HITACHI

**GE Hitachi Nuclear Energy**

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

P.O. Box 780 M/C A-65
Wilmington, NC 28402-0780
USA

T 910.675.6192
F 910.362.6192
rick.kingston@ge.com

MFN 10-094 Docket No. 52-010

March 18, 2010

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Transmittal of ESBWR DCD Tier 2, Chapters 6 and 9 Markups Related to GEH Design Development and Clarification in Section 9.1**

The purpose of this letter is to submit markups to the ESBWR DCD, Tier 2, Chapters 6 and 9, Revision 6, which are the result of GEH design development of the ESBWR. Specifically, passive pressure relief devices have been added to the upper elevation of the Reactor Building and Fuel Building so that steam can escape during a boiling event in the auxiliary pools or spent fuel pool. In addition, clarification is provided for information in DCD Tier 2 Subsection 9.1.3.5 and Table 9.1-8, as described in the summary of changes table below:

| Affected Section | Description of Change |
|---|---|
| Subsection 6.2.3.2, new 5th paragraph | Added paragraph to describe passive pressure relief devices to allow the Reactor Building refuel floor to vent if cooling is lost to the auxiliary pools (design development). |
| Subsection 9.1.3.2, 9th paragraph, new 2nd and 3rd sentences | Added sentences to describe passive pressure relief devices to allow the Reactor Building and Fuel Building to vent to relieve excessive positive pressure generated by steam buildup during pool boiling (design development). |
| Subsection 9.1.3.5, 3rd paragraph, 2nd sentence | Clarified that alarm locations for Spent Fuel Pool level are located both locally and in the Main Control Room (design clarification per teleconference on 02/18/10). |
| Subsection 9.1.7, Reference 9.1-1 | Updated reference to reflect Revision 4 to LTR NEDO-33373. Note that NEDC-33373P no longer exists (reference update). |
| Table 9.1-8, "Heat Exchangers" section, "Heat Removal Capacity" | Clarified that the heat removal capacity of the FAPCS Heat Exchangers is 8.3 MW per train (design clarification per teleconference on 02/18/10). |

The markup pages contained in Enclosure 1 will be incorporated into the DCD, Revision 7. The changes are summarized below.

The following information addresses the addition of the passive pressure relief devices to allow the Reactor Building (RB) and Fuel Building (FB) to vent to relieve excessive positive pressure generated by steam buildup during pool boiling:

- The function of passive pressure relief devices in the RB and FB is to provide a path for venting steam during a boiling event in the auxiliary pools or spent fuel pool. These devices are not credited for protecting the safety-related structures from over pressure. The set point of these devices ensures the devices remain shut during a tornado event to maintain an unvented structure.
- The FB (and RB) relief panels (passive pressure relief devices) are nonsafety-related as described in RAI Response 9.1-8S01 (Letter MFN 08-526, Reference 1). Verification of function of these devices would be performed under the Maintenance Rule as part of structural (Civil) walk downs and during testing of building pressure integrity.
- The RB passive relief device allows the RB refuel floor to vent to the environment described in attached DCD markup (Enclosure 1) to subsection 6.2.3.2.
- The FB passive relief device allows the FB spent fuel pool to vent to the environment as described in existing DCD Chapter 19 Availability Controls Manual Basis AC B3.7.4 for Spent Fuel Pool (SFP) Water Level.
- Design basis accidents associated with FB operations are limited to the Fuel Handling Accident (FHA) and Spent Fuel Cask Drop Accident, which are described in DCD Subsections 15.4.1 and 15.4.10, respectively. Dose consequences for the FHA are calculated assuming instantaneous release of noble gas and iodine radionuclides without credit for atmospheric cleanup. The Spent Fuel Cask Drop Accident does not result in any radionuclide release. Since no design basis accidents associated with Spent Fuel Building operations are identified that require atmospheric cleanup (filtration) to limit dose consequences within Regulatory Guide 1.183 and GDC 19 limits, safety-related atmospheric cleanup systems are not provided. Upgrading the nonsafety-related Fuel Building HVAC atmospheric cleanup capability to ensure availability to mitigate and further reduce fuel handling accident radiological consequences is not justified based on numerical guides for cost-benefit return set out in 10 CFR 50 Appendix I.

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

Reference:

1. MFN 08-526, Response to Portion of NRC Request for Additional Information Letter No. 201, Related to ESBWR Design Certification Application – Auxiliary Systems – RAI Number 9.1-8 S02, June 23, 2008

Enclosure:

1. Transmittal of ESBWR DCD Tier 2, Chapters 6 and 9 Markups Related to GEH Design Development and Clarification in Section 9.1 – DCD Markups

| | | |
|---|---|---|
| cc: | AE Cubbage | USNRC (with enclosure) |
| | JG Head | GEH/Wilmington (with enclosure) |
| | DH Hinds | GEH/Wilmington (with enclosure) |
| | TL Enfinger | GEH/Wilmington (with enclosure) |
| | eDRF Sections | 0000-0114-5864 |
| | | 0000-0114-4382 |

# Enclosure 1

# MFN 10-094

# Transmittal of ESBWR DCD Tier 2, Chapters 6 and 9 Markups Related to GEH Design Development and Clarification in Section 9.1

# DCD Markups

**Note:** Markups associated with this transmittal are enclosed within boxes.

In this analysis, the rupture producing the greatest blowdown of mass and enthalpy in conjunction with worst-case single active component failure is considered. Blowout panels between compartments provide flow paths to relieve pressure.

- The RB is capable of periodic testing to assure that the leakage rates assumed in the radiological analyses are met. The radiological analyses assume the RB CONAVS served areas form this boundary.

### *6.2.3.2 Design Description*

The RB is a reinforced concrete structure that forms an envelope completely surrounding the containment (except the basemat). The boundary of the clean areas and the RB are shown in Figure 6.2-17.

During normal operation, the RB potentially contaminated areas are maintained at a slightly negative pressure relative to adjoining areas by the CONAVS portion of the RBVS (Subsection 9.4.6). This assures that any leakage from these areas is collected and treated before release. Airflow is from clean to potentially contaminated areas. RB effluents are monitored for radioactivity by RB/Fuel Buidling (FB) stack radiation monitors. If the radioactivity level rises above set levels, the discharge can be routed through RB HVAC online purge Exhaust Filter Unit system for treatment before further release.

Penetrations through the RB envelope are designed to minimize leakage. All piping and electrical penetrations are sealed for leakage. The RBVS is designed with safety-related isolation dampers and tested for isolation under various accident conditions.

HELBs in any of the RB compartments do not require the building to be isolated. These breaks are detected and the broken pipe is isolated by the closure of system isolation valves (Subsection 7.4.3). There is no significant release of radioactivity postulated from these types of accidents because reactor fuel is not damaged.

The RB is equipped with passively acting pressure relief devices that allow the refuel floor to vent to the environment if cooling is lost to the auxiliary pools during an outage. The devices open at a high-pressure set point equivalent to the full tornado pressure drop described in Section 3.3.2.2.

The following paragraphs are brief descriptions of the major compartments in the ESBWR design.

**Reactor Water Cleanup (RWCU) Equipment and Valve Rooms**

The two independent RWCU divisions are located in the 0–90° and 270-0° quadrants of the RB. The RWCU equipment (pumps, heat exchangers, and filter/demineralizers) is located on floor elevations -11500 mm and -6400 mm with separate rooms for equipment and valves. The RWCU piping originates at the reactor pressure vessel. High energy piping leads to the RWCU divisions through a dedicated, enclosed, pipe chase. The steam/air mixture resulting from a HELB in any RWCU compartment is directed through adjoining compartments and pipe chase to the RB operating floor. Figure 6.2-18 shows the model of the RB compartments with the interconnecting flow paths for a typical analysis. The design basis break for the RWCU system compartment network is a double-ended break. The selected break cases are identified in Table 6.2-11. Figures 6.2-19 through 6.2-27 provide the pressure profiles due to all postulated

- The fuel storage pools have adequate water shielding for the stored spent fuel. See Subsection 9.1.3 relative to the control of water level in these pools.

RG 1.13 is applicable to spent fuel storage facilities. The RB and FB, which contains the fuel storage facilities, including the storage racks and pool, are designed to protect the fuel from damage caused by:

- Natural events such as earthquake, high winds and flooding; and
- Mechanical damage caused by dropping of fuel assemblies, bundles, or other objects onto stored fuel.

**Summary of Radiological Considerations**

By adequate design and careful operational procedures, the design bases of the spent fuel storage arrangement are satisfied. Thus, the exposure of plant personnel to radiation is maintained well below regulatory limits and in accordance with As Low As Reasonably Achievable (ALARA) principles. Further details of radiological considerations, including those for the spent fuel storage arrangement, are presented in Chapter 12.

## 9.1.3 Fuel and Auxiliary Pools Cooling System

### *9.1.3.1 Design Bases*

**Safety Design Basis**

FAPCS is a nonsafety-related system, except for the following safety-related items:

- Containment isolation valves,
- High-pressure interface with the Reactor Water Cleanup / Shutdown Cooling System,
- Emergency water supply flow paths to the spent fuel pool and Isolation Condenser/Passive Containment Cooling System (IC/PCCS) pools; and
- Gravity Driven Cooling System (GDCS) interconnecting pipes.

**Power Generation Design Basis**

FAPCS provides continuous cooling and cleaning of the spent fuel storage pool during normal plant operation. It also provides occasional cooling and cleaning of various pools located inside the containment during normal plant operation and refueling outages.

### *9.1.3.2 System Description*

**System Description Summary**

The FAPCS consists of two physically separated cooling and cleanup trains, each with 100% capacity during normal operation. Each train contains a pump, a heat exchanger and a water treatment unit for cooling and cleanup of various cooling and storage pools except for the IC/PCCS pools (refer to Figure 9.1-1). A separate subsystem with its own pump, heat exchanger and water treatment unit is dedicated for cooling and cleaning of the IC/PCCS pools independent of the FAPCS cooling and cleanup train operation during normal plant operation (refer to Figure 9.1-1). The FAPCS includes high point vents and component vents necessary to avoid gas accumulation. Operation and maintenance procedures are used to assure sufficient measures are taken to avoid water hammer and gas binding in pumps.

The primary design function of FAPCS is to cool and clean pools located in the containment, RB and FB (refer to Table 9.1-1) during normal plant operation. FAPCS provides flow paths for filling and makeup of these pools during normal plant operation and during post-accident conditions, as necessary.

FAPCS is also designed to provide the following accident recovery functions in addition to the Spent Fuel Pool cooling function:

- Suppression pool cooling (SPC);
- Drywell spray;
- Low pressure coolant injection (LPCI) of suppression pool water into the Reactor Pressure Vessel (RPV); and
- Alternate Shutdown Cooling.

In addition to its accident recovery function, the SPC mode is also designed to automatically initiate during normal operation in response to a high temperature signal from the suppression pool.

A crosstie to the Reactor Water Cleanup/Shut Down Cooling (RWCU/SDC) System is provided in the suppression pool suction and discharge headers such that this system may be used as an alternative for post-accident decay heat removal. For details regarding the crosstie, refer to Subsection 5.4.8.

Redundancy and physical separation are provided in accordance with SECY-93-087 for active components in lines dedicated to LPCI and SPC modes.

During normal plant operation, at least one FAPCS cooling and cleanup train is available for continuous operation to cool and clean the water of the Spent Fuel Pool, while the other train can be placed in standby or other mode for cooling the GDCS pools and suppression pool. If necessary during a refueling outage, both trains may be used to provide maximum capacity for cooling the Spent Fuel Pool. The water treatment units can be bypassed when necessary, and will be bypassed automatically on a high temperature signal downstream of the heat exchangers.

Each FAPCS cooling and cleanup train has sufficient flow and cooling capacity to maintain Spent Fuel Pool bulk water temperature below 48.9°C (120°F) under normal Spent Fuel Pool heat load conditions (normal heat load condition is defined as irradiated fuel in the Spent Fuel Pool resulting from 20 years of plant operations). During the maximum Spent Fuel Pool heat load conditions of a full core offload plus irradiated fuel in the Spent Fuel Pool resulting from 20 years of plant operations, both FAPCS cooling and cleanup trains are needed to maintain the bulk temperature below 60°C (140°F).

During a loss of the FAPCS cooling trains, cooling of the Spent Fuel Pool, buffer pool and IC/PCCS pools is accomplished by allowing the water to heat and boil. The Reactor Building (RB) and Fuel Building (FB) are equipped with normally closed pressure relief devices that open passively to relieve excessive positive pressure generated by steam buildup during pool boiling. The pressure set point is equivalent to the full tornado pressure drop described in Section 3.3.2.2.

Safety-related level instrumentation is provided in the spent fuel pool, buffer pool, and IC/PCCS pools to detect a low water level that would indicate a loss of decay heat removal ability in accordance with GDC 63.

### *9.1.3.4 Testing and Inspection Requirements*

The FAPCS is designed to permit surveillance test and in-service inspection of its safety-related components and components required to perform the post-accident recovery functions, in accordance with GDC 45 and ASME BPVC Section XI. The FAPCS is designed to permit leak rate testing of its components required to perform containment isolation function in accordance with 10 CFR 50 Appendix J.

### *9.1.3.5 Instrumentation and Control*

**System Instrumentation**

**Water Levels** - The skimmer surge tank level is monitored by a level transmitter. The skimmer surge tank level is displayed in the MCR. In addition to level indication, this signal is used to initiate low and high water-level alarms and to operate the Condensate Storage and Transfer System makeup water control valve for the skimmer surge tank.

The IC/PCCS pool has four safety-related level transmitters in each inner expansion pool. All transmitter signals are indicated on the safety-related displays and sent through the gateways for nonsafety-related display and alarms. All signals are validated and used to control the valve in the makeup water supply line to the IC/PCCS pool. A low level signal from these transmitters is sent to the Isolation Condenser System to open the pool cross-connect valves to the equipment storage pool. Each expansion pool also contains four nonsafety-related level transmitters that provide a backup to the safety-related transmitters.

The Spent Fuel Pool and buffer pool each have two wide-range safety-related level transmitters that transmit signals to the MCR. These signals are used for water level indication and to initiate high/low-level alarms, both locally and in the MCR. At a minimum, alarm set points are included at the top of the active fuel, an adequate shielding level (3.05 m [10 ft]above TAF), and an elevation just below normal water level to give operators advanced notice of a loss of inventory but with sufficient margin to allow for 72 hours of pool boiling.

The SFP and IC/PCCS pools contain backup nonsafety-related level indicators that can be operated using portable onsite power supplies to indicate when the pools have been replenished to their normal water level.

All other pools (upper transfer pool, lower fuel transfer pool, cask pool, reactor well, dryer and separator storage pool) have local, nonsafety-related, panel-mounted level transmitters to provide signals for high/low-level alarms in the MCR.

Level instruments for the suppression pool and GDCS pools are provided by other systems.

**Water Temperatures** – Water temperatures are monitored in the Fuel and Auxiliary pools (listed in Table 9.1-1) with temperature transmitters that send signals to the MCR for water temperature indication and high-temperature alarms. In the IC/PCCS pool, each condenser subcompartment also has temperature transmitters that send signals to the MCR for water temperature indication and high-temperature alarms. The upstream and downstream piping of

- Personnel qualifications, training, and control programs for fuel handling personnel; and
- QA programs to monitor, implement, and assure compliance to fuel handling operations;

### *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;
- 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); and
- 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, "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, "Criticality Analysis for ESBWR Fuel Racks", NEDC-33374P, Class II (Proprietary), and NEDO-33374, Class I (Non-proprietary).]**

* References that are bracketed and italicized with an asterisk following the brackets are designated as Tier 2*. Prior NRC approval is required to change Tier 2* information.

## Table 9.1-8

## Design Parameters for FAPCS System Components

| | |
|---|---|
| **Main Pumps** | |
| Number of Pumps | 2 |
| Pump Type | Centrifugal |
| Drive Unit | Constant Speed Induction Motor |
| Flow Rate | 567.8 $m^3$/hr (2500 gpm) |
| NPSH Available | 13.0 m (42.65 ft) |
| **Heat Exchangers** | |
| Number of units | 2 |
| Heat Removal Capacity | 8.3 MW per train (at rated conditions) |
| Seismic | Category II design and analysis |
| Heat Exchanger Type | Shell & Tube or Plate |
| Maximum Pressure | 2.0 MPaG (290 psig) |
| Performance Data | |
| (1) Flow (hot side) | 567.8 $m^3$/hr (2500 gpm) |
| (2) Flow (cold side) | 567.8 $m^3$/hr (2500 gpm) |
| (3) Rated Inlet Temp (tube side) | 48.9ºC (120ºF) |
| (4) Maximum Inlet Temp (shell side) | 35.0ºC (95ºF) |