

June 12, 2007

AUDIT REPORT

Purpose: Audit of General Electric's (GEs) Economic Simplified Boiling Water Reactor (ESBWR) fission product removal in the ESBWR containment and confirmatory dose rate calculation

Location: GE Nuclear Energy, Wilmington, NC

Dates: May 14-15, 2007

NRC Participants: Mohammed Shuaibi, Shawn Williams, Jay Lee

GE Participants: Frostie White, George Wadkins, Wayne Marquino, Chris Pratt, Erik Kirstein (Full Time); Jim Kinsey, David Hinds and Larry Tucker (Part-Time)

The staff performed an audit on May 14 and 15, 2007, at GE's headquarters in Wilmington, NC. The purpose of the audit was to discuss fission product removal in the ESBWR containment and associated radiological consequence dose calculations, including associated proprietary licensing topical reports. The discussion included the information provided or referenced in Design Control Document (DCD), Revision 3, Chapters 6.4, 6.5, 15.3 and 15.4.

Staff also discussed the status of associated requests for additional information (RAIs). The significant open items include (1) confirming the bounding scenario for the radiological design base accident, (2) describing the iodine transport and removal phenomena in the ESBWR containment, and (3) use of ESBWR design specific source term vs. NRC generic NUREG-1465 source terms for determining the bounding reactor accident scenario.

Staff provided GE with the following general editorial comments for which staff expects GE will globally correct in Revision 4 of the applicable chapters of the DCD:

- (1) Revise the tables and applicable text in the DCD to include both SI Units and English Units per SECY-96-098, "Final Policy Statement - Conversion to the Metric System."
- (2) Revise the incorrect reference of leak rates as "% volume per day" to the correct reference as "weight percent per day." (i.e., Section 15.4.4.5.2)
- (3) Revise the DCD to properly reference the emergency filtration unit (EFU) rather than as a "charcoal filter train." (i.e., Sections 15.4.1.2.1, 15.4.1.4.1, and 15.4.4.5.3)

- (4) Many tables incorrectly included the phrase “Exclusion Area Boundary (EAB) for the Entire Period of the Radioactive Cloud Passage.” Revise the tables so that the EAB is consistent with 10 CFR 100.11(a)(1).
- (5) Staff requested that the X/Q values are presented consistent in all tables.

The following RAIs were indicated as resolved, with an understanding that the DCD section which the RAIs address may be revised based on the general editorial comments above:

RAI 15.4-5
RAI 15.4-9
RAI 15.4-10
RAI 15.4-11
RAI 15.4-12
RAI 15.4-14
RAI 15.4-19
RAI 15.4-21
RAI 15.4-23
RAI 15.4-27

The following RAIs were discussed at the Audit and will remain unresolved until GE formally responds to the RAI:

RAI 6.5-2
RAI 15.4-6
RAI 15.4-7
RAI 15.4-8
RAI 15.4-13
RAI 15.4-15
RAI 15.4-16
RAI 15.4-17
RAI 15.4-20
RAI 15.4-22
RAI 15.4-24
RAI 15.4-25
RAI 15.4-26
RAI 15.4-28
RAI 15.4-29

The following RAIs and GE’s response were discussed at the Audit. This Audit Report will serve as the official supplemental RAI request for RAIs 15.3-25, 15.4-1, 15.4-2, 15.4-3, 15.4-4, and 15.4-18.

Supplemental No. 1 RAI 15.3-25

Reference: RAI 15.3-25 in NRC letter dated October 11, 2006
GE response in MFN 07-017 dated February 16, 2007

- (1) Concerning GE's response to Item B:
 - a) Add English Unit (curies) in the table or provide a new separate table with English units only.
 - b) Reference DCD Tier 2, Revision 3, Appendix 15B, "LOCA Inventory," as responded to RAI 15.4-9.
 - c) Revise to read fuel exposure as "35 GWd/MTU core average."
- (2) Revise Table 15.3-13 as follows:
 - a) Add number of fuel rods in core, condenser leak rate, release duration, and release points, to the table.
 - b) Correct typographical error to read Table 15.3-16 (instead of Table 15.4-19).
 - c) Add justification for the use of radial peaking factor of 1.5 for the 1000 fuel rods failed. What is the peak fuel rod average burnup? Is this radial peaking factor specified in ESBWR Technical Specifications?
 - d) Show or reference the control room χ/Q values provided in Table 15.3-13 as "1000 fuel rod failure parameters" in DCD, Tier 2, Chapter 2, Table 2.0-1.
 - e) Add justification for the amount of iodine, noble gases, and alkali metals released from the failed fuel rods. Does it meet the maximum linear heat generation rate specified in Footnote 11 of Regulatory Guide 1.183, Table 3? (See DCD, Tier 2, Revision 3, Tables 6.3-1 and 6.3-11 for bounding peak linear heat generation rate specified).
- (3) Revise Table 15.3-16 as follows:
 - a) Add the control room operator doses.
 - b) Reword EAB to read "... for any (worst) 2 hours" rather than "for the entire period of the radioactive cloud passage."

Supplemental No. 1 RAI 15.4-1:

Reference: RAI 15.3-25 in NRC letter dated October 11, 2006
GE response in MFN 07-017 dated February 16, 2007

- (1) In DCD, Tier 2, Revision 3, Section 15.4.1, GE stated that two scenarios of the fuel handling accident were postulated: drop of a raised fuel assembly (1) onto the reactor core and (2) into the spent fuel storage pool. Provide the radiological consequence analysis for each scenario complete with fission product release pathways to the environment. State which scenario is bounding and why. Include this information in the DCD.
- (2) Please state if containment, reactor building, and/or fuel building are required to maintain its integrity during fuel handling operation. Do you consider this requirement as a COL action item? State in DCD how you satisfy the guidance provided in Footnote 2 of Appendix B in Regulatory Guide 1.183.
- (3) In DCD, Tier 2, Table 2.0-1 and Table 15.4-2, provide the EAB, LPZ, and control room χ/Q values used for each release point.
- (4) State in the DCD that the control room is not isolated during this event and that the normal control room ventilation system will be in operation.
- (5) State in DCD the amount of iodine, noble gases, and alkali metals released from the failed fuel rods. Does it meet the maximum linear heat generation rate specified in Footnote 11 of Regulatory Guide 1.183, Table 3? (See DCD, Tier 2, Revision 3, Tables 6.3-1 and 6.3-11 for bounding peak linear heat generation rate specified).
- (6) Justify in the DCD the use of radial peaking factor of 1.5 for the 1000 fuel rods failed. What is the peak fuel rod average burnup?
- (7) Response to Item A of RAI 15.4-1
 - a) Reconstruct the table showing fission product inventory in curies and reference to DCD, Tier 2, Appendix 15B.
 - b) State the total number of fuel bundles in the core and DF of 200 used as notes to the table.
 - c) Correct typographical error to read RPF (not RFP) in note.
- (8) Response to Item C of RAI 15.4-1
 - a) State which sets of the control room χ/Q values in the table were used for this event.
 - b) Add the "Fuel Building Cask Door to Control Room Air Intake" to the DCD, Tier 2, Tables 2.0-1 and Table 15.4-2, if used for this event.

- (9) Response to Item E of RAI 15.4-1
- a) State in the DCD which release pathway is bounding and why.
- (10) Response to Item J of RAI 15.4-1
- a) State in the DCD where and how the control room χ/Q value of $1.0E-3$ s/m³ were used for this event.
- b) GE stated that the control room normal air intake flow rate and the control room habitability area volume are ITAAC items. Reference sections and ITAAC table numbers in DCD tier 1.
- (11) Revise Table 15.4-4
- a) Delete "Within Containment" from the table (a typographical error)
- b) Recalculate LPZ doses using LPZ χ/Q values from 0 to 30 days.
- c) The LPZ dose should be "for 0 to 30 days."

Supplemental No. 1 RAI 15.4-2

Reference: RAI 15.3-25 in NRC letter dated October 11, 2006
GE response in MFN 07-100 dated March 26, 2007

- (1) Provide revised steam and water mass releases for the main steam line break accident.
- (2) Add the following information to Table 15.4-11:
- Duration of accident
EAB, LPZ, and control room χ/Q values
Release point
Control room operator doses
Control room not isolated
Control room normal ventilation system will be in operation during this event
- (3) Revise the following information in Table 15.4-13:
- a) Reword EAB to read "... for any (worst) 2 hours" rather than "for the entire period of the radioactive cloud passage."
- b) The LPZ dose should be "for 0 to 30 days."
- c) Provide control room operator doses for pre and post-iodine spike.

Supplemental No. 1 RAI 15.4-3:

Reference: RAI 15.3-25 in NRC letter dated October 11, 2006
GE response in MFN 07-100 dated March 26, 2007

- (1) Add the following information to Tables 15.4-14 and 15.4-17:

Duration of accident
EAB, LPZ, and control room χ/Q values
Release point
Control room operator doses
Control room not isolated
Control room normal ventilation system will be in operation during this event

- (2) Revise the following information in Tables 15.4-19 and 23:

- a) Reword EAB to read "... for any (worst) 2 hours" rather than "for the entire period of the radioactive cloud passage."
b) The LPZ dose should be "for 0 to 30 days."

Supplemental No. 1 RAI 15.4-4:

Reference: RAI 15.3-25 in NRC letter dated October 11, 2006
GE response in MFN 07-197 dated April 12, 2007

- (1) Add the following information into Table 15.4-21

Duration of accident
EAB, LPZ, and control room χ/Q values
Release point
Control room operator doses
Control room not isolated
Control room normal ventilation system will be in operation during this event

- (2) The revisions of Table 15.4-19 and 23 as indicated in Supplemental No. 1 RAI 15.4-3 above are also required for resolution of this RAI.

Supplemental No. 1 RAI 15.4-18:

Reference: RAI 15.3-25 in NRC letter dated October 11, 2006
GE response in MFN 07-198 dated April 12, 2007

- (1) Provide revised or new accident model diagram shown in Enclosure 2 of the response, complete with all fission product transport and release pathways.

Supplemental No. 1 RAI 15.4-18:

Reference: RAI 15.3-25 in NRC letter dated October 11, 2006
GE response in MFN 07-198 dated April 12, 2007

- (1) Provide revised or new accident model diagram shown in Enclosure 2 of the response, complete with all fission product transport and release pathways.

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