

July 8, 2008

Dr. William J. Shack, Chairman
Advisory Committee on Reactor Safeguards
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

SUBJECT: INTERIM LETTER 3: CHAPTERS 4, 6, 15, 18, AND 21 OF THE U.S. NUCLEAR REGULATORY COMMISSION STAFF'S SAFETY EVALUATION REPORT WITH OPEN ITEMS RELATED TO THE CERTIFICATION OF ECONOMIC SIMPLIFIED BOILING WATER REACTOR DESIGN

Dear Dr. Shack:

I am responding to your letter of May 23, 2008, regarding the Advisory Committee on Reactor Safeguards' (ACRS or Committee's) meeting on May 8-9, 2008.

During the Full Committee meeting the staff discussed its safety evaluation reports (SERs) with open items (OIs) for Chapters 4, 6, 15, 18, and 21 of the economic simplified boiling water reactor design (ESBWR) certification application. These discussions included the status and technical concerns of the OIs identified in the SERs. The ACRS raised several specific concerns in its letter.

I have provided staff's responses to each of the ACRS concerns. The staff will continue to work with GE Hitachi Nuclear Energy to obtain satisfactory resolution to the OIs presented in the SERs.

W. Shack

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Thank you for your comments. I appreciate the willingness of the ACRS to engage with the staff on a chapter-by-chapter SER review. I believe this process has greatly facilitated the staff's work and they look forward to continued interactions with the Committee for the remaining chapters of the ESBWR design certification application.

Sincerely,

/RA Bruce S. Mallett for/

R. W. Borchardt
Executive Director
for Operations

Enclosure:
Staff Response to ACRS Comments

cc: Chairman Klein
Commissioner Jaczko
Commissioner Lyons
Commissioner Svinicki
SECY

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**The U. S. Nuclear Regulatory Commission Staff's Response to the
Advisory Committee on Reactor Safeguards
Interim Letter Dated May 23, 2008,
Regarding Safety Evaluation Reports with Open Items
on the ESBWR Design Certification Application**

Following are the staff's responses to comments from the Advisory Committee on Reactor Safeguards (ACRS) on the staff's safety evaluation report (SER) with open items for Chapter 4, "Reactor," Chapter 6, "Engineering Safety Features," Chapter 15, "Transient and Accident Analysis," Chapter 18, "Human Factors Engineering," and Chapter 21, "Testing and Computer Code Evaluation" of the economic simplified boiling-water reactor (ESBWR) design certification application. The staff plans to discuss final resolution of these concerns during the ACRS committee meetings on the final SER for the ESBWR design certification application.

ACRS Comment: Confirmation of coupled neutronic and thermal-hydraulic stability including interactions between the core and chimney.

The staff should pay additional attention to the confirmation of coupled neutronic and thermal-hydraulic stability including interactions between the core and chimney. The ESBWR natural circulation flow directly determines the void exiting the reactor core. Spatial or temporal variations in the void can have the feedback effect on the overall core recirculation ratio causing an oscillation in the core flow. This can cause an oscillation of the core power due to neutronic feedback effects. The ESBWR is a much larger reactor and there is a greater likelihood of spatial void variations regionally and at the assembly exits, along with density wave oscillations and associated power-flow instabilities. However, all thermal-hydraulic analyses by GE Hitachi Nuclear Energy (GEH) and independent calculations by the staff indicate that these instabilities are dampened and the reactor remains stable. GEH is completing more detailed thermal-hydraulic studies of the design to address the staff's open item related to the power-flow stability. The ACRS noted that full-scale confirmation of power-flow stability will be ultimately determined during start-up testing.

Staff Response:

The staff is pursuing this issue with GEH through two requests for additional information (RAIs). GEH used the Transient Reactor Analysis Code (TRACG) to study the ESBWR instability. The ESBWR TRACG input simulates the coupled neutronic and thermal-hydraulic stability including interactions between the core and chimney. In RAI 21.6-113, the staff requested GEH to explain how the analysis code TRACG nodalization and flow-regime maps in the chimney capture the phenomenon of the non-fully-developed flow at the chimney inlet. In the ESBWR, the flows from 16 fuel bundles and their associated bypass region join into a single chimney channel. Because of mixing and three-dimensional effects, the flow at the chimney channel inlet will not be fully developed and may transition between separated flow regimes. The staff also asked in RAI 21.6-113 that GEH identify experimental evidence that shows that the non-fully-developed flow at the chimney inlet does not cause core flow fluctuations that could be a concern for safe ESBWR operation. In RAI 21.6-114, the staff asked GEH to address how the TRACG nodalization and flow-regime maps in the chimney capture the phenomenon of flow

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oscillations caused by the turbulence of the slug/churn regime or transition to annular flow regime. In addition, RAI 21.6-114 requests experimental evidence that random fluctuations of void fraction (e.g., slug/churn flow) or transition between different flow regimes (e.g., slug to annular) do not cause core flow fluctuations that could be a concern for safe ESBWR operation. The staff will brief the ACRS on resolution of these issues after completing the final SER on ESBWR design certification.

ACRS Comment: Assurance of proper operation of the vacuum breaker system by appropriate surveillance testing, leakage monitoring, and isolation capability.

The staff should pay additional attention to assure proper operation of the vacuum breaker system by appropriate surveillance testing, leakage monitoring, and isolation capability. The vacuum breakers must perform with high reliability to allow the passive containment cooling system (PCCS) to function properly and maintain the pressure well below the containment design pressure. GEH tests indicate good performance of this new vacuum breaker design under a range of normal as well as adverse operational conditions. Both GEH and the staff have agreed that if the vacuum breaker leakage is more than double its maximum allowable limit, containment pressurization for the main steamline break can exceed containment design pressures. The ESBWR vacuum breaker design includes a leak detection system and isolation valves that close in case of vacuum breaker failure. The staff identified the reliability of the vacuum breaker system as a significant open item until GEH develops a protocol for acceptable periodic testing, leakage detection, and isolation capability. We concur with the staff that assurance of proper operation of the vacuum breaker system is important.

Staff Response:

Through RAIs 6.2-145, 6.2-146, 6.2-148, and 21.6-112, the staff is pursuing resolution of this issue with GEH to ensure proper design and operation of the vacuum breaker system. In response to these RAIs, GEH proposed to add a drywell gas recirculation system (DGRS), which will operate starting from 72 hours after a loss of coolant accident (LOCA). The DGRS will force flow of steam through PCCS condensers, which will increase their efficiency. Without the DGRS, natural forces will drive a lesser flow of steam through PCCS condensers. The DGRS also purges non-condensable gases that accumulate in the PCCS condensers to the drywell, thus eliminating the need for drywell to be at a higher pressure than the wetwell to purge non-condensable gases into the wetwell. With no pressure gradient, bypass leakage becomes negligible. As such, the operation of DGRS will resolve issues with drywell-to-wetwell bypass leakage after 72 hours following a LOCA. The applicant's responses to the staff's RAIs are expected to address bypass leakage issues during the first 72 hours after a LOCA and proper operation of the vacuum breaker system by appropriate surveillance testing, leakage monitoring, and isolation capability. The staff will brief the ACRS on resolution of these issues after completing the final SER on ESBWR design certification.

ACRS Comment: Demonstration of the performance of passive safety systems addressing issues such as gas binding.

The staff should pay additional attention to demonstrate the performance of passive safety systems addressing issues such as gas binding. Although calculations suggest that the containment pressurization results are conservative, the final factor that affects containment

pressurization is the need to ensure proper gravity drainage of water from locations such as the gravity-driven cooling system (GDCCS) to the vessel during the accident progression and from the PCCS to the GDCCS tanks. The details of the piping geometry and arrangements in these systems are critical in assuring that non-condensable gases are not initially present or do not become trapped during operation of the GDCCS and the PCCS. The staff is aware of these concerns and we urge that detailed design of the piping arrangements be reviewed to ensure gases will not be trapped in these piping systems. GEH needs to demonstrate the performance of these passive safety systems given the potential for gas pockets. GEH also needs to develop a protocol for periodic testing and venting of passive safety systems to minimize the presence of non-condensable gases.

Staff Response:

In RAI 6.2-181, the staff asked GEH to explain how the piping from the PCCS condensers to the GDCCS tanks will be designed to ensure that non-condensable gases will not collect in the lines and how features and design parameters that prevent the collection of non-condensable gases in the lines will be verified through inspections, tests, analyses, and acceptance criteria (ITAAC). The applicant's response to RAI 6.2-181 is expected to address the possibility of forming gas pockets in the piping from the PCCS to the GDCCS that could impede gravity-driven flow of condensate from the PCCS to the GDCCS.

In RAI 21.6-112, the staff requested GEH to explain the downcomer level during a LOCA, the potential that non-condensable gases in the GDCCS injection line will flow back to the GDCCS pool, and the adequacy of the TRACG model to simulate the phenomena. The applicant's response to RAIs 3.9-200 to 3.9-202, is expected to address GDCCS check valve design and orientation, provisions for non-condensable gas in GDCCS, GDCCS isolation of reactor coolant pressure boundary, and periodic venting of the GDCCS injection line.

The staff will brief the ACRS on the resolution after completing the final SER on ESBWR design certification.

ACRS Comment: Assurance that the proposed principles of Human Factors Engineering (HFE) are appropriately integrated in the ESBWR design.

The staff plans to perform on-site audits of the HFE design process. During this audit, the staff should ensure that the HFE principles are appropriately integrated into the ESBWR design. As the staff performs these audits and reviews the proposed ITAACs, we would like to be kept informed.

Staff Response:

The staff has completed its safety evaluation with open items for Chapter 18, "Human Factors Engineering," of the GEH ESBWR Design Control Document. Using applicable regulatory criteria and review guidance, the staff is continuing its evaluation of Chapter 18 in an effort to resolve outstanding open items. The staff's remaining evaluations include reviewing detailed human factors engineering (HFE) work instructions or updated implementation plans for the various HFE elements either at the applicant's site or in the NRC's office before design certification is completed. This portion of the staff's review will help to ensure that HFE

principles are appropriately integrated into the ESBWR design. The staff will keep the ACRS informed of the results of these activities.

After design certification, the staff will also conduct audits/reviews to address closure of HFE-related combined license action items and applicable design acceptance criteria ITAAC. These will be accomplished both at the NRC and licensee facilities. In addition, through directed staff inspections as part of the NRC's Construction Inspection Program, the agency will accomplish further verification of the licensee's satisfactory completion of its HFE and control room design commitments before the licensee is authorized to load fuel.