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Subject: Response to Portion of NRC Request for Additional Information Letter No. 275, Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Numbers 9.1-96 through 9.1-115

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission Request for Additional Information (RAI) sent by NRC Letter 275, dated December 11, 2008 (Reference 1). The GEH response to RAI Numbers 9.1-96 through 9.1-115 are addressed in Enclosure 1.

Should you have any questions or require additional information regarding the information provided here, please contact me.

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

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NRO

Reference:

1. MFN 08-967, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 275 Related to ESBWR Design Certification Application,* December 11, 2008.

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 275 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Numbers 9.1-96 through 9.1-115

cc:	AE Cubbage	USNRC (with enclosures)
	DH Hinds	GEH (with enclosures)
	RE Brown	GEH (with enclosures)
	eDRF	0000-0095-5343, 0000-0097-2211, 0000-0097-2211, 0000-0095-5346, 0000-0095-5347, 0000-0095-5348, 0000-0095-5349, 0000-0095-5350, 0000-0095-5351, 0000-0095-5352, 0000-0095-5353, 0000-0095-5354, 0000-0095-5355, 0000-0095-5359, 0000-0095-5362, 0000-0095-5365, 0000-0095-5366, 0000-0095-5368, 0000-0095-5369, 0000-0097-2211, respectively

Enclosure 1

MFN 09-163

Response to Portion of NRC Request for

Additional Information Letter No. 275

Related to ESBWR Design Certification Application

Auxiliary Systems

RAI Numbers 9.1-96 through 9.1-115

NRC RAI 9.1-96

In Section 9.1.4, "Design Bases," Section 9.1.5.2, "General," and Table 9.1-5, "Reference Codes and Standards," of the DCD, Revision 5, the applicant references only NUREG-0554, "Single-Failure Proof Cranes for Nuclear Power Plants," as containing the guidance it will follow in designing a single failure proof crane. Section 9.1-5, "Overhead Heavy Load Handling Systems," of NUREG-0800, "Standard Review Plan," Subsection 4(C)(i) calls for single failure proof, Type 1 cranes to be designed to the criteria of ASME NOG-1 2004. Please modify your write up in Sections 9.1.4 and 9.1.5, and Table 9.1-5 of the DCD Tier 2 to refer to the ASME standard for each single failure proof crane, and to more clearly articulate which of the cranes are going to be designed to be single failure proof. In particular, the staff desires clarification about the status of the RB and FB cranes.

GEH Response

Per the telephone call between GEH and the NRC on February 19, 2009, the following actions have been agreed upon:

- GEH is to add ASME NOG-1 as a reference in DCD Tier 2, Revision 6. Subsections 9.1.4.5 and 9.1.5.2 and Table 9.1-5 are being revised in Revision 6 to add ASME NOG-1 as a reference

DCD Tier 2, Revision 5, Subsection 9.1.4.5 currently states the refueling machine fuel mast, the fuel hoist, and the fuel handling machine fuel mast, the fuel hoist, are designed to be single failure proof. DCD Tier 2, Revision 5, Table 9.1-5, currently state the refueling and fuel building overhead cranes are both designed to be single failure proof. No additional clarification is needed concerning the single failure proof status of the RB and FB cranes.

DCD Impact

DCD Tier 2, Subsections 9.1.4.5 and 9.1.5.2 and Tables 9.1-5 and 1.9-22 are being revised in Revision 6 as noted in the attached markup.

NRC RAI 9.1-97

In Section 9.1.3.2, "System Description" of the DCD, Revision 5, the applicant states that the FAPCS "suppression pool suction line is conservatively designed to preclude a rupture between the pool and the containment isolation valves." Please provide a reference(s) where the design details and justification are provided in the DCD that this line cannot rupture under any circumstances.

GEH Response

Guidance is given in DCD Tier 2, Subsection 3.6.2.1.2 under the headings "Moderate-Energy Piping in Containment Penetration Area" and "Moderate Energy in Areas Other Than Containment Penetration".

The statement in DCD Tier 2, Subsection 9.1.3.2 is being modified in Revision 6 to clarify the intent and to include a reference to Subsection 3.6.2.1.2.

DCD Impact

DCD Tier 2, Subsection 9.1.3.2 is being revised in Revision 6 as noted in the attached markup.

NRC RAI 9.1-98

Section 9.1.3.2, "System Description," DCD, Revision 5, states that dual mode operation of FAPCS is prohibited using a single train. Please explain how that action specifically is prohibited.

GEH Response

The operation of FAPCS trains will be implemented as logic functions of PIP A N-DCIS and PIP-B N-DCIS. The DCD requirement cited by the NRC is implemented in the development of the controller software, as are the HFE requirements, which are developed as a result of task analysis. A configuration change table will be developed that defines the valid modes of operation for each FAPCS train and defines the acceptable transitions that can occur. FAPCS will be instrumented such that any configuration or alignment can be achieved or prohibited as required. Additionally, prohibited modes of operation will be alarmed.

DCD Impact

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

NRC RAI 9.1-99

Section 9.1.5, "Overhead Heavy Load Handling Systems (OHLHS)", DCD, Revision 5, describes the heavy load drop analyses performed by the applicant. Please describe how the evaluations took into account the potential for the function of main steam line and isolation condenser nozzle plugs to be affected by heavy load drops. Similarly, what is the effect of heavy load drops on SSCs that form a temporary reactor coolant boundary during shutdown activities?

GEH Response

NUREG-0612 Section 5.1.4 allows its recommended guidelines to be satisfied by (1) ensuring the reactor building overhead crane and associated lifting devices used for handling the above heavy loads, should satisfy the single-failure-proof guidelines of NUREG-0612 Section 5.1.6 or (2) the effects of heavy load drops in the reactor building should be analyzed to show the recommended guidelines evaluation criteria are satisfied. GEH has not performed a formal calculation to show the effects of heavy load drops in the reactor building satisfy the recommended guidelines evaluation criteria. Instead, GEH has chosen to have the heavy load handling equipment designed to comply with the single failure-proof guidelines of NUREG-0612 Section 5.1.6 such that no single failure will result in dropping of a load and affecting equipment such as main steam line and isolation condenser nozzle plugs, as well as other SSCs that form a temporary reactor coolant boundary during shutdown activities.

As stated in DCD Tier 2, Revision 5, Section 9.1.4.8, lifting tools for lifting heavy loads are designed using a dual load path or designed for a safety factor of 10 or better with respect to the ultimate strength of the material used. The reactor building overhead crane and associated lifting devices used for handling heavy loads meet the requirements of NUREG-0554 and are single failure-proof. Also, hoists, cranes, or other lifting comply with the applicable requirements of NRC Bulletin 96-02, ANSI N14.6, ASME/ANSI B30.9, ASME/ANSI B30.10 and NUREG-0612.

DCD Impact

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

NRC RAI 9.1-100

The Acceptance Criteria in Section 9.1.5, "Overhead Heavy Load Handling Systems:' NUREG-0800, "Standard Review Plan" (SRP) cites that General Design Criteria (GDC) 1 of Appendix A to 10 CFR Part 50 should be addressed by an applicant regarding the design, fabrication, and testing of structures, systems, and components important to safety to maintain quality standards. In particular, for GDC 1, it states that it is acceptable for an applicant to commit to meeting design, fabrication and testing guidance in NUEG-0554 for overhead handling systems and ANSI N14.6 or ASME B30.9 for lifting devices (Note NUREG-0554 and ANSI/ASME refer to NUREG-0612 seismic guidance). Section 9.1.5, "Overhead Heavy Load Handling Systems (OHLHS)," DCD, Revision 5, does not address how the design meets the GDC 1 criteria nor does it commit to meet GDC 1. Either specifically commit to meeting the above criteria for GDC 1, or identify the differences between the design features, analytical techniques, and procedural measures proposed for the ESBWR design and the SRP acceptance criteria and address how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with NRC regulations.

GEH Response

DCD Tier 2, Subsection 9.1.5.2 is being revised in Revision 6 to state that the Overhead Heavy Load Handling Systems (OHLHS) complies with meeting the criteria of GDC 1 of Appendix A to 10 CFR Part 50.

DCD Impact

DCD Tier 2, Subsection 9.1.5.2 is being revised in Revision 6 as noted in the attached markup.

NRC RAI 9.1-101

The Acceptance Criteria in Section 9.1.5, "Overhead Heavy Load Handling Systems," NUREG-0800, "Standard Review Plan" (SRP) cites that General Design Criteria (GDC) 2 of Appendix A to 10 CFR Part 50 should be addressed by an applicant regarding the ability of the structures, equipment, and mechanisms to withstand the effects of earthquakes. In particular, for GDC 2, it states that it is acceptable for an applicant to commit to meeting the relevant aspects of Position C.2 of Regulatory Guide 1.29, "Seismic Design Classification," and Section 2.5 of NUREG-0554, "Single-Failure-Proof Cranes for Nuclear Power Plants." Section 9.1.5, "Overhead Heavy Load Handling Systems (OHLHS)," DCD, Revision 5, does not address Section 2.5 of NUREG-0554 in the context of GDC 2. Either commit to meeting the above criteria for GDC 2, or identify the differences between the design features, analytical techniques, and procedural measures proposed for the ESBWR design and the SRP acceptance criteria and address how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with NRC regulations.

GEH Response

DCD Tier 2, Subsection 9.1.5.2 is being revised in Revision 6 to commit the Overhead Heavy Load Handling System (OHLHS) to complying with the requirements of NUREG-0554 thus meeting the criteria of GDC 2 of Appendix A to 10 CFR Part 50.

DCD Impact

DCD Tier 2, Subsection 9.1.5.2 is being revised in Revision 6, as noted in the attached markup.

NRC RAI 9.1-102

In the review procedure guidance, Section 9.1.5, "Overhead Heavy Load Handling Systems," NUREG-0800, "Standard Review Plan" (SRP), an applicant is expected to describe the physical arrangement of heavy load handling systems for stored fuel and safe shutdown equipment. DCD Section 9.1.5.9 states that, "The separation (arrangement, equipment interlocks, and routing) of redundant safety-related components in relation to heavy load paths minimizes the potential to cause failure of safety-related components"; however, no arrangement is provided. Section 9.1.5.4, "System Description," DCD, Revision 5 also does not provide a description of physical arrangements. Please provide these descriptions or address how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with NRC regulations.

GEH Response

Per the telephone call between GEH and the NRC on February 19, 2009, the following actions have been agreed upon:

- GEH is to list the fuel and reactor building overhead cranes, as well as the refueling machine and fuel building machine hoists as single failure proof with an ITAAC in DCD Tier 1. This action is being incorporated in the GEH proposed response to RAI 14.3-441.
- Drawings are no longer needed to show the physical arrangement of heavy load handling systems. The COL applicant will develop the heavy load safe paths and routing plans as a requirement of DCD Tier 2, COL item 9.1-5-A. The fuel and reactor building cranes and refueling machine and fuel building machine hoists are designed such that no single failure will result in the dropping of a load and cause the failure of safety related components.

DCD Impact

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

NRC RAI 9.1-103

In Section 9.1.5.2, "General," of the DCD, Revision 5, the applicant commits to having hoists, cranes, or other lifting devices comply with among other standards, ASME/ANSI B30.9. Subsection III.4.C.ii.(2) of Section 9.1.5 "Overhead Heavy Loads handling Systems," NUREG-0800, "Standard Review Plan," states, "[s]lings should satisfy the criteria of ASME B30.9 and be constructed of metallic material (chain or wire rope)." This criterion is supported by operating experience documented in NUREG-1774, "A Survey of Crane Operating Experience at U.S. Nuclear Power Plants from 1968 through 2002." The report cites various examples where Kevlar slings failed or separated causing a load drop. Please justify your choice to not specify metallic material (chain or rope) for construction of slings.

GEH Response

Per the telephone call between GEH and the NRC on February 26, 2009, both GEH and the NRC agreed upon the following item:

- GEH will revise the existing COL applicant item related to the handling of heavy loads to ensure the utility addresses issues described in Regulatory Issue Summary (RIS) 2005-25, Supplement 1, Clarification of NRC Guidelines for Control of Heavy Loads, related to the use of non-metallic slings with single failure proof lifting devices.
- DCD Tier 2 Subsections 9.1.5.8 and 9.1.5-A are being revised in Revision 6 to include the revised COL applicant information related to the use of non-metallic slings with single failure proof lifting devices.

DCD Impact

DCD Tier 2, Subsections 9.1.5.8 and 9.1.5-A, are being revised in Revision 6 as noted in the attached markup.

NRC RAI 9.1-104

In Section 9.1.5.8, "Operation Responsibilities," DCD, Revision 5, the applicant lists requirements for COL applicants to comply with regarding a Quality Assurance program to monitor, implement, and ensure compliance with the heavy load handling program. In Subsection III.4.C.i of Section 9.1.5 "Overhead Heavy Loads Handling Systems," NUREG-0800, "Standard Review Plan," (SRP) states, "the program should include at least the following elements: (1) design and procurement document control; (2) instructions, procedures, and drawings; (3) control of purchased material, equipment, and services (See also Section 10 of NUREG-0554); (4) inspection; (5) testing and test control; (6) non-conforming items; (7) corrective action; and (8) records. This guidance is typically used for developing the QA program for a non-safety system. The listing in Section 9.1.5.8 of the DCD does not appear to comply with Subsection 1I1.4.C.I of Section 9.1.5 of the SRP. Please incorporate the missing guidance or address how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with NRC regulations.

GEH Response

DCD Tier 2, Subsection 9.1.5.2 is being revised in Revision 6, to address the guidance in Subsection III.4.C.1 of Section 9.1.5 of the SRP. DCD Tier 2, Subsections 9.1.5.8 and 9.1-5-A are also being revised in Revision 6 to commit the overhead heavy load handling system (OHLHS) to meeting the quality assurance program requirements of NUREG-0554 and the program elements added to DCD Tier 2 Section 9.1.5.2.

DCD Impact

DCD Tier 2, Subsections 9.1.5.2, 9.1.5.8 and 9.1-5-A are being revised in Revision 6 as noted in the attached markup.

NRC RAI 9.1-105

Subsection III.4.C.ii.(1) of Section 9.1.5 "Overhead Heavy Loads Handling Systems," NUREG-0800, "Standard Review Plan," (SRP) states, "[a} special lifting device that satisfies ANSI N14.6 should be used for recurrent load movements in critical areas (reactor head lifting, reactor vessel internals, spent fuel casks) (See also Section 5.1.6, NUREG-0612). The lifting device should have either dual, independent load paths or a single load path with twice the design safety factor specified by ANSI N14.6 for the load." Section 9.1.5.5, "Fuel Building and Reactor Building Cranes," of the DCD, Revision 5, is silent regarding the load paths and safety factors. Either modify the DCD Tier 2 to address lifting device criteria for the FB and RB cranes or address how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with NRC regulations.

GEH Response

DCD Tier 2, Subsection 9.1.5.5 is being revised in Revision 6 to identify lifting device load path and safety factor criteria based on ANSI N14.6 and NUREG-0612, Section 5.1.6 for the FB and RB cranes.

DCD Impact

DCD Tier 2, Subsection 9.1.5.5 is being revised in Revision 6 as noted in the attached markup.

NRC RAI 9.1-106

Subsection I.1 of Section 9.1.4, "Light Load Handling System (Related to Refueling)," NUREG-0800, "Standard Review Plan (SRP)," states the staff should review, "[t]he design layout, which shows the functional geometric layout of the fuel handling equipment and areas" to determine if the various handling operations can be performed safely." SRP Section 9.1.4, Subsection III (1), "Review Procedures," also states that the Light Load Handling System (LLHS) physical arrangements for stored fuel and fuel handling areas are to be sufficiently described to establish that the various handling operations can be performed safely. Figures showing overall system arrangement, including reactor well, the buffer pool, the upper fuel transfer pool, the inclined fuel transfer pool, the fuel building storage pool, the spent fuel storage pool, the lower fuel transfer pool, cask pool, and the inclined fuel transfer system have not been provided by the applicant. Either modify the DCD Tier 2 to address the functional geometric layout of the fuel handling equipment and areas, or show how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with NRC regulations.

GEH Response

Per the telephone call between GEH and the NRC on February 19, 2009, the following actions have been agreed upon:

- GEH is to list the fuel and reactor building overhead cranes, as well as the refueling machine and fuel building machine hoists as single failure proof with an ITAAC in DCD Tier 1. This action is being incorporated in the GEH proposed response to RAI 14.3-441.
- The Nuclear Island Plan figures for the different reactor and fuel building elevations, Figures 1.2-1 to 1.2-11, are included in DCD Tier 2, Section 1.2. These figures show the overall light load handling system arrangement related to refueling and no additional drawings are needed to show the physical arrangement of the light load handling system.

DCD Impact

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

NRC RAI 9.1-107

In Section 9.1.4, "Light Load Handling System (Related to Refueling)," NUREG-0800, "Standard Review Plan," (SRP), acceptance criteria for meeting the relevant requirements of GDC 61 and GDC 62 are based on meeting the guidelines of ANSI/ANS 57.1-1992. Table 1, "Required Interlock Protection," in ANSI/ANS-57.1-1992 provides interlock protection guidelines for each component of a fuel handling system. The application describes the interlocks associated with the refueling machine and fuel handling machine, which are not complete with respect to Table 1 listed above. Additionally, Table 1 lists interlock guidelines for equipment such as the fuel building crane, reactor building crane, fuel prep machine, control component change mechanism, inclined fuel transfer system, and the upenders, which are not described in the application. Please describe in the DCD how each required interlock specified in Table 1 of ANSI/ANS 57.1-1992 is applied for each of the components listed in Table 1 and provide a markup in the DCD Tier 2 showing the above requested information or show how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with NRC regulations.

GEH Response

Per the telephone call between GEH and the NRC on February 19, 2009, the following action has been agreed upon:

- GEH is to revise DCD Tier 2 Subsection 9.1.4 to state that the list of interlocks discussed throughout the subsection is a partial list of interlocks described in Table 1 of ANSI/ANS 57.1.
- Because GEH commits in DCD Tier 2, Subsection 9.1.4.18 to meeting the criteria of GDC 61 and 62 of Appendix A to 10 CFR 50 for the fuel handling system by meeting the guidance of Regulatory Guides 1.13, 1.29, 1.117 and ANSI/ANS 57.1, it is not necessary to provide a markup in the DCD describing how each interlock specified in Table 1 of ANSI/ANS 57.1 is applied to the components listed in Table 1.

DCD Impact

DCD Tier 2, Subsection 9.1.4.1 is being revised in Revision 6 as noted in the attached markup.

NRC RAI 9.1-108

The Fuel Handling Machine is described in Section 9.1.4.5, "Refueling Equipment," of the DCD Tier 2, Revision 5. The Fuel Handling Machine transports spent fuel assemblies over and above the spent fuel racks. If the raised fuel assembly was too close to the water surface of the spent fuel pool (SFP), excessive radiation levels might occur on the fuel handling floor. Water volume shields radiation. GDC 61 requires the avoidance of excessive personnel radiation exposure. DCD Tier 2 Section 9.1.4.5 states that, "The grapple in its retracted position provides sufficient water shielding of at least 2591 mm (8.5 ft.) over the active fuel during transit." Note that the variance with RG 1.13 (8.5 feet of shielding vs. the recommended 10 ft) is addressed by RAI 9.1-50 supplement 2. DCD Tier 2 Section 9.1.4.18 states that, "the retraced position is controlled by both interlocks and physical stops to prevent raising the fuel assembly above the normal stop position required for safe handling of the fuel." However, these interlocks are not described. Please explain the operating interlocks for the Fuel Handling Machine, which ensure a spent fuel assembly is not raised above a specified water level in the SFP, such that radiation levels in the FB are as low as reasonably achievable (ALARA).

GEH Response

The interlock referred to in DCD Tier 2, Section 9.1.4.18, is the "normal up" interlock for both the fuel handling and refueling machines. For the "normal up" interlock, power to the main hoist is interrupted when the fuel grapple hook is at its normal retracted position and provides the "normal up" indicator light. The normal retracted position is designed to prevent raising fuel above the safe water shield level of 2591 mm (8.5 feet) over the top of the active fuel to the surface of the fuel pool.

Detailed design information for the "normal up" interlock is usually contained in other detailed design documents and is not intended to be in the DCD.

DCD Impact

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

NRC RAI 9.1-109

Section 9.1.4.9, "In-Vessel Servicing Equipment," of the DCD, Revision 5, discusses moving the instrument strongback with the Reactor Building auxiliary hoist and the instrument handling tool with the refueling platform auxiliary hoist. Please modify Table 9.1-5, "Reference Codes and Standards," in the next revision to the DCD Tier 2 to identify to which standards and codes these hoists are to be constructed and operated.

GEH Response

Crane Manufacturer's Association of America (CMAA) – 70, "Specifications for Electric Overhead Traveling Cranes," applies to the construction and operation of the refueling machine auxiliary hoist used for lifting light incore servicing tools that are not heavy loads, such as the instrument handling tool. CMAA–70 is already listed in Table 9.1-5 as applying to the refueling machine, and by default, the auxiliary hoist as well. The Reactor Building overhead crane auxiliary hoist is constructed and operated in the same manner as the main hoist of the Reactor Building overhead crane, thus meeting the same standards listed in Table 9.1-5. These standards are ANS – N14.6, ASME/ANSI B30.2, ASME/ANSI B30.10, ASME/ANSI B30.11, ASME/ANSI B30.16, ANSI/ANS 57.1, CMAA-70, NUREG-0554, and NUREG-0612.

DCD Impact

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

NRC RAI 9.1-110

In Section 9.1.4.12, "Fuel Transfer System," DCD, Revision 5, it states that there is a means to seal off the upper and lower ends of the transfer tube while allowing filling and venting of the tube. Please explain how this is to be accomplished and the implications of failure of these seals in such a manner as to drain the tube while fuel is being transported in it.

GEH Response

Sealing of the upper and lower ends of the transfer system tube is accomplished with valves. There are two valves at the top terminus of the transfer system. The (1) top valve closes off the inclined fuel transfer system (IFTS) tube, which has a 23 inch inside diameter, when the bottom valve is open and (2) a smaller 4-inch fill valve is used to fill the IFTS tube prior to transferring fuel from the lower fuel transfer pool to the upper fuel transfer pool. During the transfer of fuel from the lower fuel transfer pool to the upper fuel transfer pool, the bottom valve is closed.

The top valve closes after the carriage with fuel has moved downward into the middle portion of the transfer tube. The fill valve remains fully open until the fuel has completely moved downward from the IFTS upper fuel transfer pool to a position in the transfer tube that is below the surface of the water in the IFTS lower fuel transfer pool. Prior to (and a condition prior to) opening the bottom valve, the fill valve is closed. Should the bottom valve or 4-inch drain valve leak at the specified leak rate given below during transfer, water from the IFTS upper fuel transfer pool will always be available via the fill valve prior to opening the bottom valve.

There are diverse (carriage position, valve position, water level position) and redundant (2 sensors per position) sensors and interlocks that prevent simultaneous opening of the upper (top and fill) and lower (bottom and drain) valves.

Based on the design specification, the maximum leak rate for the valves will not exceed 10 cubic centimeters of water per hour. This leak rate is very small compared to the amount of water in the transfer tube during fuel transfer.

DCD Impact

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

NRC RAI 9.1-111

In Section 9.1.4.12, "Fuel Transfer System," DCD, Revision 5, it states that there are no modes of operation that allow simultaneous opening of any set of valves that could cause draining of water from the upper pool in an uncontrolled manner. Please explain the engineering basis for this assertion and whether this protection is single failure proof.

GEH Response

No single failure can cause the draining of water from the upper fuel transfer pool in an uncontrolled manner. There are diverse (carriage position, valve position, water level position) and redundant (2 sensors per position) sensors and interlocks that prevent simultaneous opening of the upper (top and 4-inch fill) valves and lower (bottom and 4-inch drain) valves.

In order for the bottom valve to open, all of the following logic conditions must be met.

- Top Valve Closed
- Fill Valve Closed
- Carriage in proper position in transfer tube (below water level elevation in spent fuel pool)
- Tube Drained (water level in tube at the same level as water level in spent fuel pool)
- Diverse Tube Drained (low water pressure at bottom valve compared to water head when tube is open and exposed to upper pool).

There are diverse (carriage position, valve positions) and redundant (2 sensors per position) sensors and interlocks that prevent simultaneous opening of the upper (top and fill) valves and the drain valve.

In order for the drain valve to open, all of the following logic conditions must be met.

- Top Valve Closed
- Fill Valve Closed
- Carriage in proper position in transfer tube (below water level elevation in spent fuel pool)

DCD Impact

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

NRC RAI 9.1-112

In Section 9.1.4.12, "Fuel Transfer System," DCD, Revision 5, it states that the inclined fuel transfer system tubes and supporting structure can withstand an SSE without failure of the basic structure or compromising the integrity of adjacent equipment and structures. In Revision 5, Section 9.1.4.12 was changed to state that cooling is provide for two instead of one freshly removed fuel assemblies in the incline fuel transfer system. Please confirm in the DCD Tier 2 whether the engineering basis for this assertion assumes at least two fuel assemblies are contained in the transport device (i.e., carriage) during the seismic event.

GEH Response

The seismic event assumes that two fuel assemblies are contained in the seismic category I Inclined Fuel Transfer System (IFTS) tube. The fuel assemblies can remain there until they are removed without damage to the fuel or excessive overheating.

DCD Impact

DCD Tier 2, Subsection 9.1.4.12 is being revised in Revision 6 as noted in the attached markup.

NRC RAI 9.1-113

NRC RAI 9.1-113

In Section 9.1.4.12, "Fuel Transfer System," DCD, Revision 5, it states that (1) controls prevent personnel from inadvertently or unintentionally being left in high radiation areas or areas immediately adjacent to the Inclined Fuel Transport System (IFTS) at the time the access doors are closed, (2) that during IFTS operation or shutdown, personnel are prevented from reactivating the IFTS while personnel are in the area or entering the controlled maintenance area while irradiated fuel or components are in any part of the IFTS. Please describe these controls in the next revision to the DCD Tier 2.

GEH Response

As discussed in the GEH response to RAI 12.4-19 S03, questions 1, 2, and 3, (MFN 06-499, Supplement 2, dated January 27, 2009) these radiation protection controls include keeping room 1702 and the trapezoidal room, permanently closed, except when maintenance is being carried out on the components (valves, seals) that service the IFTS tube. This maintenance will only be done when there is no fuel being transferred. Other areas with controls (barriers and interlocks) include the Fuel Building rail car bay, immediately adjacent to IFTS, at the 4650 and 13570 elevations. Further details on access to high radiation areas and IFTS high radiation area controls are provided in DCD Tier 2 Sections 12.3.1.3 and 12.3.1.4.4.

Per the telephone call between GEH and the NRC on February 19, 2009, the NRC has agreed that the GEH response in RAI 12.4-19 S03 is sufficient such that the requested controls do not have to be described further in the DCD.

DCD Impact

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

NRC RAI 9.1-114

Guidelines specified in Section 9.1.4, "Light Load Handling System Related to Refueling," NUREG-0800, "Standard Review Plan," (SRP) state that the objective of the review is to confirm that the light load handling system design precludes system malfunctions or failures that could cause criticality accidents, a release of radioactivity, or excessive personnel radiation exposures. Section 9.1.4, "Light Load handling System (Related to Refueling)," only indirectly addresses transfer of spent fuel to a cask. Section 9.1.4.3, "Spent Fuel Cask," of the DCD, Revision 5, states that spent fuel casks are not in the ESBWR standard plant scope. Provide a COL Action Item or a DCD Tier 1 interface item that requires a COL applicant to address spent fuel casks including identifying safety and non-safety related components, a description of the safety function of each safety related component, a discussion of the seismic capacity of the spent fuel cask system, a discussion of how the single failure criterion is satisfied, a discussion of how emergency cooling is accomplished, a discussion of the need for emergency cooling of spent fuel casks, and a discussion of interlocks.

GEH Response

Per the telephone call between GEH and the NRC on February 26, 2009, both GEH and the NRC agreed upon the following item:

- A COL Action item or a DCD Tier 1 interface item that requires a COL applicant to address spent fuel casks is not required to be included in the DCD. The NRC is satisfied with the fuel building overhead crane main hook 165-ton rated load capacity. This rated load capacity allows the fuel building overhead crane to safely lift a spent fuel cask.

DCD Impact

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

NRC RAI 9.1-115

The staffs review of pools that could potentially contain new or spent fuel includes consideration of events that could lower the level of the pools and uncover fuel. Please provide an elevation diagram of the spent fuel storage pool, lower fuel transfer pool, and cask pool, including any pits in the pools and interfaces (e.g., gates or weirs) between/among the pools or pathways that could potentially lower the water level in the pools to unacceptable levels. Similarly, provide an elevation diacram of the buffer pool, reactor well, upper fuel transfer pool, inclined fuel transfer system, and equipment storage pool, as well as any interfaces or pits in the pools. Elevation diagrams should indicate the height of the top of fuel in any pool that could contain fuel.

GEH Response

GEH notes that similar questions regarding leakage, drain-down, and fuel uncovery have been raised and resolved by RAI 9.1-46 S01 (MFN 08-440, dated May 02, 2008).

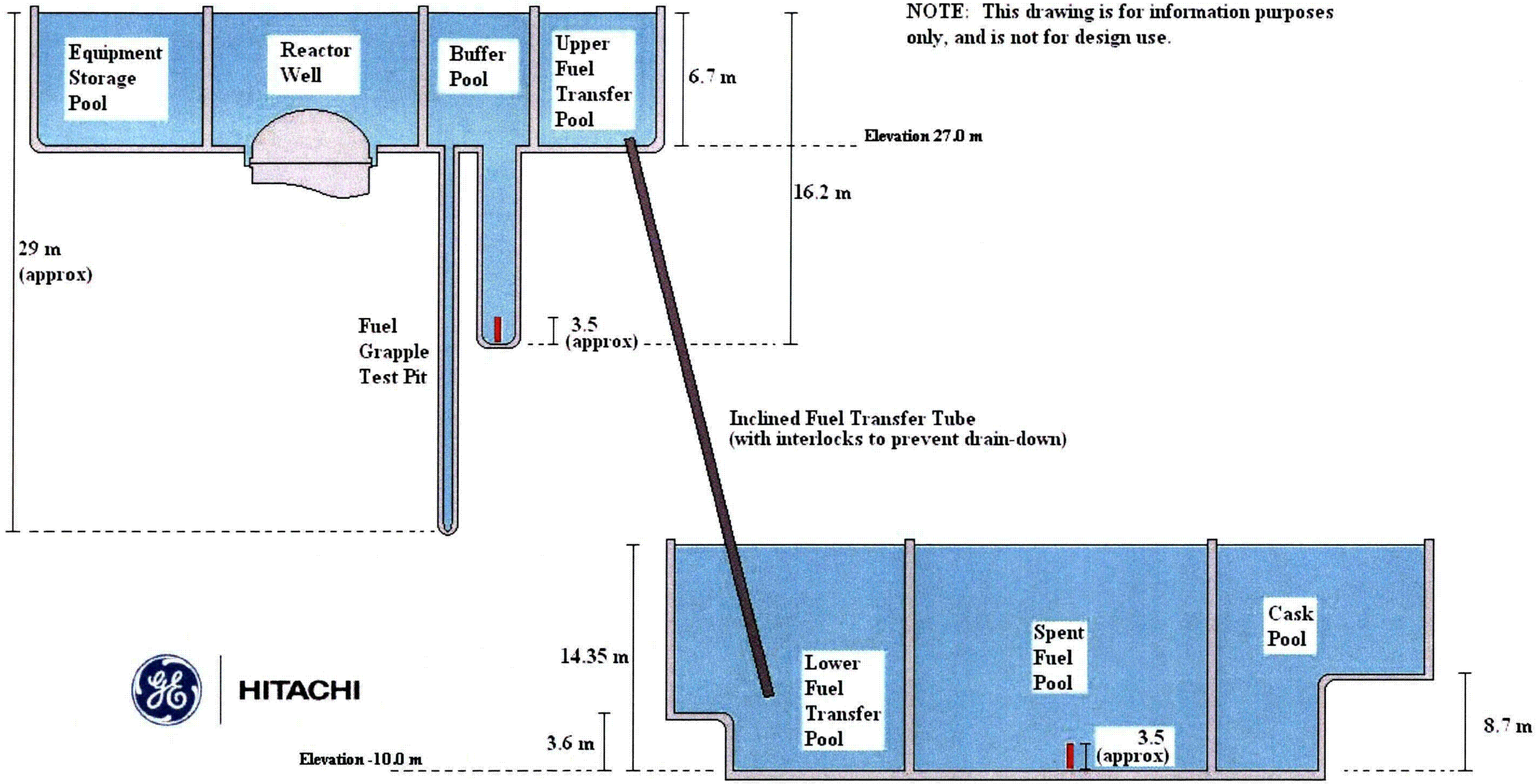
For additional clarification, please review the sketch in Attachment 1 that shows, in very basic terms, the configuration of these pools.

The drawing is not done to scale and is only intended to show the depth of normal water level from the pool floors including shelves and pits.

Certain items such as gate dimensions have not been determined yet and are not included on the sketch. The quantity of weirs in each pool has not yet been determined. Weirs are located at or above normal water level and therefore cannot lower the level of the pools below normal water level.

DCD Impact

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



NOTE: This drawing is for information purposes only, and is not for design use.

HITACHI

Table 1.9-22

Industrial Codes and Standards[2] Applicable to ESBWR

Code or Standard Number	Year	Title
N45.2.1-1980	1980	Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants (See also NQA-1 and NQA-2)
N45.2.2-1978	1978	Packaging, Shipping, Receiving, Storage, and Handling of Items for Nuclear Power Plants, QA Cases – December 1978 (See also NQA-1 and NQA-2)
N45.2.6-1978	1978	Qualifications of Inspection, Examination and Testing Personnel for Nuclear Power Plants (See also NQA-1 and NQA-2)
N45.2.9-1979	1979	Requirements for the Collection, Storage, and Maintenance of QA Records for Nuclear Power Plants (See also NQA-1 and NQA-2)
NOG-1-2004~~2~~	2004~~2~~	Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)
NQA-1-1983	1983	Quality Assurance Program Requirements for Nuclear Facilities (Note: more recent versions exist)
NQA-1a-1983	1983	Addenda to ANSI/ASME NQA-1-1983 Edition, Quality Assurance Requirements for Nuclear Facility Applications (Note: more recent versions exist)
NQA-2-1983	1983	Quality Assurance Requirements for Nuclear Facility Applications (Note: more recent versions exist)
PTC 6-1996	1996	Steam Turbines
PTC 6A-2000	2000	Appendix A to PT6, the Test Code for Steam Turbines
PTC 8.2-1990	1990	Centrifugal Pumps
PTC 17-1973	1973 (R 2003)	Reciprocating Internal-Combustion Engines
PTC 23-2003	2003	Atmospheric Water Cooling Equipment
PTC 25-2001	2001	Pressure Relief Devices
PTC 26-1962	1962	Speed Governing Systems for Internal Combustion Engine Generator Units
RA-S-2002	2002	Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications
RA-Sa7-2003	2003	Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications, Addendum A to ASME RA-S-2002
RA-Sb-2005	2005	Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications, Addendum B to ASME RA-S-2002
TDP-1-1998	1998	Recommended Practices for the Prevention of Water Damage to Steam Turbines Used for Electric Power Generation (Fossil)
TDP-2-1985	1985	Recommended Practices for the Prevention of Water Damage to Steam Turbines Used for Electric Power Generation (Nuclear)

performed to demonstrate compliance to design requirements. Except for hoisting speed, the fuel hoist is designed to meet the requirements of NUREG-0554, Single Failure Proof Cranes and ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes. An auxiliary hoist is designed to meet the requirements of NUREG-0612, Control of Heavy Loads at Nuclear Power Plants to allow simultaneous handling of the control blade and fuel support casting with the dual function grapple. A second auxiliary hoist is provided for handling smaller lightweight tools.

Fuel Handling Machine

The fuel handling machine is similar to a gantry style crane, and is used to transport fuel and reactor components to and from the inclined fuel transfer system and the spent fuel storage and equipment storage racks. It is also used to move spent fuel to the shipping cask. The machine spans the Spent Fuel Pool on embedded tracks in the refueling floor. A telescoping mast and grapple suspended from a trolley system is used to lift and orient fuel assemblies for placement in the cask or storage rack. Control of the machine is from an operator station on the fuel handling machine.

A position indicating system and travel limit computer is provided to locate the grapple over the spent fuel racks, IFTS, and prevent collisions with pool obstacles. An auxiliary hoist is provided for additional servicing. The grapple in its retracted position provides sufficient water shielding of at least 2591 mm (8.5 ft.) over the active fuel during transit. The fuel grapple hoist has a redundant load path so that no single component failure results in a fuel bundle drop. Interlocks on the machine:

- Prevent collision with fuel pool walls or other structures;
- Limit travel of the fuel grapple;
- Interlock grapple hook engagement with hoist load and hoist up power; and
- Ensure correct sequencing of the transfer operation in the automatic or manual mode.

The fuel handling machine is Seismic ~~Class~~ Category I. The fuel handling machine is designed to withstand the SSE. A standard dynamic analysis using the appropriate response spectra is performed to demonstrate compliance to design requirements. Except for hoisting speed, the fuel hoist is design to meet the requirements of NUREG-0554, Single Failure Proof Cranes and ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes.

9.1.4.6 Fuel Servicing Equipment

Fuel Prep Machine

Two fuel preparation machines are mounted on the wall of the Spent Fuel Pool and are used to assist in the loading of new fuel into the spent fuel storage pool racks and for re-channeling spent fuel assemblies. The machines are also used with fuel inspection fixtures to provide an underwater inspection capability.

Each fuel preparation machine consists of a work platform, a frame, and a movable carriage. The frame and movable carriage are located below the normal water level in the Spent Fuel Pool, thus providing a water shield for the fuel assemblies being handled. The fuel preparation machine carriage has an up-travel-stop to prevent raising fuel above the safe water shield level.

- The inability to cool fuel within the reactor vessel or within the Spent Fuel Pool; and
- Prevent a safe shutdown of the reactor.

This includes risk assessments of spent fuel and of storage pool levels, cooling of fuel pool water, or new fuel criticality. Critical load handling therefore includes all components and equipment used for moving loads weighing more than one fuel assembly with its associated handling devices.

The Reactor and Fuel Building cranes provide a safe and effective means for transporting heavy loads including the handling of new and spent fuel, plant equipment, service tools and fuel casks. Safe handling includes design considerations for maintaining occupational radiation exposure as low as practicable during transportation and handling.

Where applicable, the appropriate seismic category, safety classification, ASME, ANSI, industrial and electrical codes have been identified (refer to Tables 9.13.2-14 and 9.1-5). The designs conform to the relevant requirements of General Design Criteria 1, 2, 4, and 61 of 10 CFR 50, Appendix A by meeting the guidance of RGs 1.13, 1.29, 1.115, 1.117, and ANSI/ANS 57.1, ANSI N14.6, ASME B30.9, and NUREG-0554. The fuel handling system OHLHS is housed within a Seismic Category I structure that is designed to withstand the effects of extreme wind and tornado missiles. The OHLHS is built in accordance with an acceptable quality assurance program, which includes the following program elements:

- Design and procurement document control
- Instructions, procedures, and drawings
- Control of purchased material, equipment, and services
- Inspection
- Testing and test control
- Non-conforming items
- Corrective action
- Records

The lifting capacity of each crane or hoist is designed to at least the maximum actual or anticipated weight of equipment and handling devices in a given area serviced. The hoists, cranes, or other lifting devices comply with the requirements of NRC Bulletin 96-02, NUREG-0554, ANSI N14.6, ASME/ANSI B30.9, ASME/ANSI B30.10, and NUREG-0612 Subsection 5.1.1(4) or 5.1.1(5) and ASME NOG-1. Cranes and hoists are also designed to criteria and guidelines of NUREG-0612 Subsection 5.1.1(7), ASME/ANSI B30.2 and CMAA-70 specifications for electrical overhead traveling cranes, including ASME/ANSI B30.11, and ASME/ANSI B30.16 as applicable.

9.1.5.3 Applicable Design Criteria for All OHLH Equipment

All handling equipment subject to heavy loads handling criteria has ratings consistent with lifts required and the design loading will be visibly marked. Cranes/hoists or monorail hoists pass over the centers of gravity of heavy equipment that is to be lifted. In locations where a single

Table 9.1-5

Reference Codes and Standards

Number	Title	Device
ANS-N14.6	Standard for Special Lifting Devices for Shipping Containers Weighing (5 tons) or More for Nuclear Materials	Applicable to any item carrying a heavy load such as the Reactor Building (RB) and Fuel Building (FB) overhead cranes and the refueling and fuel handling machine
ASME/ANSI B30.9	Slings	Applicable to the RPV dryer strongback slings.
ASME/ANSI B30.10	Hooks	Applicable to the RB and FB overhead cranes.
ASME/ANSI B30.2	Performance Standards for Overhead Electric Overhead Traveling Cranes	Applicable to the RB and FB overhead cranes.
ASME/ANSI B30.16	Performance Standards for Air Wire Rope Hoists	Applicable to the RB and FB overhead cranes.
ASME/ANSI B30.11	Overhead and Gantry Crane	Applicable to the RB and FB overhead cranes.
ANSI/ANS 57.1	Design Requirements for Light Water Reactor Fuel Handling Systems	Applicable to the RB and FB overhead cranes and the refueling and fuel handling machine equipment and tools used to handle fuel and fuel components.
ASME NOG-1	Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)	Applicable to the RB and FB overhead cranes. Applicable to the hoist on the refueling and fuel handling machines that handles the combined fuel support and control blade grapple. Typically, the combined weight of the equipment and tooling exceeds the weight of a fuel assembly.
CMAA70	Specifications for Electric Overhead Traveling Cranes	Applicable to the RB and FB overhead cranes and the refueling and fuel handling machines.
NUREG-0612	Control of Heavy Loads at Nuclear Power Plants	Applicable to the RB and FB overhead cranes. A portion of the NUREG is applicable to the RPV strongback or dryer strongback interface with the lifting device. Applicable to the hoist on the refueling and fuel handling machines that handles the combined fuel support and control blade grapple. Typically the combined weight of the equipment and tooling exceeds the weight of a fuel assembly.
NUREG-0554	Single Failure Proof Cranes for Nuclear Power Plants	Applicable to the RB and FB overhead cranes. Applicable to the hoist on the refueling and fuel handling machines that handles the combined fuel support and control blade grapple. Typically the combined weight of the equipment and tooling exceeds the weight of a fuel assembly.

pressure on the containment liner the drywell spray flow rate must be less than 127 m^3/hr (560 gpm). The drywell spray flow rate is maintained below this value by a sized, flow-restricting orifice located in the drywell spray discharge line. The ring header equipped with spray nozzles is located in the drywell.

A separate cooling and cleanup subsystem completely independent of FAPCS C/C trains and their piping loop is provided for cooling and cleanup of the IC and PCC pools to prevent radioactive contamination of these pools. The subsystem consists of one pump, one heat exchanger, and one water treatment unit.

FAPCS contains two containment isolation valves on the lines that penetrate the primary containment.

For details related to FAPCS containment isolation, refer to Subsection 6.2.4.3.2.

Pipes equipped with normally closed manual valves are provided for establishing flow paths from onsite or offsite post-accident water supplies or the Fire Protection System to refill the IC/PCCS pools and Spent Fuel Pool following a design basis loss of coolant accident.

With the exception of the suppression pool suction line, anti-siphoning devices are used on all submerged FAPCS piping to prevent unintended drainage of the pools. The anti-siphoning holes for all FAPCS discharge lines are located at the elevation of normal water level to prevent significant draining of the pool in case of a suction line break at a lower elevation. The anti-siphoning holes in the suction piping of the GDCS Pools and IC/PCCS C/C subsystem are located at the elevation of minimum water level to prevent significant draining of the pool in case of a suction line break at a lower elevation. The post-accident makeup lines to the Spent Fuel Pool and IC/PCCS Pools are not submerged below the normal water level. Analysis will be performed on ~~T~~the suppression pool suction line, per the requirements of Subsection 3.6.2.1.2 for moderate energy piping, to show that the piping from the pool to the containment isolation valves remains below the threshold limit for postulating leakage cracks. ~~is conservatively designed to preclude a rupture between the pool and the containment isolation valves.~~

The spent fuel pool is equipped with drainage paths behind the liner welds. These paths are designed to:

- Prevent stagnant water buildup behind the liner plate;
- Prevent the uncontrolled loss of contaminated pool water; and
- Provide liner leak detection and measurement.

The reactor well, equipment storage pool, buffer pool, upper and lower fuel transfer pools, cask pool, and IC/PCCS pools are also equipped with stainless steel liners, and shall be equipped with leak detection drains as part of the FAPCS. All leak detection drains are designed to permit free gravity drainage to the Liquid Waste Management System.

The containment isolation valves and other equipment required for the post-accident recovery function are provided with electric power from reliable power supplies. In the event of loss of offsite power, these electric power supplies are automatically connected to the onsite power sources. The electrical power supplies, control and instrumentation of the two FAPCS trains and their supporting systems are electrically and physically separated. Pneumatic power assisted containment isolation valves on the suppression pool supply and return lines are designed to fail

Other Servicing Equipment

Outside of the containment, the main steam tunnel, or the refueling floor there are no safety-related components of one division routed over any portion of a safety-related portion of another division at locations susceptible to heavy load drops capable of causing the loss of a safety-related component required to maintain the plant in a safe condition. Therefore, inadvertent load drops cannot cause (a) a release of radioactivity, (b) a criticality accident, (c) the inability to cool fuel within reactor vessel or Spent Fuel Pool, or (d) prevent the safe shutdown of the reactor. Therefore, the servicing equipment located outside the containment, the main steam tunnel, or the refueling floor is not subject to the requirements of Subsections 9.1.5.2 and 9.1.5.3.

9.1.5.7 Equipment Operating Procedures Maintenance and Service

Each item of equipment requiring servicing is described on an interface control diagram (ICD) delineating the space around the equipment required for servicing. This includes pull space for internal parts, access for tools, handling equipment, and alignment requirements. The ICD specifies the weights of large removable parts, shows the location of their centers of gravity, and describes installed lifting accommodations such as eyes and trunnions. An instruction manual describes maintenance procedures for each piece of equipment to be handled for servicing. Each manual contains suggestions for rigging and lifting of heavy parts, and identifies any special lifting or handling tools required.

Operating instruction and maintenance manuals are provided for reference and use by operations personnel for all major handling equipment components (cranes, hoist, etc.).

9.1.5.8 Operational Responsibilities

Critical heavy load handling in the plant includes the following key elements for the administration and implementation of heavy load handling systems:

- Heavy Load Handling System and Equipment Operating Procedures;
- Heavy Load Handling Equipment Maintenance Procedures and/or Manuals;
- Heavy Load Handling Equipment Inspection and Test Plans; NDE, Visual, etc.;
- Heavy Load Handling Safe Load Paths and Routing Plans;
- QA Program to Monitor and Assure Implementation and Compliance of Heavy Load Handling Operations and Controls (This includes the QA program elements described in Subsection 9.1.5.2); ~~and~~
- Personnel Qualifications, Training and Control Program; and~~.~~
- Heavy Load Handling System Guidelines regarding the use of non-metallic slings with single failure proof lifting devices.

The COL applicant will provide a description of the program governing heavy loads handling, and the schedule for implementation (COL 9.1-5-A).

9.1.5.9 Safety Evaluations

The RB and FB cranes are interlocked to prevent movement of heavy loads over fuel storage pools. The RB and FB cranes are designed to be single failure proof, in accordance with

(Subsection 9.1.1.7)

9.1-5-A Handling of Heavy Loads

The COL applicant will provide a description of the program governing heavy loads handling, and the schedule for implementation, that addresses the following:

- Heavy loads and heavy load handling equipment outside the scope of loads described in the referenced certified design, and the associated heavy load attributes (load weight and typical load path).
- Requirements for heavy load handling safe load paths and routing plans including descriptions of automatic and manual interlocks not described in the referenced certified design and safety devices and procedures to assure safe load path compliance.
- Summary description of requirements to develop heavy load handling equipment maintenance manuals and procedures.
- Requirements for heavy load handling equipment inspection and test plans.
- Requirements for heavy load personnel qualifications, training, and control programs.
- Quality Assurance (QA) program requirements to monitor, implement, and ensure compliance with the heavy load handling program. (Subsection 9.1.5.8) (This includes the QA program elements described in Subsection 9.1.5.2).
- Issues described in Regulatory Issue Summary (RIS) 2005-25, Supplement 1, Clarification of NRC Guidelines for Control of Heavy Loads, related to the use of non-metallic slings with single failure proof lifting devices. (Subsection 9.1.5.8)

9.1.7 References

9.1-1 GE Hitachi Nuclear Energy Americas, LLC, "Dynamic, Load-Drop, and Thermal-Hydraulic Analyses for ESBWR Fuel Racks", NEDC-33373P, Class II (Proprietary), and NEDO-33373, Class I (Non-proprietary).

9.1-2 GE Hitachi Nuclear Energy Americas, LLC, "Criticality Analysis for ESBWR Fuel Racks", NEDC-33374P, Class II (Proprietary), and NEDO-33374, Class I (Non-proprietary).

- The inability to cool fuel within the reactor vessel or within the Spent Fuel Pool; and
- Prevent a safe shutdown of the reactor.

This includes risk assessments of spent fuel and of storage pool levels, cooling of fuel pool water, or new fuel criticality. Critical load handling therefore includes all components and equipment used for moving loads weighing more than one fuel assembly with its associated handling devices.

The Reactor and Fuel Building cranes provide a safe and effective means for transporting heavy loads including the handling of new and spent fuel, plant equipment, service tools and fuel casks. Safe handling includes design considerations for maintaining occupational radiation exposure as low as practicable during transportation and handling.

Where applicable, the appropriate seismic category, safety classification, ASME, ANSI, industrial and electrical codes have been identified (refer to Tables 9.13.2-14 and 9.1-5). The designs conform to the relevant requirements of General Design Criteria 1, 2, 4, and 61 of 10 CFR 50, Appendix A by meeting the guidance of RGs 1.13, 1.29, 1.115, 1.117, and ANSI/ANS 57.1, ANSI N14.6, ASME B30.9, and NUREG-0554. The fuel handling system OHLHS is housed within a Seismic Category I structure that is designed to withstand the effects of extreme wind and tornado missiles. The OHLHS is built in accordance with an acceptable quality assurance program, which includes the following program elements:

- Design and procurement document control
- Instructions, procedures, and drawings
- Control of purchased material, equipment, and services
- Inspection
- Testing and test control
- Non-conforming items
- Corrective action
- Records

The lifting capacity of each crane or hoist is designed to at least the maximum actual or anticipated weight of equipment and handling devices in a given area serviced. The hoists, cranes, or other lifting devices comply with the requirements of NRC Bulletin 96-02, NUREG-0554, ANSI N14.6, ASME/ANSI B30.9, ASME/ANSI B30.10 and NUREG-0612 Subsection 5.1.1(4) or 5.1.1(5) and ASME NOG-1. Cranes and hoists are also designed to criteria and guidelines of NUREG-0612 Subsection 5.1.1(7), ASME/ANSI B30.2 and CMAA-70 specifications for electrical overhead traveling cranes, including ASME/ANSI B30.11, and ASME/ANSI B30.16 as applicable.

9.1.5.3 Applicable Design Criteria for All OHLH Equipment

All handling equipment subject to heavy loads handling criteria has ratings consistent with lifts required and the design loading will be visibly marked. Cranes/hoists or monorail hoists pass over the centers of gravity of heavy equipment that is to be lifted. In locations where a single

Other Servicing Equipment

Outside of the containment, the main steam tunnel, or the refueling floor there are no safety-related components of one division routed over any portion of a safety-related portion of another division at locations susceptible to heavy load drops capable of causing the loss of a safety-related component required to maintain the plant in a safe condition. Therefore, inadvertent load drops cannot cause (a) a release of radioactivity, (b) a criticality accident, (c) the inability to cool fuel within reactor vessel or Spent Fuel Pool, or (d) prevent the safe shutdown of the reactor. Therefore, the servicing equipment located outside the containment, the main steam tunnel, or the refueling floor is not subject to the requirements of Subsections 9.1.5.2 and 9.1.5.3.

9.1.5.7 Equipment Operating Procedures Maintenance and Service

Each item of equipment requiring servicing is described on an interface control diagram (ICD) delineating the space around the equipment required for servicing. This includes pull space for internal parts, access for tools, handling equipment, and alignment requirements. The ICD specifies the weights of large removable parts, shows the location of their centers of gravity, and describes installed lifting accommodations such as eyes and trunnions. An instruction manual describes maintenance procedures for each piece of equipment to be handled for servicing. Each manual contains suggestions for rigging and lifting of heavy parts, and identifies any special lifting or handling tools required.

Operating instruction and maintenance manuals are provided for reference and use by operations personnel for all major handling equipment components (cranes, hoist, etc.).

9.1.5.8 Operational Responsibilities

Critical heavy load handling in the plant includes the following key elements for the administration and implementation of heavy load handling systems:

- Heavy Load Handling System and Equipment Operating Procedures;
- Heavy Load Handling Equipment Maintenance Procedures and/or Manuals;
- Heavy Load Handling Equipment Inspection and Test Plans; NDE, Visual, etc.;
- Heavy Load Handling Safe Load Paths and Routing Plans;
- QA Program to Monitor and Assure Implementation and Compliance of Heavy Load Handling Operations and Controls (This includes the QA program elements described in Subsection 9.1.5.2); ~~and~~
- Personnel Qualifications, Training and Control Program; and~~.~~
- Heavy Load Handling System Guidelines regarding the use of non-metallic slings with single failure proof lifting devices.

The COL applicant will provide a description of the program governing heavy loads handling, and the schedule for implementation (COL 9.1-5-A).

9.1.5.9 Safety Evaluations

The RB and FB cranes are interlocked to prevent movement of heavy loads over fuel storage pools. The RB and FB cranes are designed to be single failure proof, in accordance with

(Subsection 9.1.1.7)

9.1-5-A Handling of Heavy Loads

The COL applicant will provide a description of the program governing heavy loads handling, and the schedule for implementation, that addresses the following:

- Heavy loads and heavy load handling equipment outside the scope of loads described in the referenced certified design, and the associated heavy load attributes (load weight and typical load path).
- Requirements for heavy load handling safe load paths and routing plans including descriptions of automatic and manual interlocks not described in the referenced certified design and safety devices and procedures to assure safe load path compliance.
- Summary description of requirements to develop heavy load handling equipment maintenance manuals and procedures.
- Requirements for heavy load handling equipment inspection and test plans.
- Requirements for heavy load personnel qualifications, training, and control programs.
- Quality Assurance (QA) program requirements to monitor, implement, and ensure compliance with the heavy load handling program. (Subsection 9.1.5.8) (This includes the QA program elements described in Subsection 9.1.5.2).
- Issues described in Regulatory Issue Summary (RIS) 2005-25, Supplement 1, Clarification of NRC Guidelines for Control of Heavy Loads, related to the use of non-metallic slings with single failure proof lifting devices. (Subsection 9.1.5.8)

9.1.7 References

9.1-1 GE Hitachi Nuclear Energy Americas, LLC, "Dynamic, Load-Drop, and Thermal-Hydraulic Analyses for ESBWR Fuel Racks", NEDC-33373P, Class II (Proprietary), and NEDO-33373, Class I (Non-proprietary).

9.1-2 GE Hitachi Nuclear Energy Americas, LLC, "Criticality Analysis for ESBWR Fuel Racks", NEDC-33374P, Class II (Proprietary), and NEDO-33374, Class I (Non-proprietary).

monorail or crane handles several pieces of equipment, the routing is such that each transported piece passes clear of other parts.

Pendant control is required for the bridge, trolley, and auxiliary hoist to provide efficient handling of fuel shipping containers during receipt and also to handle fuel during new fuel inspection. The crane control system is selected considering the long lift required through the equipment hatch as well as the precise positioning requirements when handling the RPV and drywell heads, the RPV internals, and the RPV head stud tensioner assembly. The control system provides stepless regulated variable speed capability with high empty-hook speeds. Efficient handling of the drywell and RPV heads and stud tensioner assembly require that the control system provide spotting control. Because fuel shipping cask handling involves a long duration lift, low speed, and spotting control, thermal protection features are incorporated.

Heavy load equipment is also used to handle light loads and related fuel handling tasks. Therefore, much of the handling systems and related design, descriptions, operations, and service task information of Subsection 9.1.4 is applicable here. The cross-reference for the handling operations/equipment and Subsection 9.1.4 is provided in Table 9.1-6.

Transportation routing drawings are made covering the transportation route of every piece of heavy load removable equipment from its installed location to the appropriate service shop or building exit. Routes are arranged to prevent congestion and to assure safety while permitting a free flow of equipment being serviced. The frequency of transportation and usage of route are documented based on the predicted number of times usage either per year and/or per refueling or service outage.

9.1.5.4 System Description

9.1.5.5 Fuel Building and Reactor Building Cranes

Table 3.2-1 lists the equipment safety designation, QA requirements, and seismic category. Special lifting devices for lifting heavy loads are designed using a dual load path or designed for a safety factor of 10 or better with respect to the ultimate strength of the material used. NUREG-0612, Section 5.1.6 (3) Control of Heavy Loads at Nuclear Power Plants, applies to the head lifting load path.

Fuel Building Crane

The Fuel Building (FB) is a reinforced concrete structure enclosing the Spent Fuel Pool, cask handling and cleaning facility, and other equipment. The FB crane provides heavy load lifting capability for the Fuel Building floor. The main hook (150-metric ton/165-ton capacity) is used to lift new fuel shipping containers and the spent fuel shipping cask (refer to Table 9.1-6). The orderly placement and movement paths of these components by the FB crane preclude transport of these heavy loads over the Spent Fuel Pool.

The FB crane is used during refueling/servicing as well as when the plant is on-line. Minimum crane coverage includes the FB floor laydown areas, cask wash down area, and the FB equipment hatch. During normal plant operation, the crane is used to handle new fuel shipping containers and the spent fuel shipping cask. The FB crane is interlocked to prevent movement of heavy loads over the Spent Fuel Pool.

Upon receipt of a containment isolation signal from the Leak Detection and Isolation System, all containment isolation valves are signaled to close, with the exception of the containment isolation valves on the suppression pool supply and return lines as well as the drywell spray line.

FAPCS C/C train pumps are automatically tripped under the following operating conditions:

- Low water levels in skimmer surge tank;
- Low water level in Suppression Pool;
- Low water level in GDCS pools;
- High water level in GDCS pools;
- Low pump suction pressure;
- Low pump discharge flow; and
- High pump discharge flow.

The FAPCS IC/PCCS pools C/C subsystem pump is automatically tripped on low water level in IC/PCCSpools. Water level in the skimmer surge tanks is maintained by automatic open/closure of the makeup water supply isolation valve. Water level in the IC/PCCS pools is maintained by automatic open/closure of the makeup water supply isolation valve.

9.1.4 Light Load Handling System (Related to Refueling)

The reactor and fuel servicing system associated with the handling of light loads includes the fuel storage arrangements and the necessary facilities, special tools, and equipment required to accomplish normal fueling and refueling outage tasks.

The system is integrated with other customer provided equipment and supporting services to enhance and implement the fuel handling procedure in a safe and efficient manner.

9.1.4.1 Design Bases

The fuel handling system is designed to provide a safe and effective means for transporting and handling fuel from the time it reaches the plant until it leaves the plant after post-irradiation cooling. Safe handling of fuel includes design considerations for maintaining occupational radiation exposures as low as reasonably achievable (ALARA).

The following subsections briefly describe the integrated fuel transfer and reactor vessel servicing system that ensures that the design bases of the fuel handling system and the requirements of Regulatory Guide 1.13 are satisfied.

Table ~~9.1-4~~3.2-1 provides the design criteria for major fuel handling system equipment and lists the safety class, quality requirement and seismic category. Table 9.1-5 identifies applicable ASME, American National Standards Institute (ANSI), Industrial and Electrical Codes. Additional design criteria are described below and ~~expanded~~ further discussed in Subsection 9.1.4.2. Relevant interlocks for the fuel handling system discussed in Subsection 9.1.4 are a partial list of the interlocks listed in Table 1 of ANSI/ANS 57.1.

Fuel transfer from the point of receipt up to inspection, storage, and placement in the reactor core is accomplished with fuel grapples. A general purpose fuel grapple is used when fuel movement is performed by the fuel building crane on the fuel building floor prior to placement in the fuel conjunction with the equipment-handling platform. The equipment handling platform and the FMCRD handling equipment are powered electrically and pneumatically. It is designed in accordance with OSHA-1910.179, and American Institute of Steel Construction, AISC standards.

The under-vessel platform provides a working surface for equipment and personnel performing work in the under vessel area. It is a polar platform capable of rotating 360°.

The under-vessel servicing equipment is used in conjunction with a rail system and various carts to transport FMCRD components from outside the containment to the under vessel area.

The in-core monitoring seal flushing equipment is designed to prevent leakage of primary coolant from in-core detector housings during detector replacement. It is designed to industrial codes and manufactured from corrosion-resistant material.

9.1.4.12 Fuel Transfer System

The ESBWR is equipped with an Inclined Fuel Transfer System (IFTS). In general the arrangement of the IFTS (refer to Figure 9.1-2) consists of a terminus at the upper end in the Reactor Building buffer pool that allows the fuel to be tilted from a vertical position to an inclined position prior to transport to the Spent Fuel Pool. There is a means to lower the transport device (i.e., a carriage), means to seal off the top end of the transfer tube, and a control system to effect transfer. It has a lower terminus in the fuel building storage pool, and a means to tilt the fuel into a vertical position allowing it to be removed from the transport cart. There are controls contained in local control panels to effect transfer. There is a means to seal off the upper and lower end of the tube while allowing filling and venting of the tube.

There is sufficient redundancy and diversity in equipment and controls to prevent loss of load (carriage with fuel is released in an uncontrolled manner) and there are no modes of operation that allow simultaneous opening of any set of valves that could cause draining of water from the upper pool in an uncontrolled manner. The carriage and valves may be manually operated in the event of a power failure, to allow completion of the fuel transfer process.

The IFTS has sufficient cooling such that two freshly removed fuel assemblies can remain in the IFTS until they are removed without damage to the fuel or excessive overheating.

The IFTS tubes, ~~and~~ supporting structure, fuel assemblies and/or components within the IFTS tube, can withstand an SSE without failure of the basic structure or compromising the integrity of adjacent equipment and structures. Therefore, the portion of the IFTS transfer tube assembly from where it interfaces with the upper fuel pool, the portion of the tube assembly extending through the building, the drain line connection, and the lower tube equipment (valve, support structure, and bellows) are designated as Nonsafety-Related and Seismic Category I. The winch, upper upender, and lower terminus are designated as Nonsafety-related and Seismic Category II. The remaining equipment is designated as Nonsafety-Related and Seismic Category NS.

The IFTS is anchored to the bottom of the Inclined Fuel Transfer pool in the buffer pool floor in the Reactor Building. The IFTS penetrates the Reactor Building at an angle down to the IFTS pit in the fuel storage pool in the Fuel Storage Building.

The IFTS terminates in a separate pit in the fuel storage pool. The lower terminus of the IFTS allows for thermal expansion (axial movement relative to the anchor point in the Reactor