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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 132 Related to ESBWR Design Certification Application, RAI Numbers 19.1-163,19.1-171 and 19.1-172**

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 January 15, 2008 (Reference 1). The GEH response to RAI Numbers 19.1-163,19.1-171 and 19.1-172 are in Enclosure 1.

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

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

Reference:

1. MFN-08-040. Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request For Additional Information Letter No. 132 Related To ESBWR Design Certification Application.* January 15, 2008.

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 121 Related to ESBWR Design Certification Application, ESBWR Probabilistic Risk Assessment, RAI Numbers 19.1-163,19.1-171 and 19.1-172

cc: AE Cubbage USNRC (with enclosure)
GB Stramback GEH/San Jose (with enclosure)
RE Brown GEH/Wilmington (with enclosure)
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eDRFSection	0000-0079-8612	NRC RAI 19.1-163
	0000-0079-8613	NRC RAI 19.1-171
	0000-0079-8614	NRC RAI 19.1-172

Enclosure 1

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Response to Portion of NRC Request for

Additional Information Letter No. 132

Related to ESBWR Design Certification Application

ESBWR Probabilistic Risk Assessment

RAI Numbers 19.1-163, 19.1-171 and 19.1-172

NRC RAI 19.1-163

Question Summary: Clarify use of term "typically" used in PRA assumptions listed in DCD, Tier 2, Revision 4, Table 19.2-3 and in ESBWR PRA, Revision 2, Section 12.2.4

Full Text:

The staff is requesting GEH to clarify the use of the term "typically" used in the key assumptions listed in DCD, Tier 2, Revision 4, Table 19.2-3, "Risk Insights and Assumptions" and in ESBWR PRA, Revision 2, Section 12.2.4 as follows:

- *"Typically the main control room (MCR) communicates with the safety-related and nonsafety-related DCIS rooms with fiber optics."*
- *"Typically two load drivers are actuated simultaneously in order to actuate the component."*
- *"For the safety-related Q-DCIS cables, it will typically originate from the QDCIS divisional room in the control building and pass through its own divisional duct bank, then connect to its divisional cable chase in the reactor building."*
- *"For non-safety-related N-DCIS cables, it will typically originate from the N-DCIS rooms in the control building and pass through the nonsafety-related divisional tunnel and connect to rooms in the reactor building, turbine building, or electrical building."*

The use of the word "typically" would imply that there may be some cases where the assumptions do not apply, which presumably would impact the PRA. The staff requests that GEH be more definitive of the atypical cases (i.e., describe the atypical cases).

GEH Response

GEH concurs that more definitive statements should be used as identified in this RAI. In response to RAI 19.1-150, Supplement 1, GEH modified the relevant statements in DCD, Tier 2, Table 19.2-3, to be more definitive. Therefore, no additional changes to DCD, Tier 2, Table 19.2-3, will be made in response to this RAI.

For the assumption in NEDO-33201 Section 12.2.4, "typical" will be deleted from the sentences since there are no atypical cases.

DCD Impact

No DCD changes will be made in response to this RAI.

NEDO-33201, Section 12.2.4, Rev 3 will be revised as noted in the attached markup.

NRC RAI 19.1-171

Question Summary: Revise definition of fire protection defense in depth (NEDO-33201 Section 12.3.1)

Full Text

NEDO-33201 Section 12.3.1, Separation Criteria, includes a statement of the defense in depth criteria for fire protection of a nuclear plant. The third component of this statement is not consistent with the defense in depth description in the DCD and is not consistent with regulatory guidance. Refer to ESBWR DCD Section 9.5.1.1, Power Generation Design Bases, for an acceptable version of the defense in depth criteria. Please revise the definition of fire protection defense in depth (NEDO-33201, Section 12.3.1)

GEH Response

GEH concurs that the definition of fire protection defense-in-depth in ESBWR DCD, Tier 2, Section 9.5.1.1, is a better version. The statement in NEDO-33201, Revision 3, Section 12.3.1, will be revised to be consistent with DCD definition.

DCD Impact

No DCD changes will be made in response to this RAI.

NEDO-33201, Section 12.3.1, Rev 3 will be revised as noted in the attached markup.

NRC RAI 19.1-172

Question Summary: Revise description of the criteria for 3-hour fire barrier separation (NEDO-33201 Section 12.3.1)

Full Text

NEDO-33201 Section 12.3.1, Separation Criteria, includes the criteria for where 3-hour rated fire barriers will be provided in the plant that is inconsistent with the description in Tier 1, Section 2.16.3.1, of the DCD. Please revise NEDO-33201 to be consistent with the DCD.

GEH Response

GEH concurs that the description of the criteria for 3-hour fire barrier separation in DCD Tier 1, Section 2.16.3.1, is a better version. The statement in NEDO-33201, Revision 3, Section 12.3.1, will be revised to be consistent with DCD description.

DCD Impact

No DCD changes will be made in response to this RAI.

NEDO-33201, Section 12.3.1, Rev 3 will be revised as noted in the attached markup.

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Enclosure 1

NEDO 33201, Revision 3 Markups

Section 12.2.4 Task 3 Cable Selection Assumptions

Section 12.3.1 Separation Criteria

propagation are also assumed to result in loss of RWCU. Fire areas F4250 & F4260, and F4350 & F4360 are separated by walls. Thus a fire barrier failure rate of 1.2E-3 is assumed. Fire areas F5550 & F5560 are separated by a corridor (fire area F5100). It is conservatively assumed that fire propagation could occur via three pairs of fire doors with a fire barrier failure probability of 3*7.4E-3*7.4E-3 = 1.6E-4.

(11) The fire areas in the electrical building are well separated. Fire propagation from one area to another in the electrical building would not cause LOPP until it propagates to a third area, which is not considered per the guidance. Fire propagation between the two cable tunnels could result in a scenario similar to LOPP. Since the fire barriers between the two tunnels are walls and sealed penetrations, a fire barrier failure probability of 1.2E-3 is used. A fire in switchyard is conservatively assumed to result in a loss of preferred offsite power.

(12) A fire in the Service Water/Water Treatment Building (fire area F7300) is assumed to result in loss of service water. A fire propagation case with both F3301 and F3302 would result in a loss of service water. However, it is determined that the loss of RWCU initiator would be bounding for shutdown scenarios.

(13) A fire is assumed to cause failure of all fire-susceptible components in the subject fire area. Recovery to the failed system(s) after the postulated fire is not credited.

12.2.4 Task 3 Cable Selection Assumptions:

The following assumptions/considerations are applied in this task:

(14) Based on the plant general arrangement drawings with component locations, cable routing is assumed for PRA purposes. A list of cables is generated from system model database that includes all modeled supports for PRA components included in the system models. This list captures the majority of cables, especially for risk-important components.

(15) For some cables, their failure may only fail one input to the component, which does not impact its operability. Therefore, a cable to component mapping cannot accurately model the actual failure mechanism. For these cables, a special mapping from the cables to the fault tree gates that model the divisional actuation logic is generated.

(16) Fibers are assumed to connect RMUs to their corresponding control cabinets in the DCIS rooms. Hard wires are assumed to connect the components to RMUs. To prevent spurious actuations induced by a fire in a single fire area that could adversely affect safe shutdown, load drivers are designed to be located in different fire areas.

(17) It is assumed that there will be no controls in the MCR that can induce undesirable spurious operations that affect the PRA. The HFE process ultimately decides the hard-wired controls in the MCR. At this time, the SCRAM and MSIV closure will have hard-wired controls in the MCR. In the full-power fire PRA models, the operator action to manually scram the reactor is credited. A MCR fire is not assumed to impact this operator action since this operator action is skill-based and

will be performed as operator's first response to an accident. The HFE group has been recommended not to include other hard-wired controls because of the potential for spurious operations due to fires.

(18) The postulated cable routing obeys the separation criteria.

a. ~~For t~~The safety-related Q-DCIS cables~~, it~~ will ~~typically~~ originate from the Q-DCIS divisional room in the control building and pass through its own divisional duct bank, then connect to its divisional cable chase in the reactor building.

b. ~~For~~ The nonsafety-related N-DCIS cables~~, it~~ will ~~typically~~ originate from the N-DCIS rooms in the control building and pass through the nonsafety-related ~~divisional~~ cable tunnels, and connect to rooms in the reactor building, turbine building, or electrical building.

c. If the N-DCIS cable has to pass through the divisional rooms in reactor building, it is assumed that Q-DICS Div 1 and 3 rooms can be used for N-DCIS Div A and Div 2 and 4 used for Div B.

12.2.5 Task 6 Fire Ignition Frequencies Assumptions:

Per NUREG/CR-6850, the analysis model described in this task is based on the following assumptions.

(19) Fire ignition frequencies remain constant over time.

(20) Among the plants, total ignition frequency is the same for the same equipment type, regardless of differences in the quantity and characteristics of the equipment type that may exist among the plants.

The above assumptions are conservative since the ESBWR design will have significantly lower numbers of pumps, valves and other active components.

(21) Within each plant, the likelihood of fire ignition is the same across an equipment type. For example, pumps are assumed to have the same fire ignition frequency regardless of size, usage level, working environment, etc.

The following are other assumptions used in the fire ignition frequency calculations:

(22) The fire ignition frequencies are evaluated with the best available design information. The design inputs are subject to changes as a result of more detailed designs and PRA insights. However, it is reasonable to assume that the major components and their locations have been well designed and will not have significant changes in the final designs.

(23) It is assumed that all ignition source type bins are applicable to the ESBWR plant with the following exceptions:

a. Bins 02 and 03 are not applicable since they are used for PWR plants.

b. Bin 22 for RPS MG sets is not applicable to ESBWR plants.

(32) The bins for cable fires, cable run and junction boxes are estimated with the cable routing information generated in the cable selection task.

(33) For main control room and DCIS room fire ignition frequency calculations, additional non-PRA transformers, cabinets, and AHUs are counted, which are shown on the general arrangement drawings. This is conservative since the total counts of those components are based on the PRA components only.

(34) During shutdown conditions, a fire barrier may not be intact due to maintenance activities. However, an added fire watch would not only increase the success probability of fire detection and suppression, but also help restore the fire barrier in time to prevent fire propagation. Shutdown fire risks related to the fire barriers are evaluated and managed in accordance with the outage risk management program of 10CFR50.65(a)(4).

Because of the compounding conservative assumptions associated with the fire PRA, it is inappropriate to add the fire CDF or LRF results to the internal events results.

12.3 IDENTIFICATION OF PLANT FIRE AREAS

This section discusses the division of the plant into fire areas for the purpose of the probabilistic internal fires analysis. This division considers separation design criteria and the systems considered significant to the risk profile. The separation design criteria and the resulting fire areas are discussed below.

The plant layout drawings for fire areas and fire boundaries are included in DCD Section 9A (Figures 9A.2-1 through 9A.2-47). Table 9A.5-1 through 9A.5-7 in DCD Section 9A list additional information for these fire areas (Reference 12-4).

A fire in the switchyard could result in a plant trip if it results in loss of preferred power. Such scenario has been included in the fire PRA model with a conservative assumption that any fire in the switchyard would result in a reactor trip. For consistency and conservatism, a fire frequency of 1.8E-2/yr and 5.2E-2/shutdown-year based on RES/OERAB/S01-01 has been used (Reference 12-2). This is double counting since the fire events that could result in a plant trip has been included in the loss of preferred power initiator (the switchyard-related portion of initiator %T-LOPP) in the internal events PRA models. Therefore, the inclusion of these fire scenarios in fire PRA model is conservative.

12.3.1 Separation Criteria

The "Electrical Equipment Separation" design specification provides the basic criteria concerning separation, both physical and electrical, of redundant safety equipment. These specifications are as follows:

- NRC Regulatory Guide 1.75 and IEEE Standard 384 require physical separation and electrical isolation. In addition, the more stringent NRC Policy Statement SECY-89-013 (Paragraph 2.3.c) requires capability for safe shutdown assuming all equipment in any one fire area has been rendered inoperable by fire. In all areas except the Control Room and the primary containment, redundant electrical

divisions should be placed in different fire areas separated by fire barriers rated in accordance with the Fire Prevention and Protection Specification.

- Exceptions are anticipated, but must be individually justified. The Control Room is exempted on condition that independent alternate shutdown capability is provided that is physically and electrically independent of the Control Room (i.e., the Remote Shutdown System). The primary containment design should ensure, to as great an extent as possible, that one shutdown division is free of fire damage.

Fire protection is achieved through an adequate balance of the following objectives:

~~- Preventing fires from starting~~

~~- Detecting fires quickly, suppressing those fires by controlling and extinguishing them quickly, and limiting their damage; and~~

~~- Designing plant systems so that a fire that starts and burns for considerable time does not prevent essential plant safety functions.~~

- To prevent fires from starting;
- To rapidly detect, control, and extinguish promptly those fires that do occur; and
- To provide protection for structures, systems, and components important to safety so that a fire that is not promptly extinguished by the fire suppression activities does not prevent the safe shutdown of the plant and does not significantly increase the risk of radioactive release to the environment.

This fire PRA considers only the mitigation of fires by designs; suppression is not credited in the analysis.

The plant is divided into separate fire areas. The redundant cables and equipment are separated with fire barriers to limit any damage caused by a fire and to provide a means to ensure that there is sufficient capacity to perform safety functions in case of fire.

~~The ESBWR plant design has three-hour fire rated barriers separating:~~

~~- Safety-related systems from potential fires in nonsafety-related areas that could affect their ability to perform their safety function;~~

~~- Redundant divisions or trains of safety-related systems so that both are not subject to damage from a single credible fire that could consume everything within the given fire area; fires within inerted containment during plant operation are not considered credible;~~

~~- Components within a single safety division that could present a fire hazard to other safety-related components;~~

~~- Redundant remote shutdown panels.~~

Fire barriers of 3-hour fire resistance rating are provided in the ESBWR plant design that separate:

- Safety-related systems from any potential fires in nonsafety-related areas that could affect the ability of safety-related systems to perform their safety function.

- Redundant divisions or trains of safety-related systems from each other to prevent damage that could adversely affect a safe shutdown function from a single fire.
- Components within a single safety-related electrical division that present a fire hazard to components in another safety-related division.
- Electrical circuits (safety-related and nonsafety-related) whose fire-induced failure could cause a spurious actuation that could adversely affect a safe shutdown function.

The application of these separation criteria ensures an adequate independence of each safety system division, such that a fire in a single fire area can only affect one safety system division. These criteria are used in this analysis to support definitions of the major fire areas.

ESBWR nonsafety-related systems with the potential to adversely affect safety are designed with similar separation considerations.

12.3.2 Plant Fire Areas

The global plant analysis boundary uses all the fire areas defined in DCD Rev. 4 Chapter 9 (Reference 12-4), which covers all the protected area. All fire areas defined in the Fire Hazard Analysis (FHA) are included in the plant boundary. These fire areas are used to map to physical rooms and then to components.

A total of 148 fire areas are defined in FHA tables. Table 12.3-1 summarized all the fire areas with the exceptions described as follows.

Primary containment is not a significant fire area because it is inerted during plant operation. During shutdown the primary containment is not inerted; however, the small quantity of combustible materials and spatial separation prevent damage to the redundant divisional circuits in this area. The Level 2 PRA considers de-inerted operation prior to and following shutdown as described in NEDO-33201, Section 8.1.4.

The FHA fire areas are grouped in the plant locations described as follows.

12.3.2.1 Reactor Building

This building houses all safety-related structures, systems and components (SSCs), except for the main control room, safety-related distributed control and information system equipment rooms and spent fuel storage pool. This includes the reactor, containment, equipment rooms/compartments outside containment, the refueling area with the fuel buffer pool, and auxiliary equipment area.

- The reactor building contains cabinets and electrical equipment associated with each of the safety-related divisions. This electrical equipment includes the batteries and the DC distribution panels for all safety-related equipment. The electrical equipment is distributed on different elevations within the Reactor Building. Each division is located in a separate fire area, which in some cases include areas on more than one elevation. Each divisional fire area is bounded on all sides by three-hour rated fire barriers. Likewise, it is also assumed that the routing of associated cables respects the separation criteria. It is assumed that all