

September 23, 2005

Mr. Steven A. Hucik, General Manager
Nuclear Plant Projects
General Electric Company
P.O. Box 780, M/C A-30
Wilmington, NC 28401

SUBJECT: RESULTS OF ACCEPTANCE REVIEW FOR ESBWR DESIGN
CERTIFICATION APPLICATION (TAC NO. MC8168)

Dear Mr. Hucik:

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 purpose of this letter is to inform you of the results of the U.S. Nuclear Regulatory Commission (NRC) staff's acceptance review of the ESBWR design certification application. In an acceptance review, the NRC staff determines whether the application is sufficiently complete to allow the staff to proceed with its detailed technical review.

The NRC staff has reviewed the contents of your application following the requirements for the contents of design certification applications contained in 10 CFR 52.47, and determined that portions of the application are not sufficiently complete for the staff to begin its review of those areas. Accordingly, pursuant to 10 CFR 2.101(a)(4), the application will not be formally accepted for docketing until additional information is provided by GE. The deficient portions of the application that preclude docketing are described in the enclosure. Additional issues that have been identified during the acceptance review will be forwarded to GE in the form of requests for additional information under separate cover.

GE may modify and supplement its application to provide the missing information. The staff will review the additional information GE provides to determine whether the application, as modified or supplemented, is acceptable for docketing. A schedule for the design certification review will be established when the staff can determine, in light of additional information, that the application is acceptable for docketing. Nonetheless, the staff will begin to review those portions of the application that now contain sufficient information for the staff to begin a detailed review. The staff will continue to document ESBWR review activities under Project Number 717, which was established for the conduct of the ESBWR pre-application review.

S. Hucik

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We request that you notify us in writing within 30 days of the issuance of this letter of your plans with respect to your design certification application, including a schedule for addressing the deficiencies identified in the enclosure. If you have any questions on this matter, please contact the NRC Project Manager, Amy Cabbage, at 301-415-2875 or aec@nrc.gov.

Sincerely,

/RA/

William D. Beckner, Program Director
New, Research and Test Reactors Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Project No. 717

Enclosure: As stated

cc w/encl: See next page

S. Hucik

-2-

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*See previous concurrence

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ESBWR

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SPECIFIC DEFICIENCIES IDENTIFIED
IN ACCEPTANCE REVIEW OF
ESBWR DESIGN CERTIFICATION APPLICATION

This enclosure describes the incomplete areas in the application for certification of the ESBWR design that form the basis for the NRC staff's determination that the application cannot be accepted for docketing. The pertinent legal requirements for the contents of a design certification application are as follows:

- 10 CFR 52.47, "Content of Applications," provides the requirements for the contents of applications for standard design certification;
- 10 CFR 52.47(a)(1) requires that the application contain "the technical information which is required of applicants for construction permits and operating licenses by 10 CFR part 20, part 50 and its appendices, and parts 73 and 100, and which is technically relevant to the design and not site-specific;"
- 10 CFR 52.47(a)(2) requires that "the application must contain a level of design information sufficient to enable the Commission to judge the applicant's proposed means of assuring that construction conforms to the design and to reach a final conclusion on all safety questions associated with the design before the certification is granted;"
- 10 CFR 52.47(a)(3) states that "the staff shall advise the applicant on whether any technical information beyond that required by this section must be submitted;" and
- 10 CFR 52.47(b)(2)(i) states that "[c]ertification of a standard design which . . . uses simplified, inherent, passive, or other innovative means to accomplish its safety functions will be granted only if . . . the scope of the design is complete except for site-specific elements such as the service water intake structure and the ultimate heat sink[] or . . . acceptable testing of an appropriately sited, full-size, prototype of the design . . . demonstrate[s] that the non-certified portion of the plant cannot significantly affect the safe operation of the plant."

As set forth below, the staff has explicitly connected some of the incomplete areas to the requirements of 10 CFR 50.34, the General Design Criteria (GDC) in 10 CFR Part 50, Appendix A, or some other requirement in Part 50, but has not done so for every identified deficiency. For example, 10 CFR 50.34(h) requires that applications "include an evaluation of the facility against the Standard Review Plan (SRP) in effect on May 17, 1982, or the SRP revision in effect six months prior to the docket date of the application, whichever is later." While not always explicitly identified as such, many of the incomplete areas in the application described below relate to GE not providing sufficient information to address this requirement with respect to specific technical subject areas addressed in the application. The incomplete areas in the application are as follows:

- (1) Fuel and control rod design: The application does not provide information sufficient for the staff to determine the adequacy of the fuel design or control rod design with respect to the requirements of 10 CFR 50.34(b)(2)(i) and GDC 10 and 27.

In Section 4.2 of the ESBWR design control document (DCD) Tier 2, the applicant states that "to demonstrate the ESBWR system response in this DCD Tier 2, a reference core,

based upon a current NRC-approved GE14 fuel design, is modified to account for the shorter active fuel length. The COL applicant provides the ESBWR fuel design for a specific application to the NRC.” The DCD also states that “the COL applicant will provide the fuel bundle design name (i.e., GE-14 or other) and a reference to the fuel design documentation,” and that “the COL applicant will provide the control rod model and a reference to the control rod design documentation.” The regulation in 10 CFR 50.34(b)(2)(i), however, requires that, for nuclear reactors, “such items as the reactor core . . . shall be discussed insofar as they are pertinent,” GDC 10 requires that “[t]he reactor core . . . shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded,” and GDC 27 requires that “[t]he reactivity control systems shall be designed to have a combined capability . . . of reliably controlling reactivity changes to assure that under postulated accident conditions . . . the capability to cool the core is maintained[.]” Accordingly, the sections of the DCD quoted above do not provide information sufficient for the staff to determine the adequacy of the fuel design or control rod design, in accordance with the regulations, as part of the design certification review process. Moreover, the ESBWR DCD does not refer to an approved fuel and control rod design capable of being used for the COL first cycle core loading without further NRC staff review as specified in SRP Section 14.3.4, “Reactor Systems (Tier 1),” Draft Revision 0, April 1996. SRP 14.3.4 states that “[t]he specified fuel, control rod, and core designs presented in Tier 2 will constitute an approved design that may be used for the COL first cycle core loading, without further NRC staff review. If any other core design is requested for the first cycle, the COL applicant or licensee will be required to submit for staff review that specific fuel, control rod, and core design analyses as described in DCD Tier 2, Chapters 4, 6, and 15.”

- (2) Thermal Hydraulic Code: The application does not provide justification of the applicability of the staff’s approval of the TRACG thermal hydraulic code to the current ESBWR plant design and limiting break location, as needed to demonstrate compliance with 10 CFR 50.46 and GDC 16.

The TRACG thermal-hydraulic computer code is used by GE to meet the requirements of 10 CFR 50.46 concerning emergency core cooling systems and GDC 16 concerning the containment design. In the DCD, the limiting break location for a loss-of-coolant accident (LOCA) is reported as the feedwater line break (FWLB). The application does not provide justification of the applicability of the TRACG code and the associated PIRT and test programs to the FWLB. (The staff’s approval of the TRACG thermal-hydraulic computer code for applicability to ESBWR LOCA analyses was based on the gravity driven cooling system line break, the bottom drain line break, and the main steam line break as the limiting break locations. The FWLB was not considered.)

10 CFR 50.46 requires that a spectrum of break sizes and locations be analyzed to demonstrate that the limiting break has been identified. Sufficient information has not been provided to show that this requirement has been satisfied. For example, the limiting FWLB in the application is not the largest break possible in the feedwater line.

The applicant has not addressed all of the confirmatory items documented in the staff’s safety evaluation (SE) dated October 28, 2004, regarding the applicability of the TRACG thermal-hydraulic computer code to ESBWR LOCA analyses. For example, the staff’s SE was based on the 4000 MWth ESBWR reference design as described in the ESBWR design description submitted in August 2003. The staff’s SE states that “at the design certification stage, GE should demonstrate that the reference design as described in [the

ESBWR design description] has not been altered in such a way as to affect the staff's conclusions of this report. Significant changes in the design that challenge the conclusions of this report will result in the staff reevaluating the applicability of the TRACG code." The applicant did not address this confirmatory item in the DCD to demonstrate applicability of the TRACG code to the current 4500 MWth ESBWR design.

- (3) Fuel correlation: The application does not contain sufficient information regarding the thermal hydraulic behavior of the new fuel bundle design for the ESBWR core.

The fuel bundle design for the ESBWR constitutes a new fuel design. As such, GE needs to provide detailed fuel design drawings, the expected values of fuel performance parameters for the new fuel, a test matrix specifying the Critical Heat Flux (CHF) (dryout) testing GE intends to conduct for selected power profiles, and the CHF correlation corresponding to this ESBWR fuel design, under steady state and transient conditions.

- (4) Fission Product Removal: The application does not contain sufficient information regarding the removal of airborne fission products from the containment.

Section 50.34(a)(1) states, in part, that:

[s]pecial attention must be directed to plant design features intended to mitigate the radiological consequences of accidents. In performing this assessment, an applicant shall assume a fission product release from the core into the containment assuming that the facility is operated at the ultimate power level contemplated. The applicant shall perform an evaluation and analysis of the postulated fission product release, using the expected demonstrable containment leak rate and any fission product cleanup systems intended to mitigate the consequences of the accidents, together with applicable site characteristics, including site meteorology, to evaluate the offsite radiological consequences.

The regulation also includes a footnote which states that:

[t]he fission product release assumed for this evaluation should be based upon a major accident, hypothesized for purposes of site analysis or postulated from considerations of possible accidental events. Such accidents have generally been assumed to result in substantial meltdown of the core with subsequent release into the containment of appreciable quantities of fission products.

The application provides neither an evaluation model for the removal of airborne fission products from the containment atmosphere nor aerosol transport and behavior mechanisms in the containment following a loss-of-coolant accident (LOCA). Furthermore, the application does not provide any fission product removal mechanism or aerosol characteristics in the main steam lines. Therefore, the application does not contain the technical information required in accordance with 10 CFR 52.47, 10 CFR 50.34(a)(1), and the applicable requirements of 10 CFR 100.21.

- (5) Human Factors Engineering: The application does not contain sufficient information to evaluate human factors engineering, nor does the application address current regulatory guidance.

Guidance for the staff's review of the applicant's Human Factors engineering program is provided in Chapter 18 of the NUREG-0800, Standard Review Plan, "Human Factors Engineering," Revision 1, February 2004, which refers to NUREG-0711, "Human Factors Engineering Program Review Model," February 2004, which contains the applicable review criteria. The DCD did not provide an evaluation of the facility against the current SRP guidance in the human factors area as required by 10 CFR 50.34(h).

- (6) Digital Instrumentation and Control: The application does not provide sufficient information for the staff to review the instrumentation and control system, nor does the application fully address current regulatory guidance.

The applicant has not provided a reference to an NRC approved digital protection system platform nor has it submitted a new digital protection system platform for NRC review as part of the design certification process. GE did not address how it complies with 10 CFR 50.55a(h), which incorporates IEEE Std. 603 by reference, nor did GE fully address current applicable guidance including SRP Chapter 7.0, Revision 4, June 1997 and RG 1.152.

BTP HICB 16, "Guidance on the Level of Detail Required for Design Certification Applications," Revision 4, June 1997, states that the application "should (1) describe the resolution of unresolved and generic safety issues applicable to the I&C systems, (2) describe the interface requirements to be met by portions of the plant for which the application does not seek certification and which are necessary to ensure proper functioning of the I&C systems, and (3) identify and describe the validation of innovative means of accomplishing I&C system safety functions. Furthermore, applications that propose the use of computers for systems important to safety should describe the computer system development process. Applications that propose the use of computers for reactor trip system (RTS) or engineered safety features actuation system (ESFAS) functions should also describe the design of the overall I&C systems with respect to defense-in-depth and diversity (D-in-D&D) requirements."

Further, as discussed in BTP HICB 16, the staff's acceptance of software for safety system functions includes the review of the applicant's plans addressing the review topics described in section B.2.1 of BTP HICB 14, "Guidance on Software Reviews for Digital Computer-Based Instrumentation and Control Systems," Revision 4, June 1997, which are: (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 ESBWR Tier 2 DCD Section 7B, "Software Quality Program for Hardware/Software Design and Development," listed several software development documents. These documents represent the first step in the software life cycle design process, but the ESBWR specific documents will need to be submitted for staff review.

- (7) Operating Experience Evaluation: The application does not contain a sufficient evaluation of operating experience as requested by Commission Policy.

The Commission requested, in its Staff Requirements Memoranda dated July 31, 1989, and February 15 and March 5, 1991, that the staff consider how operating experience has been incorporated into designs for which certification have been requested. Operating experience is addressed in NRC generic communications (Generic Letters and Bulletins). Generic letters and bulletins were explicitly addressed in the applications for the three previously certified designs (ABWR, System 80+ and AP600) and for the AP1000, which is currently in the design certification rulemaking phase. The ESBWR application did not explicitly address generic letters and bulletins in the DCD. The staff has identified technical issues that were addressed in NRC generic communications but not in the ESBWR DCD (for example, Generic Letter 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Power-Operated Valves," Generic Letter 88-01 "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping," and NRC Bulletin 96-02, "Movement of Heavy Loads over Spent Fuel, over Fuel in the Reactor Core, or over Safety-Related Equipment.") GE should address all Generic Letters and Bulletins issued between January 1, 1980, and February 24, 2005, to assure that operating experience has been appropriately considered.

- (8) Flood protection: The application does not contain sufficient information for the staff to evaluate the protection from internal flooding.

Design descriptions and assumptions for flood protection will need to be provided before the staff can start its review in this area to ensure compliance with GDC 4. The needed assumptions and descriptions include defining the design basis flood, drain and piping sizes, equipment elevations, and curb heights or other barriers necessary to address the regulatory guidance contained in SRP Section 3.4.1, "Flood Protection," Revision 2, July 1981.

- (9) Steam dryer design and structural integrity: The application does not describe the methods to be used to design, fabricate, install, and monitor the steam dryer so that the steam dryer will maintain its structural integrity under plant operating conditions.

The Commission requested, in its Staff Requirements Memoranda dated July 31, 1989, and February 15 and March 5, 1991, that the staff consider how operating experience has been incorporated into designs for which certification has been requested. Operating experience has shown that the method to be applied in providing confidence in the structural integrity of boiling water reactor steam dryers under operating conditions needs to be described in sufficient detail to demonstrate that the applicant has adopted a credible approach to the analysis before the NRC staff initiates its review in this area. The ESBWR DCD does not describe the methods to be used to design, fabricate, install, and monitor the steam dryer so that the steam dryer will maintain its structural integrity under plant operating conditions. A clear definition of applicable design loads that includes their sources, nature, and magnitude, is prerequisite to the staff's determination of the dryer's design adequacy. The DCD does not indicate what instrumentation will be installed on the steam dryer to provide pressure loads, strain, and acceleration to demonstrate the acceptable performance of the steam dryer upon reactor startup. The DCD does not indicate the methods that will be used to evaluate pressure loads acting on the steam dryer such as installing main steam line instrumentation and evaluating the measurements.

- (10) Chimney assembly design and structural integrity: The application does not describe the methods to be used to design, fabricate, install, and monitor the chimney so that the chimney will maintain its structural integrity under plant operating conditions.

The design of the new internals component, the chimney assembly, needs to be described. The methods to be used to design, fabricate, install, and monitor this new component so that it will maintain its structural integrity needs to be described in sufficient detail to demonstrate that the applicant has adopted a credible approach to the analysis before the NRC staff initiates its review in this area.

- (11) Reactor pressure vessel (RPV) internals vibration: The application does not provide sufficient information regarding the RPV vibration assessment program.

10 CFR 50.55a requires that the core support structure be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section III. Section III, Subsection NG, Article NG-3000, Paragraph NG-3111, of the ASME Code requires that vibratory loads be taken into account in the design. The DCD indicates that a vibration assessment program using Regulatory Guide 1.20 will be implemented for the RPV internals without providing information regarding the planned approach. The analytical portion of a detailed RPV vibration assessment program needs to be provided so that the NRC staff can initiate its review in this area. Information needed includes: descriptions of the analytical methods used for the RPV internals vibration assessment program including computer models; results of the analyses; vibration frequencies and amplitudes of critical internals components; correlations of vibration frequencies and amplitudes of critical internals components; correlations of vibration data obtained from other BWR internals designs; recommended locations for instrumentation such as pressure sensors, strain gauges, and accelerometers for pre-operational vibration tests; and comparisons of calculated stress and fatigue levels to selected acceptance criteria.

- (12) Radiation Protection: The application does not provide final design information in the radiation protection area, nor does the application address the requirements of 10 CFR 20.1406.

The discussion in DCD Tier 2, Section 14.3.3.4, indicates that the information in Section 3.4 of the Tier 1 document is not the final design, but describes a process that the COL holder will use to complete and verify the adequacy of the design. This implies the use of design acceptance criteria (DAC) for the radiation protection area. GE has not requested the use of DAC in this area, nor does the staff believe that the use of DAC in this area is appropriate. Also, the requirements of 10 CFR 20.1406, "Minimization of Contamination," are not specifically addressed in the application.

- (13) Fire Protection: The application does not address current regulatory guidance in the fire protection area.

The ESBWR Tier 2 DCD, Table 1.9-9, "Summary of Differences from SRP Section 9," lists several deviations from specific SRP acceptance criteria, and indicates that the discussion of the deviations is provided in specific subsections of section 9.5.1 of the DCD. The staff did not find the discussion of the deviations in Tier 2 DCD Section 9.5.1 as indicated. The ESBWR Tier 2 DCD, Table 1.9-20, "NRC Standard Review Plans and Branch Technical Positions Applicability to ESBWR" refers to SRP Section 9.5.1, "Fire Protection Program," Revision 4, dated October 2003 (this contains Branch Technical

Position (BTP) SPLB 9.5-1, "Guidelines for fire protection for Nuclear Power Plants"). However, the ESBWR DCD Tier 2 Appendix 9A, "Fire Hazard Analysis" Section 9A.2.1 "Codes and Standards" refers to the 1981 version of this BTP, NRC BTP CMEB 9.5-1, "Guidelines for fire protection for Nuclear Power Plants." The 1981 BTP CMEB 9.5-1 does not apply to the ESBWR design. In addition, the ESBWR DCD does not address plant safe-shutdown criteria provided in Appendix B to SPR Section 9.5.1, Revision 4, October 2003.

- (14) Safeguards information: The safeguards information submittal was not provided with the initial application.

The cover letter for the application indicated that a separate safeguards information submittal would be provided under separate cover. This submittal has not been received, therefore the staff does not have detailed information to review in this area.