



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

January 16, 2018

MEMORANDUM TO: Joseph Colaccino, Branch Chief  
Licensing Branch 3  
Division of New Reactor Licensing  
Office of New Reactors

FROM: James Shea, Project Manager */RA/*  
Licensing Branch 3  
Division of New Reactor Licensing  
Office of New Reactors

SUBJECT: REGULATORY AUDIT RESULTS SUMMARY REPORT OF THE  
PROBABILISTIC RISK ASSESSMENT OF DESIGN CHANGES FOR  
THE ADVANCED BOILING-WATER REACTOR DESIGN  
CERTIFICATION RENEWAL

Enclosed is the U.S. Nuclear Regulatory Commission (NRC) staff's Probabilistic Risk Assessment (PRA) Audit report regarding the GE Hitachi (GEH) Advanced Boiling-Water Reactor (ABWR) design certification (DC) renewal application (Docket No. 52-045). The staff performed an off-site-audit of the process and procedures GEH used to assess proposed design changes impact on the ABWR DC PRA as part of the GEH ABWR DC renewal application.

The audit was conducted over three months, starting on July 25, 2017 and concluding with an exit meeting on September 27, 2017. The ABWR DC renewal PRA audit was completed remotely using the GEH electronic reading room (eERR). The staff reviewed several of the applicants engineering change reports and conducted phone conferences with the applicant for clarification information as part of the staff audit activities. In addition, as the audit proceeded the staff requested additional documents to review in the eRR, which were provided by GEH.

Docket No. 52-045

Enclosure:  
As stated

cc w/encl: See next page

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SUBJECT: REGULATORY AUDIT REPORT OF THE PROBABILISTIC RISK  
ASSESSMENT OF DESIGN CHANGES FOR THE ABWR DC RENEWAL

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<b>DATE</b>	12/16/2017	12/18/2017	12/21/2017	12/22/2017	12/21/2017

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**U.S. NUCLEAR REGULATORY COMMISSION REGULATORY AUDIT RESULTS**  
**SUMMARY OF PROBABILISTIC RISK ASSESSMENT IMPACT AS PART OF**  
**THE ADVANCED BOILING-WATER REACTOR DESIGN CERTIFICATION RENEWAL**  
**APPLICATION**

**(Docket No. 52-045)**

**Dates of Audit:** July 27 – September 27, 2017

**Audit Location:** U.S. NRC Headquarters  
Two White Flint North  
11545 Rockville Pike  
Rockville, MD 20852-2738

**Audit Team:** James Shea (NRC Project Manager)  
Michelle Hayes (NRC SPRA Branch Chief (Acting))  
Hanh Phan (NRC Lead Technical Reviewer)  
Malcolm Patterson (NRC Technical Reviewer)  
Marie Pohida (NRC Technical Reviewer)

**Audit Scope**

The specific scope of this audit included a review of the process/guidance and all related documentation used to evaluate impact on Probabilistic Risk Assessment (PRA) of the changes resulting from the design modifications or departures as part of the GE Hitachi (GEH) Advanced Boiling-Water Reactor (ABWR) design certification (DC) renewal application.

The purpose of this audit was for the staff to (1) understand the process used to determine the potential impact of design changes or departures on ABWR design-specific PRA, (2) review related documentation and non-docketed information to evaluate conformance with the standard review plan and staff guidance, and (3) ensure the quality of the process/procedures used by GEH for PRA update meet appropriate regulatory requirements.

A list of GEH documents available for this audit is included in Table 1, "List of Reports and Supporting Information for the ABWR DC Renewal PRA Audit," which was provided by the applicant during the audit.

**Audit Summary**

During the audit entrance NRC staff made introductory remarks regarding the regulatory audit background, scope, objectives, and agenda. This included the regulatory basis for the staffs' audit and the office instruction procedure for conducting a regulatory audit.

Following these remarks, GEH presented an overview of its Engineering Change Authorization / PRA process and procedures. These processes and procedures are used by GEH to evaluate the impact of engineering changes on specific risk metrics for the ABWR.

During the audit, the staff reviewed the documents placed in the electronic reading room (eRR). While reviewing the process, the staff focused on three ABWR DC specific design changes as examples to better understand the details of the GEH ABWR PRA design change.

The audit concluded with an exit meeting on September 27, 2017, where the staff conveyed to GEH that the NRC had no findings in regards to the process GEH used to evaluate design changes to the ABWR in its renewal application. The staff also provided audit "Observations" on GEH process and procedures, during the audit exit meeting.

The audit team finds that the information presented to the staff addressed the purpose of this audit. Specifically, it provided an understanding of the technical basis, assumptions, and methods by which GEH evaluates, screens, and tracks for PRA inputs or design changes.

### **Detailed Review and Discussions**

After reviewing the documents provided in the eRR, the staff identified some design changes as having the potential to have an impact on the ABWR PRA and asked the applicant to conduct a table-top exercise with three specific change packages:

1. CP1-ECA-0012, "ABWR DCD [design control document] Fukushima Recommendation 4.2 – Mitigation Strategies"
  - Add a subsystem to residual heat removal loop B for alternating-current-independent water addition (ACIWA). The new subsystem includes a connection to the fire protection system and an external hose connection for a fire truck.
  - Make the diesel-driven fire pump fuel capacity sufficient for 72 hours of operation; include severe weather/flooding protection for ACIWA and the diesel-driven fire pump.
2. CP1-ECA-0014, "ABWR DCD Fukushima Recommendation 4.2 – Mitigation Strategies – [Remote Shutdown System] Required Changes"
  - During a station blackout (no offsite ac power and no combustion turbine generator or emergency diesel generator available) additional features added to the remote shutdown system panels used by the operators.
3. CP1-ECA-0018, "ABWR DCD Aircraft Impact Assessment – Mechanical"
  - Main control room heating, ventilation, and air conditioning is required to function following postulated aircraft impact strikes in order to support the core cooling function.
  - Interface requirements are specified relevant to the loss of reactor service water and ultimate heat sink systems.

The table top exercise was conducted on September 21, 2017. The staff concluded that the process followed by GEH provides an appropriate level of evaluation for determining whether design changes could impact the ABWR PRA. Also, the audit team did not identify the need to request additional information. Notwithstanding the staff's conclusion, the staff communicated the following observations during the audit's exit meeting on September 27, 2017:

- The audit team observed that the responsible engineer assigned to an engineering change is authorized to determine that a reliability analysis is not required. It was not clear what training or qualification provides confidence that a responsible engineer will be aware of all aspects of a change that can affect the PRA.
- In the case of changes to address the aircraft impact assessment, GEH identified its potential to change the severe accident, containment, and large early release frequency assessments. These changes were not quantified for its effect on the PRA but the audit team found that the applicant evaluated them appropriately for the purpose of design certification renewal.
- During the table top exercise, the audit team noted that on some engineering change authorization (ECA) forms, the subsections referenced the PRA scope to the “parent” form, but the “parent” form did not include a clear statement regarding PRA scope. . In response, GEH initiated a condition report to evaluate the issue. Although the condition report was not yet closed at the time of the exit interview, the evaluation and its conclusions that no adverse condition exists and no action is needed were already documented.
- During the exit meeting, the staff noted that the description of the ACIWA system testing in App 19K-12 of the DCD did not include the subsystem added in CP1-ECA-0012. Because this change was not credited in the PRA, the testing of this system was considered outside the scope of the audit..
- The staff observed that the evaluation and screening process applied by GEH only considers the negative PRA impacts on core damage frequency, large release frequency, and conditional containment failure probability. Although this observation would have insignificant impact on the ABWR DC renewal application, the staff suggested that GEH should also evaluate the positive impact on its PRA to ensure that the PRA accurately reflects the as-designed, as-built, and as-operated plant.

This audit summary report supports the staff safety review that will be documented in Chapter 19 of the safety evaluation report for the renewal of the ABWR standard plant design certification.

**TABLE 1:  
List of Reports and Supporting Information for the ABWR DC Renewal PRA Audit**

ECA Number	ECA Subject
CP1-1-ECA-0001	Design Changes due to Aircraft Impact Assessment
CP1-ECA-0002	ABWR CST Leakage
CP1-ECA-0004	ABWR DCD R5 Aircraft Impact Assessment RAI
CP1-ECA-0006	ABWR DCD Revised Containment Analysis
CP1-ECA-0007	ABWR DCD Rev 4 Aircraft Impact Assessment
CP1-ECA-0009	ABWR DCD Gas Accumulation Locations - Addition of Vent Lines to RPV Head Spray Nozzle
CP1-ECA-0010	Deletion of New Fuel Vault
CP1-ECA-0012	ABWR DCD Fukushima Recommendation 4.2 - Mitigation Strategies
CP1-ECA-0013	ABWR DCD COPS Size Correction
CP1-ECA-0014	ABWR DCD Fukushima Recommendation 4.2 - Mitigation Strategies - FLEX
CP1-ECA-0015	ABWR DCD Fukushima Recommendations 4.2 - Electrical Strategies
CP1-ECA-0016	ABWR DCD Spent Fuel Pool Wide Range Level Instrumentation
CP1-ECA-0017	ABWR DCD Aircraft Impact Assessment - Civil
CP1-ECA-0018	ABWR DCD Aircraft Impact Assessment - Mechanical
CP1-ECA-0019	ECCS $\Delta$ PCT DCD Update
CP1-ECA-0020	ABWR Tornado and Hurricane Missile Speeds
CP1-ECA-0021	ABWR Mitigation of Open Phase Condition (OPC)
CP1-ECA-0022	RAI 09.05.01-1 concerning Multiple spurious operations (MSOs)
CP1-ECA-0023	ABWR ECCS Suction Strainer Design Change- GE Optimized Stacked Disk

**TABLE 1:  
List of Reports and Supporting Information for the ABWR DC Renewal PRA Audit**

<b>Procedure #</b>	<b>Title</b>
CP-03-113	Engineering Change Control
WI-03-113-01	NPE Design Change Control
WI-03-113-04	Product Design Change Control Evaluation of Changes Affecting NRC Design Certification Documents
WI-03-113-05	GEH Product Design Change Control – PRA Model Maintenance and Update
<b>Additional Documents added to the EFF during the Audit</b>	
WI-03-113-04-F01	Form associated with WI-03-113-04
CP-03-113-F01	Form associated with CP-03-113 (Engineering Change Authorization)
CP-03-113-F02	Form associated with CP-03-113 (Engineering Change Authorization)
CP-03-100-G230,	Reliability Analysis
CP-03-100-G515	PLM Issue Management
ISS-0000617	for ECAs 12 and 14 – PROPRIETARY
ISS-0000745	for ECA 18 - PROPRIETARY
CR-26820	for PRA Scope Pointer Error in ECAs – PROPRIETARY
CR-26862	for Error in DCD Section 19.K.5 (4) - PROPRIETARY

**TABLE 2:****ABWR DC Renewal PRA Audit July 27 through September 27, 2017,  
GEH Participants**

<b>Last name</b>	<b>First Name</b>	<b>Organization</b>	<b>Title</b>
Schumitsch	Walter (Skip)	GEH	Project Management Overall GEH Lead
Enfinger	Timothy	GEH	Senior Licensing Engineer Regulatory Affairs GEH Lead
Campbell	Patricia	GEH	Reg Affairs Audit Support
Beard	Alan	GEH	Principal Engineer
Hinds	David	GEH	Technical Leader
Seeman	Glen	GEH	Senior PRA Engineer
Li	Jonathan	GEH	PRA Technical Lead
Miller	Gary	GEH	Manager, Risk and Reliability
Marshall	AnnMarie	GEH	Senior Engineer, Configuration Management
Head	Jerry	GEH	Senior Vice President, Regulatory Affairs