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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 407 Related to ESBWR Design Certification Application – Fuel Pools – RAI Number 9.1-128 S01**

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) 9.1-128 S01 sent by NRC Letter No. 407, Reference 1. The response to RAI 9.1-128 (Reference 2) was previously submitted via Reference 3.

GEH response to RAI Number 9.1-128 is addressed in Enclosure 1. Enclosure 2 contains the DCD markups associated with this response.

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

References:

1. MFN 10-050, Letter from U.S. Nuclear Regulatory Commission to Jerald G. Head, *Request for Additional Information Letter No. 407 Related to ESBWR Design Certification Application*, January 26, 2010
2. MFN 09-645, Letter from U.S. Nuclear Regulatory Commission to Jerald G. Head, *Request for Additional Information Letter No. 377 Related to ESBWR Design Certification Application*, October 13, 2009
3. MFN 09-697, Response to Portion of NRC Request for Additional Information Letter No. 377 Related to ESBWR Design Certification Application – Fuel Pools – RAI Number 9.1-128, November 16, 2009

Enclosures:

1. Response to Portion of NRC Request for Additional Information Letter No. 407 Related to ESBWR Design Certification Application – Fuel Pools - RAI Number 9.1-128 S01
2. Response to Portion of NRC Request for Additional Information Letter No. 407 Related to ESBWR Design Certification Application – Fuel Pools - RAI Number 9.1-128 S01 – DCD Markups

cc:	AE Cubbage	USNRC (with enclosures)
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	DH Hinds	GEH/Wilmington (with enclosures)
	TL Enfinger	GEH/Wilmington (with enclosures)
	eDRF Section	0000-0113-0833

Enclosure 1

MFN 10-040

Response to Portion of NRC Request for Additional Information Letter No. 407 Related to ESBWR Design Certification Application

Fuel Pools

RAI Number 9.1-128 S01

NRC RAI 9.1-128 S01

The additional information that was provided in a letter dated November 16, 2009, to address operating experience insights associated with Inspection and Enforcement Bulletin 84-03, "Refueling Cavity Water Seal," was found to be very thorough and complete in most respects. However, the staff found that the proposed markup of the DCD did not provide the level of detail that is needed. In particular, the following information should be reflected in Tier 2 of the DCD:

a. *The reactor cavity seal descriptive information provided in Items a, b, and the first paragraph of Item c of the response, including a figure for illustrative purposes (note that some of the descriptive information in Item b can be combined with the information in Item a to eliminate duplication). The seal descriptive information that was provided in the response should be supplemented as necessary to explain/specify:*

   - *if the seal is treated as a structure or mechanical component*
   - *codes or standards that apply to the seal assembly*
   - *codes/standards that apply to welds, and distinction between shop vs. field welds*
   - *why catastrophic failure of weld to refueling cavity floor will not occur*

b. *Information concerning maintenance and inspection of the bellows provided in Item b of the response.*

c. *Information concerning fuel pool level monitoring provided in the last paragraph of Item c of the response.*

d. *The information in the proposed DCD markup on Tier 2 Page 12.4-6, edited to indicate/include:*

   - *fuel in transit can* ***quickly*** *be placed in a safe location in the core or in the deep pit of the buffer pool* ***with at least 6 meters of water above the fuel***

   - *a two-assembly-out-of-core configuration on the refuel floor is not anticipated as there is no fuel preparation machine in the buffer pool and tasks such as fuel sipping, rechanneling, and fuel inspections will take place in the spent fuel pool (from the response to item c, 4th paragraph)*

e. *Information concerning the plugs for the main steam and isolation condenser lines provided in the 5th paragraph of Item d.*

f. *COL information items or other means as appropriate to ensure that COL applicants will establish and implement procedures for:*

   - *responding to pool drain down events,*
   - *performing periodic maintenance and inspection of the cavity seal and plugs for the main steam lines and isolation condenser lines in accordance with vendor recommendations,*
   - *monitoring cavity seal leakage*

g. DCD Tier 2 Table 1C-2 for IE Bulletin 84-03 needs to be revised to reference those sections of the DCD that reflect the above information.

While the information referred to above can be reflected in those Tier 2 sections of the DCD deemed most appropriate by the applicant, it is the staff's preference to include this information in Tier 2 Section 9.1.4 to the extent this is practical and convenient.

GEH Response

a. The cavity seal descriptive information in Items a, b and the first paragraph of c of the previous response (Letter MFN 09-697, dated November 16, 2009) will be added to DCD, Tier 2, Subsection 6.2.1.1.2. This information will be supplemented with the additional information requested by this RAI supplement. In addition, Figure 6.2-35 will be added as requested. Note that Figure 6.2-35 shows the location of the field welds.

b. The information related to maintenance and inspection of the bellows provided in Item b of the previous response will be added to DCD, Tier 2, Subsection 6.2.1.1.2.

c. The information related to fuel pool level monitoring provided in the last paragraph of Item c of the previous response will be added to DCD, Tier 2, Subsection 6.2.1.1.2.

d. The DCD, Tier 2, Subsection 12.4.4 changes in the previous response will be edited to include the two items requested in this RAI supplement.

e. The information concerning the Main Steam and Isolation Condenser System plugs provided in the 6th paragraph of Item d in the previous response will be added to DCD, Tier 2, Subsection 9.1.4.8.

f. DCD, Tier 2, Subsection 13.5.2 will be revised to require that procedures related to monitoring refueling cavity leakage, responding to drain down events, and performing cavity seal and plug maintenance be prepared.

g. DCD, Tier 2, Table 1C-2 will be revised to reference Tier 2 Subsections 6.2.1.1.2, 9.1.4.21 and 12.4.4.

DCD Impact

DCD Tier 2, Table 1C-2 and Subsections 6.2.1.1.2, 9.1.4.8, 12.4.4 and 13.5.2 will be revised; and Tier 2, Figure 6.2-35 and Subsection 9.1.4.21 will be added, as shown in the attached markups.

Enclosure 2

MFN 10-040

Response to Portion of NRC Request for Additional Information Letter No. 407 Related to ESBWR Design Certification Application

Fuel Pools

RAI Number 9.1-128 S01

DCD Markups

Table 1C-2

Operating Experience Review Results Summary – IE Bulletins

No.	Issue Date	Title	Evaluation Result or Topic's Tier 2 Location(s)
81-03	4/10/81	Flow Blockage of Cooling Water to Safety System Components by Corbicula Sp. (Asiatic clam) and Mytilus Sp. (Mussel)	Not applicable. Safety-related ESBWR systems do not rely on cooling water sources that can be blocked by these species.
82-04	12/3/82	Deficiencies in Primary Containment Electrical Penetration Assemblies	Applies to a specific equipment supplier that is no longer selling primary containment electrical penetration assemblies. ESBWR primary containment electrical penetration assemblies are qualified to Institute of Electrical and Electronic Engineers (IEEE) 317 requirements in accordance with Regulatory Guide 1.63. See Subsection 3.11.1.1.
83-06	7/22/83	Non-Conforming Materials Supplied by Tube-Line Corp.	Not applicable, vendor supply issue
84-01	2/3/84	Cracks in Boiling Water Reactor Mark I Containment Vent Headers	Not applicable to the ESBWR containment design
84-03	8/24/84	Refueling Cavity Water Seal	The ESBWR utilizes permanently installed flexible bellows between the RPV and the refueling cavity. See Subsections 6.2.1.1.2, 9.1.4.21 and 12.4.4.
85-03	11/15/85	Motor-Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings	Subsection 3.9.6.1
85-03, Supp 1	4/27/88	Motor-Operated Valve Common Mode Failure During Plant Transients Due to Improper Switch Settings Past Related Correspondence: IE Bulletin 85-03, IE Notice 86-29, and IE Notice 87-01	Subsection 3.9.6.1
86-01	5/23/86	Minimum Flow Logic Problems That Could Disable RHR Pumps	Not Applicable. The ESBWR does not have safety-related RHR pumps
86-03	10/8/86	Potential Failure of Multiple ECCS Pumps Due to Single Failure of Air-Operated Valve in Minimum Flow Recirculation Line	Not Applicable. The ESBWR does not have ECCS pumps

- The containment structure shall withstand coincident fluid jet forces associated with the flow from the postulated rupture of any pipe within the containment.
- The containment structure shall accommodate flooding to a sufficient depth above the active fuel to maintain core cooling and to permit safe removal of the fuel assemblies from the reactor core after the postulated DBA.
- The containment structure shall be protected from or designed to withstand hypothetical missiles from internal sources and uncontrolled motion of broken pipes, which could endanger the integrity of the containment.
- The containment structure shall direct the high energy blowdown fluids from postulated LOCA pipe ruptures in the DW to the pressure suppression pool and through the PCCS condensers.
- The containment system shall allow for periodic tests at the calculated peak or reduced test pressure to measure the leakage from individual penetrations, isolation valves and the integrated leakage rate from the containment structure to confirm the leak-tight integrity of the containment.
- The Containment Inerting System establishes and maintains the containment atmosphere to $\leq 3\%$ by volume oxygen during normal operating conditions to ensure inert atmosphere operation.
- PCCS shall remove post-LOCA decay heat from the containment for a minimum of 72 hours, without operator action, to maintain containment pressure and temperature within design limits.

6.2.1.1.2 Design Features

The containment structure is a reinforced concrete cylindrical structure, which encloses the Reactor Pressure Vessel (RPV) and its related systems and components. Key containment components and design features are exhibited in Figures 6.2-1 through 6.2-5. The containment structure has an internal steel liner providing the leak-tight containment boundary. The containment is divided into a DW region and a WW region with interconnecting vent system. The functions of these regions are as follows:

- The DW region is a leak-tight gas space, surrounding the RPV and reactor coolant pressure boundary, which provides containment of radioactive fission products, steam, and water released by a LOCA, prior to directing them to the suppression pool via the DW/WW Vent System. A relatively small quantity of DW steam is also directed to the PCCS during the LOCA blowdown.
- The WW region consists of the suppression pool and the gas space above it. The suppression pool is a large body of water to absorb energy by condensing steam from SRV discharges and pipe break accidents. The pool is an additional source of reactor water makeup and serves as a reactor heat sink. The flow path to the WW is designed to entrain radioactive materials by routing fluids through the suppression pool during and following a LOCA. The gas space above the suppression pool is leak-tight and sized to collect and retain the DW gases following a pipe break in the DW, without exceeding the containment design pressure.

The DW/WW Vent System directs LOCA blowdown flow from the DW into the suppression pool.

The containment structure consists of the following major structural components: RPV support structure (pedestal), diaphragm floor separating DW and WW, suppression pool floor slab, containment cylindrical outer wall, cylindrical vent wall, containment top slab, and DW head. The containment cylindrical outer wall extends below the suppression pool floor slab to the common basemat. This extension is not part of containment boundary; however, it supports the upper containment cylinder. The reinforced concrete basemat foundation supports the entire containment system and extends to support the RB surrounding the containment. The refueling bellows, which is treated as a mechanical component, is an all steel, permanent installation with primary and secondary seals that are fabricated from stainless steel for corrosion resistance. The refueling bellows extends from the lower flange of the reactor vessel to the interior of the reactor cavity, and provides a 360° structural barrier to prevent leakage from the reactor cavity into the DW. This extension is also not part of the containment boundary, however, it provides a Seismic Category I seal between the upper DW and reactor well during a refueling outage.

The design parameters of the containment and the major components of the containment system are given in Tables 6.2-1 through 6.2-4. A detailed discussion of their structural design bases is given in Section 3.8.

Refueling Cavity Bellows Seal

As shown in Figure 6.2-35, the RPV is fabricated to include a refueling bellows skirt, and the refueling bellows is installed as a module that is welded to the lower horizontal flange of the RPV refueling bellows skirt. The connections to the drywell bulkhead are also fully welded using AWS standards. The final assembly contains welded connections that provide a permanent barrier to leakage and can only leak if there is a through-wall defect. A spring-loaded secondary seal is provided to prevent leakage into the drywell in the event a leak occurs through the primary seal. The bellows structure is vertically oriented with a corrugated configuration that is designed to be flexible under differential thermal expansion and seismic motion. The bellows material meets ASME/ASTM standards, and bellows examinations are in accordance with Section III of the ASME BPV Code. The bellows assembly is located below the RPV flange such that it cannot interfere with the removal of core components for refueling. Normally open leak detection connections are located on the dry side of the bellows for continuous leakage monitoring.

Cover plates are provided for the bellows to protect against objects (e.g., a fuel assembly) that may be dropped during refueling. The cover plates remain in place during operation, but are designed to be readily removable. In addition, the bellows assembly has a plate over the vertically oriented bellows, which provides further protection in the event the cover plates are removed for cleaning or inspection. Routine maintenance and inspection of the bellows is performed based on supplier recommendations.

As the bellows configuration is not susceptible to dropped objects, any seal failures would likely be related to normal wear or fatigue. All bellows materials are designed to have a 60-year design life. For shop welds, all welding procedures and welder qualifications are in accordance with Section IX of the ASME Code, with any exceptions approved prior to execution. Any leakage due to fatigue or weld failure would not result in a rapid drain down event and would be easily

detectible and isolable. As mentioned above, leak detection is provided on the dry side of the bellows, and a second seal is in place that prevents leakage into the drywell in the event of bellows leakage.

Pool level on the refuel floor is constantly monitored, and alarms are provided in the event level drops. The buffer pool is equipped with safety-related water level sensors that alarm the operators if the pool level is below normal. Operators also have the ability to provide makeup water and suspend refueling operations, as needed. In addition to pool level alarms, the drywell sump provides alarms in the event excess water is present.

Drywell

The DW (Figure 6.2-1) comprises two volumes: (1) an upper DW volume surrounding the upper portion of the RPV and housing the main steam and feedwater piping, GDCS pools (see Figure 6.2-3 for pool arrangement) and piping, PCCS piping, ICS piping, SRVs and piping, Depressurization Valves (DPVs) and piping, DW coolers and piping, and other miscellaneous systems; and (2) a lower DW volume below the RPV support structure housing the lower portion of the RPV, fine motion control rod drives, other miscellaneous systems and equipment below the RPV, and vessel bottom drain piping.

The upper DW is a cylindrical, reinforced concrete structure with a removable steel head and a diaphragm floor constructed of steel girders with concrete fill. The RPV support structure separates the lower DW from the upper DW. There is an open communication path between the two DW volumes via upper DW to lower DW connecting vents, built into the RPV support structure. Penetrations through the liner for the DW head, equipment hatches, personnel locks, piping, electrical and instrumentation lines are provided with seals and leak-tight connections.

The DW is designed to withstand the pressure and temperature transients associated with the rupture of any primary system pipe inside the DW, and also the negative differential pressures associated with containment depressurization events, when the steam in the DW is condensed by the PCCS, the GDCS, the FAPCS, and cold water cascading from the break following post-LOCA flooding of the RPV.

For a postulated DBA, the calculated DW pressure in Table 6.2-5 is below the design value shown in Table 6.2-1. The structure stresses are evaluated in Section 3G.5 considering the DW fluid temperature transients for multiple break locations.

Three vacuum breakers are provided between the DW and WW. The vacuum breaker is a process-actuated valve, similar to a check valve (Figure 6.2-28). The purpose of the DW-to-WW vacuum breaker system is to protect the integrity of the diaphragm floor slab and vent wall between the DW and the WW, and the DW structure and liner, and to prevent back-flooding of the suppression pool water into the DW. The vacuum breaker is provided with redundant proximity sensors to detect its closed position. The vacuum breaker is provided with redundant proximity sensors to detect its closed position. One out of the three vacuum breakers is required to perform vacuum relief function. The third vacuum breaker provides redundancy while the second vacuum breaker provides single failure protection for opening. On the upstream side of each vacuum breaker, pneumatically operated fail-as-is safety-related isolation valves are provided to isolate a leaking (not fully closed) or stuck open vacuum breaker. During a LOCA, when the vacuum breaker opens and allows the flow of gas from WW to DW to equalize the DW and WW pressure and subsequently does not fully close as detected by the proximity sensors, a

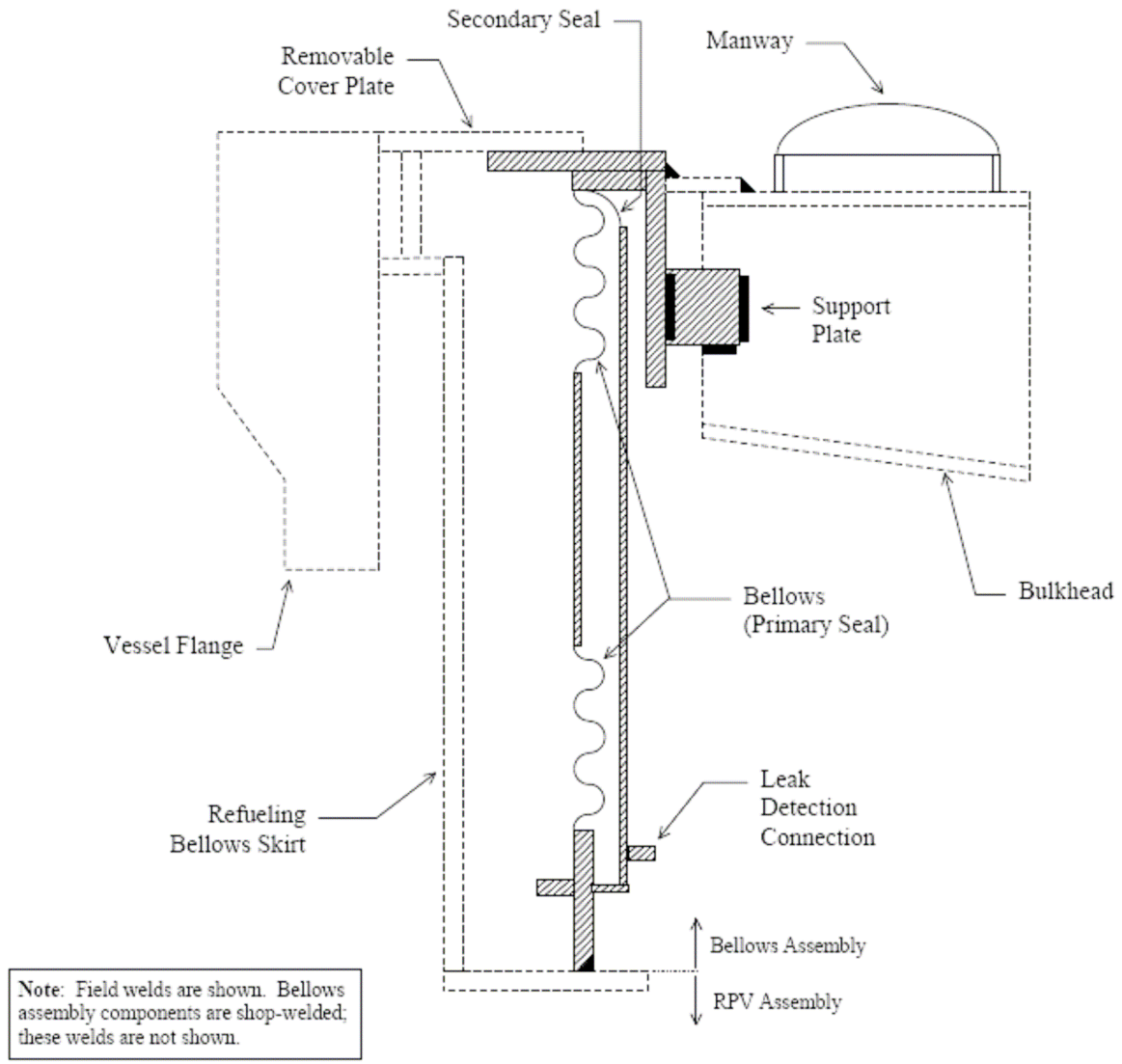

Figure 6.2-35. Refueling Cavity Bellows Assembly

The channel handling tool is suspended by its bail from a spring balancer on the channel handling boom located on the Spent Fuel Pool periphery.

General Purpose Grapple

The general purpose grapple performs many tasks and is primarily used on the auxiliary hoist of either the refueling or fuel handling machines. It is designed to fit a standard fuel bail, which is replicated on certain tooling for handling purposes. One example is handling the underwater vacuum cleaner.

The general purpose grapple, when utilizing an extension cable, is also attached to the auxiliary hook of the FB crane as the need arises for handling new fuel.

9.1.4.7 Servicing Aids

General area underwater lights are provided with a suitable reflector for illumination.

Support brackets are furnished to support the lights in the reactor vessel to allow the light to be positioned over the area being serviced independent of the platform. Local area underwater lights are small diameter lights for additional illumination. Drop lights are used for illumination where needed.

Other servicing aids that are available include the following:

- A radiation-hardened portable underwater television camera for in-vessel inspection or observation of servicing activity.
- General purpose viewing aids to prevent surface motion water and alleviate image distortion of submerged objects.
- A portable, submersible underwater vacuum cleaner to help remove crud or miscellaneous loose matter from the reactor vessel or storage pools. The required pump and filter is also submersible for extended periods. The filter can be changed remotely and disposed of in standard containers after use for offsite burial.

9.1.4.8 Reactor Vessel Servicing Equipment

Table 3.2-1 lists the safety designation, QA requirements, and the seismic category for principal vessel service components. Lifting tools for lifting heavy loads are designed using a dual load path or designed for a safety factor of ten 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. The following subparagraphs describe the equipment contained in the table.

Reactor Vessel Service Tools

These tools are used when the reactor is shut down and the reactor vessel head is being removed or reinstalled. Tools in this group are as follows:

- RPV Stud Tensioning System and RPV Head Strongback;
- Stud handling tool;
- Seal Surface Protector;

- Stud thread protector;
- Stud elongation measuring rod;
- Dial indicator elongation measuring device; and
- Head guide cap.

Steam and DPV/IC Line Plugs

Prior to refueling when the reactor water is at the refueling level, the main steam and Depressurization Valve (DPV)/IC line nozzles ~~must~~ will be plugged to prevent outflow of water from the reactor.

The plugs are housed on the end of a spider structure and are lowered into the vessel and aligned with their respective nozzles, actuated into position, and then their pressurized seals are activated. The plug structure is constructed of corrosion resistant materials and has a factor of safety of five or greater. The plugs are designed with redundant seals (one pneumatic and one mechanical) such that failure of one will not degrade the maintenance boundary and allow loss of water from the reactor vessel. Each seal on each plug is individually leak-tested prior to a refueling outage to ensure operability.

Head Support Pedestals

Head support pedestals are mounted on the refueling floor for supporting the reactor vessel head and strongback/carousel during periods of reactor servicing.

The pedestals have dowel pins that engage three evenly spaced stud holes in the head flange. The flange surface rests on replaceable wear pads made of aluminum.

When resting on the pedestals, the head flange is sufficiently high above the floor to allow access to the seal surface for inspection and O-ring replacement.

The pedestal structure is a carbon steel weldment coated with an approved paint. It has a base with bolt holes for mounting it to the concrete floor.

A seismic analysis is used to determine the input forces imposed onto the pedestals and floor anchors. The structure is designed to withstand these calculated forces and meet the requirements of AISC-325, Manual of Steel Construction: Load and Resistance Factor Design and AISC-M016, Manual of Steel Construction: Allowable Stress Design.

Dryer / Separator Strongback

The dryer / separator strongback is a lifting device used for transporting the steam dryer or the steam separators between the reactor vessel and the storage pools. The strongback structure has a hook box with two hook pins in the center for engagement with the RB crane sister hook. The strongback has a socket with a remotely operated pin on the end of each arm for engaging it to the four lift eyes on the steam dryer or shroud head.

The strongback has been designed such that one hook pin and one main beam of the cruciform is capable of carrying the total load (160-metric ton, 176 ton) and no single component failure could cause the load to drop or swing uncontrollably out of the Safety-Related level attitude. The strongback meets the requirements of NUREG-0612, Control of Heavy Loads at Nuclear Power Plants and ANSI-N14.6, Standard for Special Lifting Devices.

Testing

Functional tests are performed on refueling and servicing equipment in the shop prior to the shipment of most production units and generally include electrical tests, leak tests, and sequence of operations tests.

When the unit is received at the site, it is inspected to ensure that no damage has occurred during transit or storage. Prior to use and at periodic intervals, each piece of equipment is again tested to ensure that the electrical and mechanical functions are operational.

Fuel handling and vessel servicing equipment preoperational tests are described in Subsection 14.2.8.1.

9.1.4.20 Instrumentation Requirements

Refueling and Fuel Handling Machines

The refueling and fuel handling machines have a position indicator system to indicate to the operator which core fuel cell the fuel grapple is accessing. Interlocks and a monitor are provided to prevent the fuel grapple from operating in a fuel cell where the control rod is not in the proper orientation for refueling.

There is also a series of mechanically activated switches and relays that provides monitor indications on the operator's console for grapple limits, hoist and cable load conditions, and confirmation that the grapple's hook is either engaged or released.

A series of load cells is installed to provide automatic shutdown whenever threshold limits are exceeded for either the fuel grapple or the auxiliary hoist units.

Fuel Grapple

Although the fuel grapple is not safety-related, it is equipped with a mounted video camera, lighting system, and instrumentation system consisting of mechanical switches and indicator lights. This system provides the operator with a positive indication that the grapple is properly aligned and oriented and that the grappling mechanism is either extended or retracted.

9.1.4.21 Refueling Cavity Integrity

Design features intended to ensure the integrity of the refueling cavity are discussed in Section 6.2.1.1.2. Section 13.5.2 discusses procedures related to monitoring cavity seal leakage, responding to drain down events and performing maintenance activities. Section 12.4.4 discusses refueling operations and conditions during refueling in the RB pools.

9.1.5 Overhead Heavy Load Handling (OHLH) Systems

9.1.5.1 Design Bases

The objective for the OHLH system is to control the movement of heavy loads in order to ensure the safe handling of heavy loads, to reduce the potential for uncontrolled movement of heavy loads or load drops, and to limit the consequences of dropping a heavy load.

9.1.5.2 General

The equipment described in this subsection covers items considered as heavy loads that are handled under conditions that mandate critical handling compliance.

The dose projections below are based on representative systems currently used in the industry. Dose from surveillance and maintenance activities in the RW are captured in the other respective categories of this analysis.

More of the radwaste operations involve remote handling than in a typical BWR. General RW work consists of pump and valve maintenance, shipment handling, radwaste management and general cleanup activity. Maintenance collective dose estimates are captured in Section 12.4.2. The LWMS collects liquid wastes from equipment drains, floor drains, filter backwashes and other sources within the facility. Some examples of SWMS activities include movement of casks and liners, filter handling, resin transport, and movement or reconfiguration of radwaste processing skids. Generally, much of the activity is remotely performed and controlled by operators in the RW Control Room. Dose estimates for the collection, packaging and shipment of radwaste quantities are based on the assumptions below.

Operation of the RW Control Room is assumed to occur approximately once per day for one shift with a maximum dose rate of 10 μSv/hr (1 mrem/hr). Processing and packaging of DAW is assumed to occur once a day for two hours using two workers in a dose field of 50 μSv/hr (5 mrem/hr) as appropriate. This activity is assumed to occur three times per week. Shipments of concentrated wet solid waste in HICs are assumed to occur once per week for four hours in a dose field of 50 μSv/hr (5 mrem/hr) as appropriate using four workers. DAW shipments are assumed to occur once per month for eight hours in a dose field of 50 μSv/hr (5 mrem/hr) as appropriate using three workers. Finally, miscellaneous activities in high dose rate areas such as valve lineups or filter changes are assumed to be required approximately 4 person-hours per week in an average dose rate field of 150 μSv/hr (15 mrem/hr) as appropriate.

The estimated annual collective doses associated with waste processing operations appear in Table 12.4-4.

12.4.4 Refueling Operations

In the ESBWR design, refueling operations are conducted in two general areas. The Fuel Building houses the SFP and various equipment used for the receipt of new fuel assemblies. Space is also provided for fuel assembly receipt inspection and the installation of fuel channels on the new fuel assemblies. When new fuel assemblies are readied for transfer to the reactor, the assemblies are transferred using the IFTS, which is located in the upper portion of the RB. Here the new fuel assemblies are kept in the buffer pool until the refueling outage. This dual pool system is similar to that implemented in the BWR/6 product line. During the refueling outage, new fuel assemblies are placed in the reactor core using the refueling machine, the core shuffled, and spent fuel removed to the RB buffer pool. At this time, control rods or other in-core components may be replaced. Spent fuel assemblies, which were removed from the core, are then transferred through the IFTS to the FB SFP. The Fuel Building also contains facilities for the transfer of spent fuel assemblies into casks for possible storage at an onsite independent spent fuel storage installation.

Prior to commencing refueling operations, the drywell and reactor vessel heads must be disassembled and removed. Reactor vessel access and reassembly exposure times are reduced by use of a special stud tensioner for the 84 RPV head bolts. Underwater transfer of the dryer,

chimney/partitions, and chimney head/separator decreases exposures during refueling operations. The improved fuel inspection equipment and increased use of remote operations significantly reduce the refueling floor exposure. Drywell access and RPV disassembly and reassembly in conventional BWRs typically require 4,500 person-hours of work at an effective dose rate of 30 µSv/hr. The ESBWR work involves the use of an automated stud tensioner for the RPV top head. This equipment, coupled with other automatic equipment available, is estimated to reduce the drywell access and RPV vessel disassembly/reassembly time to 1,200 person-hours.

ESBWR refueling is accomplished via the refueling bridge. ~~Time for refueling operations including control rod replacement is reduced from a typical BWR value of 4,400 person-hours to approximately 1,500 person-hours. It is estimated that approximately 500 person-hours are spent in transfer of the spent fuel and other replaced components to the buffer pool in the RB, and 1,000 person-hours are spent transferring the spent fuel and removed components through the IFTS to the SFP in the FB.~~ General area RB refueling floor and FB radiation zone effective values of 25 µSv/hr (2.5 mrem/hr) are used for the dose projections. An additional 4,000 person-hours are estimated for an optional spent fuel transfer campaign into storage casks for possible onsite storage in an independent spent fuel storage installation. Because cask loading operations are conducted entirely underwater, an effective dose rate value of 5 µSv/hr is used for the cask loading and transfer process. The total person-Sv associated with the above refueling operations is shown in Table 12.4-5.

During refueling operations, a rapid drain down of the reactor cavity is not credible for the ESBWR. The ESBWR does not introduce any new potential drain down paths and all potential drain down paths result in a slow loss of cavity water. The Fuel and Auxiliary Pool Cooling System and Fire Protection System provide make up capability and have the capacities to ensure fuel in the core remains covered. Fuel in transit when a leak is identified can be quickly placed in a safe location in the core or in the deep pit of the buffer pool with at least 6.0 m (19.7 ft) of water above the fuel. The possibility of having two fuel assemblies out of the core or out of the deep pit fuel storage racks at the same time in the RB pools is not anticipated because there is no fuel preparation machine in the buffer pool, and tasks such as fuel sipping, rechanneling, and fuel inspections will take place in the spent fuel pool in the FB. Core components stored in the pools for refueling (i.e. steam dryer, separator, chimney partitions) will not become uncovered as a result of a slow loss of reactor cavity water, therefore, dose consequences associated with exposure of these components are not considered. The need to restore containment integrity is not anticipated as a result of a slow loss of reactor cavity water.

13.5 PLANT PROCEDURES

Plant procedures are developed to provide control for activities that are important for safe operation of the facility. The applicable portions of Regulatory Guide 1.33 Rev. 2 (Reference 13.5-5) concerning plant procedures shall be followed.

13.5.1 Administrative Procedures

An Administrative Procedures Plan shall be generated and describe administrative procedures that provide administrative control over activities that are important to safety for operation of the facility. These procedures include those which provide the administrative controls with respect to procedures, and those which define and provide controls for operational activities of the plant staff.

The COL Applicant will develop the Administrative Procedures (COL 13.5-1-A).

13.5.2 Operating and Maintenance Procedures

The development of Operating Procedures is generally described in Section 18.9 (Procedure Development).

A Plant Operating Procedures Development Plan shall be generated and have the following attributes:

- That the scope encompassed by the procedures development process includes those operating procedures defined in Subsection 13.5.2, which direct operator actions during normal, abnormal and emergency operations. The procedure development process will also include consideration of plant operations during periods when plant systems/equipment are undergoing test, maintenance or inspection.
- The procedure development process will address methods and criteria for the development, verification and validation, implementation, maintenance and revision of procedures. The methods and criteria shall be in accordance with TMI I.C.1, NUREG-0737 (Reference 13.5-3).

The development of Operating and Maintenance Procedures is the responsibility of the COL Applicant (COL 13.5-2-A).

Implementation of the Plant Operating Procedures Development Plan shall establish:

- Procedures that are consistent with the requirements of 10 CFR Part 50 and the TMI requirements described in NUREG-0737 (Reference 13.5-3) and Supplement 1 to NUREG-0737 (Reference 13.5-7).
- Requirements that the procedures developed shall include, as necessary, the elements described in American National Standards Institute (ANSI)/American Nuclear Society (ANS)-3.2-1994; R1999 (Reference 13.5-2). Elements of ANSI/ANS-3.2-1994; R1999 addressing water hammer shall be applied in the development of procedures for RTNSS systems.
- That the operator basis for plant operating procedures shall use actions identified in the operational task analysis and Probabilistic Risk Assessment (PRA) efforts in support of the Standardized Design certification, Standardized Plant Design Emergency Procedure

Guidelines and consideration of plant-specific equipment selection and site-specific elements such as the service water intake structure.

- That the definition of the methods through which specific operator skills and training needs, as may be considered necessary for reliable execution of the procedures, will be identified and documented.
- That the procedures specified above shall be made available for the purposes of the Human Factors Verification and Validation (V&V) described in GE Report NEDE-33217P (Reference 13.5-1) provided under separate cover.
- Procedures for the incorporation of the results of operating experience and the feedback of pertinent information into plant procedures in accordance with the provisions of TMI I.C.5, NUREG-0737 (Reference 13.5-3).

The COL Applicant will establish a Plant Operating Procedures Development Plan (COL 13.5-4-A).

The following procedures shall be included in the scope of the Plant Operating Procedures Development Plan described above:

System Procedures

Procedures as delineated in Section A3 of ANSI/ANS-3.2-1994; R1999 (Reference 13.5-2) shall be prepared as appropriate.

Procedures For Off-Normal Or Alarm Conditions

Procedures for off-normal or alarm conditions that require operator action in the MCR and Remote Shutdown System (RSS) shall be prepared as appropriate.

General Plant Operating Procedures

As discussed in Section A5 of ANSI/ANS-3.2-1994; R1999 (Reference 13.5-2), procedures shall be prepared for the integrated operations of the plant.

Procedures for Combating Emergencies and Other Significant Events

As discussed in Section A10 of ANSI/ANS-3.2-1994; R1999 (Reference 13.5-2), procedures shall be provided to guide operations in emergencies and other significant events.

Procedures for Maintenance and Modification

All maintenance and modification procedures including those that require operator actions in the MCR or RSS shall be prepared as appropriate.

Procedures for Radiation Control

Procedures for the control of radioactive releases as discussed in Section A7 (d) of ANSI/ANS-3.2-1994; R1999 (Reference 13.5-2) shall be prepared as appropriate.

Procedures for Calibration, Inspection and Testing

Calibration, inspection and testing procedures that require operator actions to be taken in the MCR or RSS shall be prepared as appropriate.

The COL Applicant will include in its operating procedure development program:

- Procedures for calibration, inspection, and testing.
- Milestone for completing this category of operating procedures (COL 13.5-6-A).

These procedures will ensure that all portions of the safety-related logic circuitry are adequately covered as described in Generic Letter 96-01 (Reference 13.5-6).

Procedures for Radiation Monitoring

Procedures for the monitoring of radioactive releases as discussed in Subsection 5.3.7.4 of ANSI/ANS-3.2-1994; R1999 (Reference 13.5-2), shall be prepared as appropriate.

Procedures for Handling of Heavy Loads

Procedures for load handling and load handling equipment shall be prepared as appropriate using the guidance of Section 5.1 of NUREG-0612 (Reference 13.5-4).

Procedures Related to Refueling Cavity Integrity

Procedures for monitoring refueling cavity seal leakage, responding to refueling cavity and buffer pool drain down events and performing periodic maintenance and inspection of the refueling cavity seal and the Main Steam and Isolation Condenser System plugs in accordance with vendor recommendations.

The COL Applicant will include the abovementioned procedures in the scope of the Plant Operating Procedures Development Plan (COL 13.5-5-A).

Emergency Procedures

A writer's guide shall be developed and implemented which defines the process for developing emergency procedures. The writer's guide will contain objective criteria that require that the emergency procedures developed are consistent in organization, style, content and usage of terms.

The documentation describing the emergency procedure development activity results shall include, but is not limited to:

- The objectives of the emergency procedure development process,
- The methods employed during emergency procedure development,
- Deviations from generic technical guidelines approved by the NRC, and
- Discussion of any design change recommendations or negative implications that the current design may have on safe operation as a result of emergency procedures development plan implementation.

The development of Emergency Procedures is the responsibility of the COL Applicant (COL 13.5-3-A).

13.5.3 COL Information

13.5-1-A Administrative Procedures Development Plan