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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 201 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.5-71**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC letter dated May 28, 2008, Reference 1. GEH's response to RAI Number 9.5-71 is addressed in Enclosure 1.

If you have any questions or require additional information, please contact me.

Sincerely,

Richard E. Kingston
Richard E. Kingston
Vice President, ESBWR Licensing

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KIRO

Reference:

1. MFN 08-499, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 201 Related To ESBWR Design Certification Application*, dated May 28, 2008.

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 201 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.5-71.

cc: AE Cabbage USNRC (with enclosure)
RE Brown GEH/Wilmington (with enclosure)
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Enclosure 1

MFN 08-634

**Response to Portion of NRC Request for
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NRC RAI 9.5-71

The DCD does not address how the design specifically prevents or mitigates spurious actuations. RG 1.189 discusses the need to prevent or mitigate fire-induced (includes smoke, heat, and ignition) failures of systems, including spurious actuations, which could prevent safe shutdown. RG 1.209 notes that smoke clearly has the potential to be a significant environmental stressor that can result in adverse consequences for advanced digital systems. DCD Tier 2 Section 9.5.1.10 does identify that fire barrier separation is provided for electrical circuits (safety-related and nonsafety-related) whose fire-induced failure could cause a spurious actuation that could prevent safe shutdown as is described in DCD Tier 2 Section 8.3.1.4.1. However, DCD Tier 2 Section 8.3.1.4.1 does not address spurious actuations. Please describe how the ESBWR design ensures that the effects of fire, including smoke, will not cause spurious actuations that could prevent safe shutdown? The description should include equipment design requirements and describe test programs and/or analyses that will provide this assurance.

GEH Response

While design choices, such as chip packaging and conformal coatings, can reduce equipment susceptibility to smoke exposure, no practical repeatable testing methodology is available. Therefore, it is not feasible to assess smoke susceptibility as part of equipment qualification. As noted in RG 1.209, "The most effective approach for addressing smoke susceptibility is to minimize the likelihood of smoke exposure by rigorously adhering to the fire protection requirements in 10 CFR Part 50.48, "Fire Protection," or other individual plant license commitments."

The requirements of RG 1.209 are consistent with GEH previous commitment in response to RAI 19.1-75 (MFN 07-507, 10/10/07) to provide a balanced design approach to mitigate the adverse effects of smoke. Part of this balanced design approach involves smoke control. For Fire Zones containing equipment that could cause spurious actuations affecting safe shutdown, GEH will provide smoke detectors and smoke dampers to minimize smoke migration into these areas. As noted in DCD Subsection 9.5.1.12:

Guidance — "In addition, it should be demonstrated that smoke, hot gases, or the fire suppressant does not migrate into other fire areas to the extent that safe shutdown capabilities, including operator actions, could be adversely affected."

Conformance — The ESBWR fire protection design satisfies this guidance with a combination of fire dampers and other barriers, smoke evacuation capabilities, and minimal required operator actions. Details are provided in the fire hazards analysis in Appendix 9A.

In addition to preventing smoke migration, the ESBWR is designed to prevent spurious actuation induced by smoke. The ESBWR Distributed Control and Information System (DCIS) is located in four general areas of the plant; 1) The main control room where all

four divisions may be found in a common fire zone, 2) four safety-related DCIS (Q-DCIS) rooms - one per division, 3) two nonsafety-related DCIS (N-DCIS) rooms that correspond to plant investment protection (PIP) A and (PIP) B DCIS trains and 4) remote multiplexing unit (RMU) equipment locations throughout the plant (such as the Reactor Building, Control Building, Fuel Building, etc).

The main control room consoles are connected to the equipment in the safety-related or nonsafety-related DCIS rooms via optical fiber; the DCIS equipment rooms are in separate fire zones from each other and from the main control room. The VDUs require that at least two distinct operator actions be performed for any actuation to satisfy GEH human factors requirements. Additionally each of the messages associated with those two operator actions are authenticated by sending/receiving addresses, and (for safety related and DPS communications) sequence numbering, cyclic redundancy checks and, hash functions. At least two distinct actions are required to be performed for any actuation. It is essentially impossible for a smoke or fire impaired VDU or its controller to inadvertently emit the required commands/authentication once and then again representing the operator actions.

There are also hard wires between the MCR/RSS and actuation equipment that represent "fail safe" functions like reactor scram and turbine trip. Inadvertent actuation of these functions will not prevent a safe shutdown.

The two nonsafety-related DCIS equipment rooms and four safety-related DCIS rooms are in separate fire zones and single fires can only affect one division or PIP train at a time. The communication between the controllers in these rooms and their RMUs is protected such that neither fires nor smoke will cause inadvertent triggering of 2/4 logic or cause competent inadvertent commands to be sent (nor would it affect the "intelligence" in the remote equipment). A single fire in these areas is not expected to cause inadvertent actuations affecting a safe shutdown.

Finally, the RMUs in the field contain the logic/"intelligence" that responds to the controllers and operates the switches. The MSIV and RPS load drivers open circuits to actuate; these are fail-safe in that inadvertent actuation causes safe shutdown. The switches that operate the various ECCS solenoids or squib igniters are either a series circuit of two (solenoid) or three (squib) switches; the switches (even within the same division) are located in separate cabinets that are in separate fire zones. A single fire could only affect one of the cabinets and therefore could not "hot short" and cause an inadvertent actuation. The logic/"intelligence" in the switches will not close the output contacts on either the loss of communication or incompetent communication from the DCIS equipment room controllers.

The communication and authentication functionality described above will represent DCIS requirements that will be developed, validated and tested per the previously submitted software plans (NEDO-33245, ESBWR Software Quality Assurance Plan Manual, Class I (Non-proprietary) & "ESBWR Software Quality Assurance Plan Manual," NEDE-33245P, Class III (Proprietary), Revision 3, July 2008 (MFN 08-256, 7/11/08) and "ESBWR - Software Management Program Manual," NEDO-33226, Class I (Non-proprietary) & "ESBWR - Software Management Program Manual," NEDE-

33226P, Class III (Proprietary), Revision 3, June 2008) (MFN 08-269, 7/10/08) for safety-related and nonsafety-related software.

Software testing of DCIS equipment is in accordance with DCD Tier 1 Revision 5 Table 3.2-1, ITAAC For Software Development. Safety-related DCIS (Q-DCIS) systems and functions are listed in DCD Tier 1 Revision 5 Table 2.2.10-1. Nonsafety-related DCIS (N-DCIS) systems and functions are listed in DCD Tier 1 Revision 5 Table 2.2.11-1.

DCD Tier 1 Revision 5, Table 2.16.3-1, ITAAC for Fire Barriers, Item 1 provides ITAAC for fire barriers that separate electrical circuits (safety-related and nonsafety-related) whose fire-induced failure could cause a spurious actuation that could adversely affect a safe shutdown function.

DCD Tier 1 Revision 5, Table 2.16.3-2, ITAAC for Fire Protection System, Item 6 provides ITAAC for smoke detectors installed in areas containing safety-related equipment.

DCD Impact

No change to the DCD is required.