

June 23, 2010

APPLICANT: GE Hitachi Nuclear Energy

PROJECT: Economic Simplified Boiling Water Reactor Design Certification

SUBJECT: SUMMARY OF THE JUNE 3 AND 15, 2010 REGULATORY AUDITS OF THE ECONOMIC SIMPLIFIED BOILING WATER REACTOR SPENT FUEL POOL REQUIRED WATER INVENTORY AT NUCLEAR ENERGY INSTITUTE OFFICE IN ROCKVILLE, MARYLAND

On June 3 and 15, 2010, the U.S. Nuclear Regulatory Commission (NRC) staff conducted regulatory audits of the supporting information for the spent fuel pool required water inventory as described in Economic Simplified Boiling Water Reactor (ESBWR) Design Control Document (DCD), Section 9.1, "Fuel Storage and Handling," and Chapter 19 ACM "Availability Controls Manual." Prior to the audit, the staff identified that the spent fuel pool water level in Availability Control (AC) 3.7.4 is inconsistent with information provided in multiple GE Hitachi Nuclear Energy (GEH) responses to requests for additional information. The audit was primarily focused on understanding the technical basis for AC 3.7.4 through the review of supporting GEH calculations and discussions with GEH. GEH identified that changes to the AC 3.7.4 and corresponding sections of the DCD would be made to address the issues identified during the audit. As a result of the June 3, 2010, audit, GEH made changes to AC 3.7.1, "Emergency Makeup Water." During the June 15, 2010, audit, the staff reviewed the supporting information for the required volume and delivery rate of makeup water to be supplied from 72 hours to 7 days following an accident. The audits were conducted at the Nuclear Energy Institute office in Rockville, Maryland. A summary of the audit, including participants and audit activities, is provided in Enclosure 1.

/RA/

Dennis Galvin, Project Manager
BWR Projects Branch
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-010

Enclosure:
1. Audit Summary

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SUMMARY OF THE REGULATORY AUDITS OF THE ECONOMIC SIMPLIFIED BOILING WATER REACTOR SPENT FUEL POOL REQUIRED WATER INVENTORY

On June 3, 2010, the U.S. Nuclear Regulatory Commission (NRC) staff conducted a regulatory audit of the supporting information for the spent fuel pool required water inventory as described in the Economic Simplified Boiling Water Reactor (ESBWR) Design Control Document (DCD), Section 9.1, "Fuel Storage and Handling," and Chapter 19 ACM "Availability Controls Manual." Prior to the audit, the staff identified that the spent fuel pool water level in Availability Control (AC) 3.7.4 is inconsistent with information provided in multiple GEH responses to requests for additional information (RAIs). The audit was primarily focused on understanding the technical basis for AC 3.7.4 through the review of supporting GEH calculations and discussions with GEH. GEH identified that changes to the AC 3.7.4 and corresponding sections of the DCD would be made to address the issues identified during the audit. The audit was conducted at the Nuclear Energy Institute (NEI) office in Rockville, Maryland. A summary of the audit, including participants and audit activities, is provided below.

Prior to the audit, the staff identified several RAIs which provide information on heat up and boiling of the spent fuel pool for the first 72 hours following the loss of cooling. Table 5 provides a list and brief description of the RAI responses and other documents related to the audit topics. The RAI responses identify that an initial 8.85 m of water above the top of fuel is needed to keep the fuel covered upon loss of cooling while AC 3.7.4 identifies that 8.5 m is needed. Several GEH analyses and calculations are identified as providing the technical bases for these values, both in the RAI responses and in AC 3.7.4. The staff conducted the audit to review these analyses and calculations and to verify the technical bases. Additional information on audit participants and documentation reviewed are provided in Tables 1 and 2 below.

On June 15, 2010, the staff reviewed GEH's updated analysis of the spent fuel pool required water inventory which GEH revised based on discussions during the June 3, 2010 audit. In addition, as a result of the June 3, 2010, audit, GEH made changes to AC 3.7.1, "Emergency Makeup Water." During the June 15, 2010, audit, the staff reviewed the supporting information for the required volume and delivery rate of makeup water to be supplied from 72 hours to 7 days following an accident. Additional information on audit participants and documentation reviewed are provided in Tables 3 and 4 respectively. As noted above, Table 5 provides a summary of key docketed information related to the audits.

The staff identified 11 open items during the June 3 and June 15, 2010 audits. Open items 1 to 9 were identified during the June 3, 2010 audit and open items 10 to 11 were identified during the June 15, 2010 audit. The audit open items identify several inconsistencies and non-conservative assumptions in the applicant's analysis. GEH indicated that these open items would be addressed in revised spent fuel pool boil-off and emergency makeup water calculations and corresponding changes to the DCD.

Audit Open Items

1. The bounding thermal analysis evaluation has not taken into consideration the impact of a seismic event on the SFP capability to maintain the spent fuel cooled and cover with water for 72 hrs without any makeup water. The applicant's evaluation of this event should postulate the failure of all non-seismic components attached to the SFP (including but not limited to pipes, gates, and drains).

2. DCD Section 9.1.3 states that the SFP water level is maintained at elevation of 14.35 meters with a volume of 1690 m³ of water above the active fuel. The latest SFP thermal analysis states that a loss of FAPCS could boil off up to 1730 m³ of water. This inconsistency would imply that a loss of FAPCS could uncover the fuel. The DCD needs to be updated to reflect the latest minimum inventory of water required to prevent fuel uncover.

Also changes to DCD Section 19A discussion of spent fuel cooling and the availability control may be necessary based on the new calculations.

The staff identified a typographical error in Table 6 of GEH Calculation 0000-0036-0326.

3. The locations (elevation) of the anti-siphon devices are not clearly specified. These devices are needed to prevent the siphoning of SFP water inventory below the minimum inventory needed to prevent fuel uncover under worst conditions. This minimum elevation should be included in the DCD.
4. The staff considers that the minimum inventory of water needed in the SFP should be control through a TS and not through availability controls (AC), as the applicant proposed.
5. The thermal analysis does not specify the boil off rate from the SFP at 72 hrs. This rate needs to be lower than the SFP makeup water flow.
6. The applicant's DCD states that the buffer pool contains sufficient inventory of water to boil for 72 hrs without uncovering the fuel, but it is not clear that the applicant has taken into consideration the impact of a seismic event.
7. While reviewing the applicant's thermal analysis, the staff could not confirm that the heat loads developed for the analysis was calculated based on core thermal power that took into consideration uncertainty in core power measurements.
8. The staff found that the Basis of AC B 3.7.4 needed clarifications, as it relates to the required makeup water that the Fire Protection system needs to reserve for SFP makeup.
9. An apparent inconsistency was found between the latest thermal analysis results and the AC B 3.7.1, Emergency Make-up (1921 m³ vs. 1151 m³).
10. The applicant should clarify whether there are any non-seismic Category 1 and 2 connections that could provide potential drain paths from the spent fuel pool, the buffer pool, the lower fuel transfer pool, and cask pool. If there are potential seismic Category 1 and 2 drain paths for these pools, they should be included in DCD Tier 2, Table 3.2-1 and described in the appropriate sections of the DCD.
11. Section 1 of NUREG-0800, SRP 9.1.3 "Spent Fuel Pool Cooling And Cleanup System," states that:

"The safety function to be performed by the system in all cases remains the same; that is, the spent fuel assemblies must be cooled and must remain covered with water during all storage conditions."

SRP 9.1.3 also states that compliance with GDC 61 requires that the fuel storage and handling shall be designed (4) with a residual heat removal capability having reliability and testability that reflects the importance to safety of decay heat and other residual heat removal, and (5) to prevent significant reduction in fuel storage coolant inventory under accident conditions.

The ESBWR SFP is designed to permit boiling of the SFP water in order to provide cooling for the stored fuel. The applicant proposed to modify a technical specification (TS) that will ensure that the SFP has sufficient inventory of water to permit cooling of the stored fuel for 72 hrs after the loss of forced cooling, without requiring makeup water. The applicant's TS is based on the spent fuel pool water level being at the top of active fuel at 72 hours after the loss of forced cooling. This is inconsistent with the guidelines of SRP 9.1.3, as noted above. In addition, the applicant has not shown that there is sufficient residual heat removal capability with the spent fuel pool in a boiling condition and the water level at the top of active fuel. For example, the applicant has not addressed whether the thermal-hydraulics conditions in the fuel racks are sufficient to preclude fuel damage. The applicant needs to identify a water level at 72 hours that meets the requirements of GDC 61, including providing the justification for the water level, and modify the TS limit accordingly.

Table 1: Regulatory Audit on June 3, 2010 of ESBWR Spent Fuel Pool Required Water Inventory: Audit Participants

Participants	Organization
Patricia Campbell	GEH
Rick Wachowiak	GEH
Tim Enfinger (by phone)	GEH
Sara Anderson (by phone)	GEH
John Gels (by phone)	GEH
Dennis Galvin	NRC
Larry Wheeler	NRC
Raul Hernandez	NRC
Angelo Stubbs	NRC
Ryan Nolan	NRC
Samuel Lee (by phone)	NRC
John Segala (by phone)	NRC
Amy Cabbage (by phone)	NRC

Table 2: Regulatory Audit on June 3, 2010 of ESBWR Spent Fuel Pool Required Water Inventory: Documentation Reviewed

Title	GEH Document # / DRF #
ESBWR Spent Fuel Pool Decay Heat	0000-0036-0326
ESBWR Spent Fuel Pool Decay Heat Part II	0000-0035-7904
Spent Fuel Pool Boil-Off	0000-0038-9392, Rev. 4
ESBWR Post-72 Hour Make Up Water Volume Day 3 to Day 7 including "Supplement for 20 Year Spent Fuel Storage Capacity"	0000-0055-4699, Rev. 2
Fuel Storage Rack Design Specification	26A7032, Rev. 4
Calculation to Support RAI 9.1-46	0000-0080-9022, Rev. 1

Table 3: Regulatory Audit on June 15, 2010 of ESBWR Spent Fuel Pool Required Water Inventory: Audit Participants

Participants	Organization
Patricia Campbell	GEH
Tim Enfinger (by phone)	GEH
Sara Anderson (by phone)	GEH
John Gels (by phone)	GEH
Dennis Galvin	NRC
Raul Hernandez	NRC
Angelo Stubbs	NRC

Table 4: Regulatory Audit on June 3, 2010 of ESBWR Spent Fuel Pool Required Water Inventory: Documentation Reviewed

Title	GEH Document # / DRF #
ESBWR Spent Fuel Pool Boil-off Calculation	0000-0038-9392, Rev. 5
ESBWR Post-72 Hour Make Up Water Volume Day 3 to Day 7 including "Supplement for 20 Year Spent Fuel Storage Capacity"	0000-0055-4699, Rev. 3
Calculation to Support RAI 9.1-46	0000-0080-9022, Rev. 1

Table 5: Regulatory Audit on June 3, 2010 of ESBWR Spent Fuel Pool Required Water Inventory: Background Information

Number	Reference	Description	ADAMs
RAI 16.2-76 S01	MFN 07-022 S04	RAI response resulted in the addition of an availability control for spent fuel pool water level, AC LCO 3.7.3. The AC LCO was later renumbered as AC 3.7.4	ML072390025
RAI 9.1-10 S02	MFN 06-309 S08	RAI response defines spent fuel pool heat loads. 3 associated GEH calculations are identified.	ML073520108
RAI 9.1-11 S01	MFN 06-309 S02	RAI response states that anti-siphon holes are located at the normal water level for all FAPCS cooling system discharge lines.	ML071710538
RAI 9.1-18 S02	MFN 07-646	RAI response identifies the amount of water that boils off in 72 hours, amount of water in the spent fuel pool after 72 hours, safety-related water level instrumentation alarm levels. An associated GEH calculation is identified.	ML073460226
RAI 9.1-44	MFN 07-660	RAI response provides brief discussion of the spent fuel pool boil-off. An associated GEH calculation is identified.	ML073520121
RAI 9.1-46 S01	MFN 08-440	RAI response provides results of calculation assuming the failure of	ML081280402

		transfer gates and loss of spent fuel pooling cooling	
RAI 9.1-115, RAI 9.1-115 S01	MFN 09-163 MFN 09-530 MFN 09-530, Rev1	RAI response described the wiers and gates between the spent fuel pool and connected pools.	ML090780421 ML092220592 ML092360295
DCD Tier 2 Section 9.1.3.2	Pg 9.1-10 to 9.1-11	Describes spent fuel pool water level and loss of cooling.	
DCD Tier 2 Section 19A	ACLCO 3.7.4	ACLCO for spent fuel pool water level.	
DCD Tier 2 Figure 3G.3-4	Pg 3G-281	Provides dimension of the spent fuel pool.	
NEDO-33373 Section 5.0	Pg 459-487	Identifies spent fuel pool heat loads and identifies corresponding references.	ML100820357

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