7, 8, and 10 (listed in DCD 2.2.1) proposes simulated signals for verifying the design commitments of the computer-based system. For a computer-based system, the tests should cover the life cycle of the system and include testing of the installed system during initial start-up and full power operation of the plant.
14.3-3	Beacom / Li	Requirements to be addressed by DCD Tier 1, Section 2.2.2, Control Rod Drive System (CRD).	<p>DCD Tier 1 Section 2.2.2, Control Rod Drive System, should address but not be limited to the following requirements:</p> <ul style="list-style-type: none"> C Diversity from hydraulic-powered scram. C Describe the design details and I&C system diversity between the Control Rod Drive system and the Hydraulic-powered Scram system. C Isolation between Class 1E and non Class 1E portions of the system. C Interface between three major elements - (1) the electro-hydraulic fine motion control rod drive (FMCRD) mechanisms, (2) the hydraulic control unit (HCU) assemblies, and (3) the control rod drive hydraulic subsystem (CRDHS).

RAI number	Reviewer	Question Summary	Full Text
14.3-4	Beacom / Li	Requirements to be addressed by DCD Tier 1, Section 2.2.7, Reactor Protection System (RPS).	<p>DCD Tier 1 Section 2.2.7, Reactor Protection System (RPS), should address but not be limited to the following requirements:</p> <ul style="list-style-type: none"> C The RPS can withstand seismic design basis loads without loss of safety function. C The RPS has electrical surge withstand capability (SWC), and can withstand the electromagnetic interference (EMI), radio frequency interference (RFI), and electrostatic discharge (ESD) conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function. C The RPS can withstand the room ambient temperature, humidity, pressure, and mechanical vibration conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function. C The RPS is powered from its Class 1E division. C The RPS provides process signals to the Essential Distributed Control and Information System (E-DCIS) through isolation devices. Data communication between safety and nonsafety systems does not inhibit the performance of the safety function. C The RPS provides the transfer of control capability from the main control room to the remote shutdown panel. C The RPS trip setpoints are determined using a methodology which accounts for loop inaccuracies, and accommodates response time testing. C The RPS hardware and software is developed using a planned life cycle process.

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