

July 13, 2017

Mr. Jerald G. Head
Senior Vice President, Regulatory Affairs
GE-Hitachi Nuclear Energy
3901 Castle Hayne Road MC A-18
Wilmington, NC 28401

SUBJECT: THE GE-HITACHI NUCLEAR ENERGY ADVANCED BOILING WATER
REACTOR AIRCRAFT IMPACT ASSESSMENT INSPECTION FOLLOW-UP,
NUCLEAR REGULATORY COMMISSION INSPECTION REPORT
NO. 05200045/2017-201

Dear Mr. Head:

On April 27, 2017, and June 20, 2017, the U.S. Nuclear Regulatory Commission (NRC) conducted an inspection of the GE-Hitachi Nuclear Energy (GEH) Aircraft Impact Assessment (AIA) related to implementation of corrective actions associated with Notice of Violation (NOV) 05200045/2016-201-01 cited in NRC Inspection Report No 05200045/2016-201 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16285A219). The NRC staff performed this inspection at the GEH facility in Washington, DC on April 27, 2017, and the Nuclear Energy Institute New Plant Oversight Committee Office in Rockville, MD, on June 20, 2017. The purpose of the inspection was to assess GEH's compliance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.150, "Aircraft Impact Assessment." The enclosed report presents the results of this inspection.

Based on GEH's implementation of corrective actions associated with NOV 05200045/2016-201-01, the NRC inspection team concluded the GEH is in compliance with the requirements of 10 CFR 50.150. The NRC inspection team did not identify any new violations within the scope of this inspection and has closed NOV 05200045/2016-201-01.

In accordance with 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding," which is part of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System, which is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>. This letter and its enclosures will be withheld for 5 days from the date of issuance to allow you to identify any information you consider to be proprietary or sensitive. If you consider any information in this letter or its

enclosures to be proprietary or sensitive, you must submit a timely request for the NRC to withhold that information in accordance with 10 CFR 2.390.

Sincerely,

/RA/

Terry W. Jackson, Chief
Quality Assurance Vendor Inspection Branch-1
Division of Construction Inspection
and Operational Programs
Office of New Reactors

Docket No.: 05200045

Enclosure:
Inspection Report No. 05200045/2017-201
and Attachment

SUBJECT: THE GE-HITACHI NUCLEAR ENERGY ADVANCED BOILING WATER REACTOR
AIRCRAFT IMPACT ASSESSMENT INSPECTION FOLLOW-UP, NUCLEAR
REGULATORY COMMISSION INSPECTION REPORT NO. 05200045/2017-201

Dated: July 13, 2017

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NRO-002

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**U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NEW REACTORS
DIVISION OF CONSTRUCTION INSPECTION AND OPERATIONAL PROGRAMS
VENDOR INSPECTION REPORT**

Docket No.: 05200045

Report No.: 05200045/2017201

Inspection Locations: GE-Hitachi Nuclear Energy (GEH) facility in Washington, DC, on April 27, 2017
Nuclear Energy Institute New Plant Oversight Committee Office in Rockville, MD, on June 20, 2017

Contact: Patricia Campbell
GEH
Washington Regulatory Affairs
patriciaL.campbell@ge.com

Nuclear Industry Activities: GEH has completed their aircraft impact assessment of the advanced boiling water reactor design certification to comply with the U.S. Nuclear Regulatory Commission requirements in Title 10 of the *Code of Federal Regulations* Section 50.150, "Aircraft Impact Assessment." The NRC performed an inspection of the GEH aircraft impact assessment in September 2016. This inspection was associated with the design certification renewal application submitted to the NRC by GEH on December 7, 2010. The inspection resulted in one Notice of Violation documented in NRC Inspection Report No. 05200045/2016-201 (ML16285A219).

Inspection Dates: April 27, 2017, and June 20, 2017

Inspectors: Stacy Smith, Team Leader, NRO/DCIP/QVIB1
Dennis Andrukat, NRO/DSRA/SPSB
Ata Istar, NRO/DEI/SEB

Approved by: Terry W. Jackson, Chief
Quality Assurance Vendor Inspection Branch-1
Division of Construction Inspection
and Operational Programs
Office of New Reactors

Enclosure

EXECUTIVE SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) conducted this inspection to verify that GE-Hitachi Nuclear Energy (GEH) had implemented the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.150, "Aircraft Impact Assessment," and performed a design-specific assessment¹ of the effects on the facility of the impact of a large commercial aircraft. Specifically, this inspection verified corrective actions associated with Notice of Violation (NOV) 05200045/2016-201-01 cited in NRC Inspection Report (IR) No. 05200045/2016-201 (ADAMS Accession No. ML16285A219).

The NRC conducted the inspection of GEH in Washington, DC, on April 27, 2017, and in the Nuclear Energy Institute (NEI) New Plant Oversight Committee Office in Rockville, MD, on June 20, 2017.

The following served as the bases for the NRC inspection:

- 10 CFR 50.150

During this inspection, the NRC inspection team implemented Inspection Procedure (IP) 37804, "Aircraft Impact Assessment," dated February 9, 2012.

This inspection was performed to verify that GEH's aircraft impact assessment (AIA) of the advanced boiling water reactor (ABWR) design complies with the requirements of 10 CFR 50.150. Revision 8 of NEI 07-13, "Methodology for Performing Aircraft Impact Assessments for New Plant Designs," dated April 2011, has been endorsed by the NRC in Regulatory Guide (RG) 1.217, "Guidance for the Assessment of Beyond-Design-Basis Aircraft Impacts," as one means of performing an AIA acceptable to the NRC. Specifically, this inspection was performed to verify implementation of GEH's corrective actions to determine whether full compliance has been achieved and maintained.

The NRC inspection team concluded that the portions of the GEH ABWR AIA reviewed by the NRC inspection team comply with the applicable requirements of 10 CFR 50.150. The NRC inspection team did not identify any new violations within the scope of this inspection and has closed NOV 05200045/2016-201-01.

The results of the inspection are summarized below.

Corrective Actions associated with NOV 05200045/2016-201-01

Based on GEH's implementation of corrective actions associated with NOV 05200045/2016-201-01, the NRC inspection team concluded the GEH is in compliance with the requirements of 10 CFR 50.150. The NRC inspection team did not identify any new violations within the scope of this inspection and has closed Violation 05200045/2016-201-01.

¹ By a "design-specific" assessment, the NRC means that the impact assessment must address the specific design of the facility that is either the subject of a construction permit, operating license, standard design certification, standard design approval, combined license, or manufacturing license application (see 74 FR 28129; June 12, 2009).

REPORT DETAILS

1. Corrective Actions associated with NOV 05200045/2016-201-01

a. Inspection Scope

The NRC inspection team reviewed corrective actions associated with the four examples cited in NOV 05200045/2016-201-01 documented in NRC IR 05200045/2016-201 (ML16285A219).

Specifically, the NRC inspection team reviewed corrective actions associated with GEH's failure to identify and/or accurately incorporate in the design control document (DCD), the following examples.

- Section 3H.6, "Summary of Key Structural Design Features," stated that walls will be strengthened to limit physical damage as described in NEDE-33875P. However, NEDE-33875P failed to identify the wall, wall location, elevation, and an exterior wall designation used to limit physical damage in the assessment.
- Location of a water tight door and 3-hour, 5-pounds per square inch differential (psid) fire barrier on Elevation 3F.
- Fixed locations of buildings needed to prevent damage from an aircraft impact.

In addition, the NRC reviewed corrective actions associated with GEH's failure to use realistic analyses in certain aspects of its AIA. Specifically, GEH did not provide enough information to demonstrate that the spent fuel pool (SFP) liner has adequate resolution of the localized plastic deformation to ensure that the structural integrity of SFP is maintained.

b. Observations and Findings

b.1 Section 3H.6, "Summary of Key Structural Design Features"

The NRC inspection team reviewed actions taken in Condition Report (CR) 21466, dated September 15, 2017, to address GEH's failure to identify a wall, wall location, elevation, and an exterior wall designation used to limit physical damage in the AIA. During this inspection, the NRC verified that updated tables and associated figures in Table 4-4 of NEDE-33875P Report, "ABWR US Certified Design AIA Licensing Basis Information and Design Details for Key Design Features," Revision 3, and ANATECH Report 1600262.401, "GEH ABWR Plant Design Structural Response Analysis," Revision 3, appropriately identified key structural design features cited in the NOV.

Since 10 CFR 50.150(b)(2) requires that GEH describe how key design features meet AIA requirements in the DCD, the NRC requested that GEH clarify if NEDE-33875P is incorporated by reference in the DCD in a letter sent to GEH on January 25, 2017 (ML17005A468). In a letter sent back to the NRC on February 1, 2017, GEH stated that it was their intent that NEDE-33875P be incorporated by reference in the DCD and that the content be considered part of the DCD (ML17033B598). The NRC verified NEDE-33875P is incorporated by reference to the DCD, and as such, its content be considered part of the DCD (ML17059C517).

The NRC inspection team verified that the changed tables and figures in NEDE-33875P were identified and described consistent with 10 CFR 50.150 requirements.

b.2 Water Tight Door

The NRC inspection team verified actions in CR 20448, dated September 13, 2016, to address GEH's failure to identify and/or accurately incorporate in the DCD the location of a water tight door on Elevation 3F (i.e. Elevation 23500mm). During this inspection, the NRC verified that DCD Figure 9A.4-6, "Reactor Building Fire Protection at Elevation 23500 mm," accurately reflected the location and water tight door functional capabilities assigned to that key design feature. The inspection team also verified the mark-up made in DCD Figure 9A.4-6 was translated to other applicable DCD drawings on the 23500 mm elevation (i.e., Figure 1.2-10 and Figure 12.3-7) were accurate. The mark-ups were submitted to the NRC in an enclosure to Letter MFN 16-027, Revision 2 (ML16334A292), dated November 23, 2016. Based on discussions with GEH personnel, the NRC verified the commitments identified in MFN 16-027, Revision 2, will be incorporated into Revision 7 of the DCD. In addition, the NRC reviewed a draft copy of Revision 7 of the DCD and verified that the location and ratings of the water tight door and fire barriers on Elevation 3F are appropriately identified.

The NRC inspection team verified the location and water tight door functional capabilities were identified and described consistent with 10 CFR 50.150 requirements.

b.3 Fixed Design Features

The NRC reviewed NEDE-33875P, Revision 3, to address GEH's failure to adequately identify and/or accurately incorporate in the DCD the fixed locations of buildings credited to prevent damage from an aircraft impact. The NRC inspection team verified the information, tables, and figures updated in NEDE-33875P accurately reflect fixed locations of the structures credited as intervening structures assigned to protect the control building. The inspection team verified that Table 3-2, of NEDE-33875P included fixed dimensions to lock the spatial distance between each credited intervening structure and the control building. In addition, the NRC verified that DCD Figure 1.2-20, "Control and Service Building, Arrangement Plan at Elevation 12300 mm," addressed the alignment of the control annex building in relation to the control building. Furthermore, the team verified that the structures credited in DCD Section 19G.4.2 are accounted for in NEDE-33875P, Table 3-2 and Figure 3-1. As noted in Section 1.b.1 of this report, the NRC verified NEDE-33875P is incorporated by reference to the DCD, and as such, its contents are considered part of the DCD (ML17059C517).

b.4. SFP Structural Integrity

The NRC inspection team reviewed CR 20399, dated September 5, 2017, to address GEH's failure to use realistic analyses in certain aspects of its AIA. In addition, GEH informed the NRC in their letter, dated December 7, 2016 (ML16342B005), that ANATECH Report 1600262.401 had been revised to include a new subsection entitled "Assessment for Mesh Sensitivity," in Section 5, "Summary and Conclusion."

This section included more detailed information, such as model development, simulations of experimental test data, and review of analysis results to assess conditions where a more refined mesh might lead to different results. The inspection team discussed the review of analysis results with GEH staff. Regarding the development of mathematical models of concrete walls, GEH described how more refined meshing was used at the area of surface impact and less refined meshing was used in the areas away from aircraft surface impact. In addition, GEH described how the same parameters and modeling techniques used in the full scale aircraft impact simulations performed at Sandia National Laboratories (SNL) were also used for the GEH ABWR plant design. Furthermore, GEH described that application of finer mesh refinement in the wall models would tend to increase energy absorption. Thus, the impacting momentum would be resisting over a longer time period, where the absorption due to the bending components would be increased and shear forces generated would be decreased. Finally, GEH described that, due to the shear forces, one layer of reinforcing bars (dowels) at the top free edges of the SFP wall is sufficient to meet the NEI criteria for keeping the SFP liner intact at a specified plastic strain. However, GEH added a second layer of reinforcing bars at the top free edges of the SFP to bring the plastic strain in the SFP liner to a more conservative percentage. Based on these discussions, the NRC inspection team concluded that uncertainty in the results due to the application of finer mesh refinement would not affect the final conclusion of the AIA.

c. Conclusions

Based on GEH's implementation of corrective actions associated with NOV 05200045/2016-201-01, the NRC inspection team concluded the GEH is in compliance with the requirements of 10 CFR 50.150. The NRC inspection team did not identify any new violations within the scope of this inspection and has closed NOV 05200045/2016-201-01.

2. Entrance and Exit Meetings

On April 27, 2017, the NRC inspection team discussed the scope of the inspection with representatives from GEH. On June 20, 2017, the NRC inspection team presented the inspection results and observations during an exit meeting with representatives from GEH.

ATTACHMENT

1. PERSONS CONTACTED

Name	Affiliation	Entrance	Exit	Interviewed
Patricia L. Campbell	GEH	X	X	X
J. Alan Beard	GEH	X	X	X
Stacy Smith	NRC	X	X	
Dennis Andrukat	NRC	X	X	
Ata Istar	NRC	X	X	

2. Inspection Procedures Used

Inspection Procedure 37804, "Aircraft Impact Assessment," dated February 9, 2012.

3. List of Items Opened, Closed, and Discussed

<u>Item Number</u>	<u>Status</u>	<u>Type</u>	<u>Description</u>
05200045/2016-201-01	CLOSED	NOV	10 CFR 50.150(a)(1)

4. Documents Reviewed

Condition Reports

CR 20399, dated September 5, 2017
CR 20401, dated September 5, 2016
CR-17917, dated September 13, 2016
CR 20448, dated September 13, 2016
CR 21455, dated September 15, 2016
CR 21466, dated September 15, 2017
CR 25495, dated April 27, 2017

Letters

M170049, "GE-Hitachi Nuclear Energy Advanced Boiling Water Reactor Design Certification Rule Renewal Application – ABWR DCD Changes for Aircraft Impact Assessment (AIA) - Key Design Features (Revision 3)," dated February 28, 2017 (ML17059C517)

MFN 16-027, "GE-Hitachi Nuclear Energy Advanced Boiling Water Reactor Design Certification Rule Renewal Application - ABWR DCD Changes for Aircraft Impact Assessment (AIA) - Key Design Features (Revision 2)," dated November 23, 2016 (ML16334A292)

DCD, Revision 7 Figures

Figures 1.2-1, "Site Plan"

Figure 1.2-8, "Reactor Building, Arrangement Plan at Elevation 12300 mm"

Figure 1.2-9, "Reactor Building, Arrangement Plan at Elevation 18100 mm"

Figure 1.2-10, "Reactor Building, Arrangement Plan at Elevation 23500 mm"

Figure 1.2-11, "Reactor Building, Arrangement Plan at Elevation 27200 mm"

Figure 1.2-12, "Reactor Building, Arrangement Plan at Elevation 31700/38200 mm"

Figure 1.2-20, "Control and Service Building, Arrangement Plan at Elevation 12300 mm"

Figure 1.2-21, "Control and Service Building, Arrangement Plan at Elevation 17150 mm"

Figure 1.2-22, "Control and Service Building, Arrangement Plan at Elevation 22200 mm"

Figure 1.2-24, "Turbine Building, General Arrangement at Elevation 5300 mm"

Figure 1.2-25, "Turbine Building, General Arrangement at Elevation 12300 mm"

Figure 1.2-26, "Turbine Building, General Arrangement at Elevation 20300 mm"

Figure 1.2-27, "Turbine Building, General Arrangement at Elevation 30300 mm"

Figure 1.2-28, "Turbine Building, General Arrangement, Longitudinal Section A-A"

Figure 1.2-29, "Turbine Building, General Arrangement, Section B-B"

Figure 1.2-30, "Turbine Building, General Arrangement, Section C-C"

Figure 1.2-31, "Turbine Building, General Arrangement, Section D-D"

Other

PLM 003N6099, Rev 3

NEDE-33875P, Revision 3, "ABWR US Certified Design AIA Licensing Basis Information and Design Details for Key Design Features," February 2017

NEDE-33875P Table 3-2, "Intervening Structure Credited in ABWR Aircraft Impact Assessment,"

NEDE-33875P Figure 3-1, "ABWR Site Plan – Location of Structures."

Structural Integrity Association (SIA)-ANATECH Report: No.: 1600262.401, Revision 3, "GEH ABWR Plant Design Structural Response Analysis," dated February 1, 2017

Jensen Hughes Report, No.: C01020800007-9536, Revision 4, "Aircraft Impact Assessment for Fuel Cooling Report on the GEH ABWR DCD, Revision 6 Design."

5. **ACRONYMS USED:**

ABWR	advanced boiling water reactor
ADAMS	Agencywide Documents Access and Management System
AIA	aircraft impact assessment
ADAMS	Agencywide Documents Access and Management System
CFR	Code of Federal Regulations
CR	Condition Report
DCD	design control document
DCIP	Division of Construction Inspection and Operational Programs
GEH	GE-Hitachi Nuclear Energy
GE	General Electric Company
IP	inspection procedure
IR	inspection report
NEI	Nuclear Energy Institute
NOV	Notice of Violation
NRC	(U.S.) Nuclear Regulatory Commission
NRO	Office of New Reactors
psid	pounds per square inch differential
QA	quality assurance
RG	Regulatory Guide
SIA	Structural Integrity Association
SFP	spent fuel pool
SNL	Sandia National Laboratories
U.S.	United States (of America)