UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

March 20, 2008

Mr. Luis A. Reyes
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: INTERIM LETTER: CHAPTERS 9, 10, 13, AND 16 OF THE NRC STAFF'S SAFETY EVALUATION REPORT WITH OPEN ITEMS RELATED TO THE CERTIFICATION OF THE ESBWR DESIGN

Dear Mr. Reyes:

During the 550th meeting of the Advisory Committee on Reactor Safeguards, March 6-7, 2008, we discussed four Chapters from the NRC staff's Safety Evaluation Report (SER) with open items related to the Economic Simplified Boiling Water Reactor (ESBWR) design certification application. Our ESBWR Subcommittee held a meeting on November 15, 2007, to discuss technical aspects of the ESBWR design as well as the open items and the combined license (COL) action items identified in each of these SER Chapters. During these meetings, we had the benefit of discussions with representatives of the NRC staff and General Electric-Hitachi (GEH) Nuclear Energy Americas, LLC. We also had the benefit of the documents referenced. We previously commented on Chapters 2, 5, 8, 11, 12, and 17 in our letter dated November 20, 2007. Our reviews have not addressed security matters and their impact on the ESBWR design.

**RECOMMENDATIONS**

1. Our review of the staff's SER Chapters 9, 10, 13, and 16 has identified several issues that merit further consideration:

    - Potential adverse system interactions
    - Control room habitability and equipment operability in the 72-hour post-accident period
    - Effects of inadvertent injection of nitrogen gas during operation of standby liquid control system (SLCS) operation
    - Development of a sound technical basis for testing passive safety systems

2. We plan to review the staff's resolution of the open items in SER Chapters 9, 10, 13, and 16 during future meetings.

3. Many of the ESBWR systems described in these Chapters may interact with systems discussed in other SER Chapters that have not been reviewed. We will comment on potential safety implications of any system interactions in future interim letters and in our final report.

**BACKGROUND**

The ESBWR uses a direct-cycle power conversion system with natural circulation cooling in the reactor vessel under normal operation and passive emergency core cooling system (ECCS) operation without the need for emergency alternating current power systems for core cooling within the first 72 hours following a reactor transient or accident. The ESBWR also uses passive containment cooling to ensure heat transport to the ultimate heat sink for all accident scenarios. To cope with a severe reactor accident, the ESBWR design incorporates a lower drywell core retention device and allows passive drywell flooding to provide long-term debris cooling.

At the request of the staff, we have agreed to review the staff's SER on a chapter-by-chapter basis to identify technical issues that merit consideration, thereby aiding effective resolution of any concerns, as well as assisting timely completion of the review of the ESBWR design certification application. Accordingly, the staff has provided SER Chapters 9, 10, 13, and 16 with open items and COL action items for our review.

**DISCUSSION**

Based on the information presented to us to date, we have the following comments on aspects of the ESBWR design addressed in these Chapters.

<u>Chapter 9: Auxiliary Systems</u>

The ESBWR application classifies the auxiliary systems into five categories: fuel storage and handling; water systems; process auxiliaries; heating, ventilation, and air conditioning (HVAC) systems; and other auxiliaries.

The ESBWR application describes the systems employed for receipt of new fuel bundles as well as for spent fuel storage, spent fuel pool cooling, cleaning and transfer. The staff identified a number of open items related to these systems, such as justification of postulated dropped loads, provisions for spent fuel cooling and shielding without makeup for 72 hours, and spent fuel decay heat loads. During the discussions, we had inquired whether sufficient cooling is available for an isolated inclined transfer tube containing fuel bundles. At our most recent meeting, we were informed that, based on boiling water reactor-6 (BWR-6) fuel transfer tube designs, GEH performed additional analyses that bound this event for the ESBWR, thereby assuring cooling without operator action for at least 10 hours. The staff found this acceptable, and we agree with the staff.

The ESBWR differs from traditional BWR designs in that passive systems are designed to perform the functions needed to address design-basis accidents for 72 hours after an initiating event, independent of operator action or offsite support. After 72 hours, non-safety-related active systems may be required to replenish the passive systems or to perform core and containment heat removal duties directly. In existing plants, many of these active systems are designated as safety related. However, in the ESBWR, they are designated as non-safety-related because credit is not taken for these systems in the design-basis accident analyses.

The NRC and the Electric Power Research Institute (EPRI) have developed a process, termed RTNSS (regulatory treatment of non-safety systems), to identify such systems and to maintain appropriate regulatory oversight of these systems. This process does not require that these systems be subjected to all safety-related special treatment requirements. However, sufficient controls are imposed on these systems to provide a high level of confidence that they will be available when needed.

It is not apparent whether the staff has fully examined potential inter-system impacts. For example, the instrument air (IA) system is not an ESBWR safety system or RTNSS system. However, it does interface with safety and RTNSS systems. According to the ESBWR design application, the nitrogen systems are normally removed from service during outages. During this time, the IA system is aligned to all pneumatic loads normally supplied by nitrogen. If contamination enters the nitrogen piping through the IA system during these periods, it could later affect equipment operation, even after nitrogen is re-connected.

Contamination has been a problem in existing plants. Despite redundant oil-free compressors and dryers, moisture detectors, and designer expectations, operating experience has shown that dryers have failed or have been bypassed, allowing moisture to enter the system, and desiccant has been released from dryers. Movement of such contaminants through IA systems has led to spurious actuation of air-operated components, and prevented "fail-safe" operation of valves due to mechanical binding of the pneumatic solenoids. These impacts are often not revealed until a substantial time after the initial contamination, and they have sometimes affected multiple components. Many of these events have proved challenging for operators.

The staff's review does not seem to account for the normal alignment of IA to the nitrogen systems during outages, nor consider the extent of possible interactions that could occur, should IA become contaminated. It is difficult to understand how the staff's review of these impacts can be complete without an evaluation of the specific components and failure modes that may be affected by the IA system. This is an example of the need for the staff to more fully examine adverse inter-system interactions.

HVAC systems maintain environmental design temperatures, quality of air, and proper pressurization. Maintaining adequate environmental conditions is important during the 72-hour post-accident period. When no alternating current power systems are available, there is a need to address effects on control room habitability due to temperature, humidity, and quantity of intake and exhaust air. Acceptable equipment operating temperature and humidity conditions must also be maintained throughout the post-accident period. This is of particular concern for protection of digital instrumentation and control systems located in the control building, reactor building, and electrical building. The staff has identified a number of open items related to HVAC system design. The staff and GEH have noted our concerns, and we look forward to reviewing the more detailed analyses relative to these issues.

The SLCS provides backup capability for reactivity control independent of the control rod system. The SLCS injects a boron solution to shut down the reactor. The SLCS accumulator uses nitrogen to inject the boron solution under accident conditions. GEH stated that the potential exists for the injection of a large volume of nitrogen gas into the reactor coolant system, although the system is designed to prevent this. We plan to discuss this matter further in the context of a probabilistic risk assessment (PRA) scenario of particular interest as more information is made available regarding the effects of such nitrogen gas intrusion on long-term cooling.

Chapter 10: Steam and Power Conversion System

The components of the steam and power conversion system are designed to produce electrical power using steam generated by the reactor to flow through steam turbines, condense steam into water, and return the water to the reactor as heated feedwater. In addition, a major portion of the gaseous, dissolved, and particulate impurities are removed in order to satisfy water quality requirements. The steam and power conversion system also includes protective features that accommodate key potential challenges such as loss of electrical load, main steamline overpressure, and turbine events, such as turbine trip or overspeed protection.

In this Chapter, the staff has identified several open items regarding completeness of the specification of weld filler material, requirements for fracture toughness of Class 2 feedwater components, and material specifications for feedwater and condensate piping that could be susceptible to erosion and corrosion. We agree that these open items need to be addressed.

Chapter 13: Conduct of Operations

The ESBWR organizational structure, training, plant procedures, and operational programs will largely be the responsibility of the COL applicant. Issues related to human factors and the man-machine interface will be considered in Chapter 18, “Human Factors Engineering,” of the SER. Thus, the conduct of operations considering human factors design requirements will be addressed in the COL application referencing the certified ESBWR design.

Emergency planning is not within the scope of the ESBWR design certification. However, the ESBWR application describes features, facilities, and functions needed for emergency planning. The ESBWR standard plant complies with the Technical Support Center design requirements. The staff identified an appropriate set of open items related to physical security that the applicant will have to address.

Chapter 16: Technical Specifications

The ESBWR Technical Specifications are designed to provide a common technical basis for any COL applicant to ensure that the ESBWR is operated under conditions consistent with the Design Control Document and that the equipment essential to prevent accidents or mitigate their consequences is operable. The staff is evaluating the ESBWR Technical Specifications to confirm that they do ensure that the plant will remain within its design bases during operation. At this time, the Technical Specifications documented in Chapter 16 are still incomplete and the staff identified a number of open items that require the applicant’s response. Of particular interest are the surveillance test procedures and test frequencies for the passive safety systems. The test procedures are still under development. A sound technical basis for testing passive safety systems that goes beyond sole reliance on past experience and engineering judgment should be required by the staff.

We plan to review the resolution of the open items identified in the SER Chapters 9, 10, 13, and 16 during future meetings. Many of the ESBWR systems described in these Chapters may interact with systems discussed in other Chapters of the SER that have not been reviewed. We also plan to comment on the potential safety implications of any system interactions in future interim letters and in our final report.

Sincerely,

***/RA/***

William J. Shack
Chairman

REFERENCES

1. Memorandum to Frank P. Gillespie, Executive Director, Advisory Committee on Reactor Safeguards and Advisory Committee on Nuclear Waste and Materials, from David B. Matthews, Director, Division of New Reactor Licensing, Office of New Reactors, transmitting Safety Evaluation Report with Open Items of the EWBWR Design Certification Application, Chapter 9, “Auxiliary Systems,” dated November 1, 2007, (ML072900345 and ML072900355).

2. Memorandum to Frank P. Gillespie, Executive Director, Advisory Committee on Reactor Safeguards and Advisory Committee on Nuclear Waste and Materials, from David B. Matthews, Director, Division of New Reactor Licensing, Office of New Reactors, transmitting Safety Evaluation Report with Open Items of the EWBWR Design Certification Application, Chapter 10, “Steam and Power Conversion System,” dated September 20, 2007, (ML072350529 and ML070720143).

3. Memorandum to Frank P. Gillespie, Executive Director, Advisory Committee on Reactor Safeguards and Advisory Committee on Nuclear Waste and Materials, from David B. Matthews, Director, Division of New Reactor Licensing, Office of New Reactors, transmitting Safety Evaluation Report with Open Items of the EWBWR Design Certification Application, Chapter 13, “Conduct of Operations,” dated November 1, 2007, (ML072290020 and ML072290010).

4. Memorandum to Frank P. Gillespie, Executive Director, Advisory Committee on Reactor Safeguards and Advisory Committee on Nuclear Waste and Materials, from David B. Matthews, Director, Division of New Reactor Licensing, Office of New Reactors, transmitting Safety Evaluation Report with Open Items of the EWBWR Design Certification Application, Chapter 16, “Technical Specifications,” dated November 1, 2007, (ML072910513 and ML072910702).

5. Letter to the U.S. Nuclear Regulatory Commission from James C. Kinsey, Project Manager, ESBWR Licensing, General Electric-Hitachi, transmitting ESBWR Design Control Document, Revision 3, dated February 22, 2007, (ML070660561).

6. Letter to Luis A. Reyes, Executive Director for Operations, from William J. Shack, Chairman, Advisory Committee on Reactor Safeguards, “Interim Letter: Chapters 2, 5, 8, 11, 12, and 17 of the NRC Staff’s Safety Evaluation Report with Open Items Related to the Certification of the ESBWR Design,” dated November 20, 2007, (ML073070006).

6. Letter to Luis A. Reyes, Executive Director for Operations, from William J. Shack, Chairman, Advisory Committee on Reactor Safeguards, “Interim Letter: Chapters 2, 5, 8, 11, 12, and 17 of the NRC Staff’s Safety Evaluation Report with Open Items Related to the Certification of the ESBWR Design,” dated November 20, 2007, (ML073070006).

March 20, 2008

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