From: Shea, James
Sent: Monday, January 11, 2021 3:32 PM
To: GEH-BWRX-300MtgSumPEm Resource
Subject: GEH BWRX-300 Public Meeting Summary December 9, 2020, December 15, 2020 and December 23, 2020
Attachments: GEH BWRX-300 Public Meeting Summary December 9, 15 and 23 2020.docx

James Shea
NRR/DNRL/NRLB/PM

Hearing Identifier: GEH_BWRX300_Mtgs_Public
Email Number: 26

Mail Envelope Properties (DM8PR09MB699830A9ECCA65BA2B50D87094AB0)

Subject: GEH BWRX-300 Public Meeting Summary December 9, 2020, December 15, 2020 and December 23, 2020
Sent Date: 1/11/2021 3:31:39 PM
Received Date: 1/11/2021 3:31:42 PM
From: Shea, James

Created By: James.Shea@nrc.gov

Recipients:
"GEH-BWRX-300MtgSumPEm Resource" <GEH-BWRX-300MtgSumPEm.Resource@nrc.gov>
Tracking Status: None

Post Office: DM8PR09MB6998.namprd09.prod.outlook.com

Files	**Size**	**Date & Time**
MESSAGE	48	1/11/2021 3:31:42 PM
GEH BWRX-300 Public Meeting Summary December 9, 15 and 23 2020.docx	46411	

Options
Priority: Normal
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:

U.S. Nuclear Regulatory Commission Public Meeting Summary

Title: General Electric Hitachi (GEH) public teleconference to discuss technical issues related to Containment Evaluation Method.

Meeting Notice: Agency Document Accession Management System (ADAMS) accession number: ML20344A054, ML20345A359, ML20356A113, respectively.

Date of Meetings: Wednesday, December 9, 2020, Tuesday, December 15, 2020, and Wednesday, December 23, 2020

Location: Via teleconference

Type of Meeting: Category 1 and Closed

Purpose of the Meetings:

Public teleconference meeting to discuss the BWRX–300, Containment Evaluation Method Topical Report (ML20269A472)

Summary of Meetings:

The meetings started with a brief introduction by NRC licensing project manager (PM) Marieliz Johnson, who explained the purpose of the meeting, asked participants to introduce themselves, and described how the meeting would be conducted. The purpose of the meetings was to ask some initial questions to decide what needs to be audited and what needs to be asked as a formal Request for Additional Information (RAI). No members of the public joined any of the meetings. Below the topics discussed.

<u>Containment Design & GOTHIC Modeling</u>

1. The LTR does mention the Transient Reactor Analysis Code General Electric (TRACG) qualification for the Economic Simplified Boiling Water Reactor (ESBWR) configuration for the effect of the non-condensable gases, but it is silent on the GOTHIC qualification for the effect of the non-condensable gases that would be relevant to the BWRX-300 containment safety analysis. The Licensing Topical Report (LTR) also did not discuss how the non-condensable gases were explicitly modelled in GOTHIC for the BWRX-300 containment design, and what quantitative assumptions were made in this regard. The LTR only refers to a recently developed Heat and Mass Transfer Analogy Method (HMTAM) based on CONAN and COPAIN test data that include the effect of non-condensables. Without additional information, the staff would not be able to assess the conservatism due to the non-condensables, which would be relevant to meeting the GDC 38 containment heat removal requirements of rapidly reducing the containment pressure and temperature and maintaining them at acceptably low levels, following the design basis event. The LTR does not present any sensitivity analysis regarding the effect of non-condensables in condensation modeling on the results, either.

GEH - Diffusion model in GOTHIC is used to model non-condensable gas. Further qualification was done in the method LTR Section 6.8. Section 6.9 of this LTR documented the qualification for calculating the non-condensable transport.

NRC: 6.2 of LTR does discuss the high-level information of non-condensables. No quantified information for GOTHIC.

GEH: Passive Containment Cooling System (PCCS) outer surface, containment dome. Containment bottom is excluded.

2. GOTHIC containment peak pressure and temperature calculations are known to be sensitive to the selection of inertial lengths for the momentum equation, as they account for how the mass moves from one node to the other to capture the flow physics, and potentially influencing the stratification, mixing, and circulation otherwise missing from the lumped-parameter approach. The LTR does not provide any information on the selection and justification for the inertial lengths for the containment safety analyses. The staff would also like to discuss any sensitivity studies GEH may have conducted by modeling the entire containment volume as a single GOTHIC node or a few nodes, in order to assess the conservatism in using the finer containment nodalization.

GEH: 3-D GOTHIC model uses CFD type of cells. The lumped parameter control volume is not used for this application. Therefore, the selection of inertial lengths for lumped parameter sub-compartment does not matter. More detailed mechanistic model is used to calculate the non-condensable gas distribution. More challenging test benchmark/assessments were used to justify the application to BWRX-300. Proprietary information will be discussed during the closed session.

GEH did the sensitivity analysis and found not significant between the fine nodalization model and the lumped parameter model. Small Break Loss of Coolant Accident (SBLOCA) is not sensitive to the stratification of non-condensable gas. Large Break Loss of Coolant Accident (LBLOCA) could be sensitive to this. However, it does not alter the peak pressure significantly due to the nodalization.

3. Section 5.2.4 states that "Both [Isolation Condensers System] ICS and PCCS use the same qualification base and testing that were originally performed for the Simplified Boiling Water Reactor (SBWR) design and supplemented for ESBWR design." As indicated in section 5.2, the PCCS is totally different from that used in ESBWR, so the previous PCCS validations for ESBWR would not be applicable to the BWRX design and no validations were provided in this LTR. The staff did not understand how the earlier testing for the SBWR/ESBWR designs could provide a qualification base for the BWRX-300 PCCS that is a new system with a different configuration and is still being designed. Besides, the BWRX-300 PCCS design potentially involves a challenging natural circulation heat transfer phenomenon with high uncertainty due to dominant thermal resistance on the thermosyphon side. This aspect of the PCCS design is expected to be safety-significant during the first 24 hours as well as the long-term cooling for the un-isolated small break LOCA. The staff did not see any information in the LTR about the PCCS design validation or the corresponding GOTHIC qualification for modeling the density-gradient driven recirculatory flow established in the PCCS thermosyphon. The modeling therefore used for GOTHIC (Section 6.5) and results generated would not have adequate basis consistent with Regulatory Guide 1.206 - Combined License Applications for Nuclear Power Plants. If it is determined that PCCS significantly contributes to the success of the peak pressure analysis, providing a hand calculation as a justification would not be adequate.

GEH: Qualification tests were done for PCCS/ICS of ESBWR. These were not used to qualify BWRX-300 PCCS which are different from PCCS in ESBWR.

GEH: PCCS qualification and the thermal-siphon phenomenon, Section 6, of this LTR covers the qualification of PCCS modeling using GOTHIC. The secondary side flow is 1-D single phase natural circulation based on temperature and density gradients, which is well understood. Additional information of PCCS hand calculation can be provided during an upcoming audit.

4. GDC 38 requires a system to remove heat from the reactor containment. The system safety function is to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any LOCA and maintain them at acceptably low levels. The LTR describes the PCCS design, demonstrating its safety function in rapidly reducing containment pressure and temperature during the most limiting BWRX-300 Design Basis Event (DBE), a large-break LOCA with loss of offsite power and a single active failure. However, the staff noticed that the LTR is silent on the 2nd part of GDC 38 requirement, i.e., maintaining the containment pressure and temperature at acceptably low levels for the limiting DBE, and does not demonstrate it.

GEH: The compliance of GDC 38 requirement is not within the scope of this LTR. They are asking for the approval of the methodology with its application to GDC 38 compliance.

5. Section 4.0 (Overview of the Valuation Model) states “While this method compounds conservatisms, it gives reasonable assurance that the overall method results bound the uncertainties, and greatly reduces the number of sensitivity calculations.” There are several other generic statements in the LTR about conservatisms in the safety analysis that lack the associated quantitative information in the LTR. For example, Section 6.11 states “Free space volume in the containment is conservatively calculated”, but the staff could not identify how much conservatism was applied to the containment free volume.

GEH: Conservatism assumption for free space volume in the containment is not part the scope of this LTR.

6. To satisfy the requirements of GDC 38 and 50 with respect to the functional capability of the containment heat removal systems and containment structure under LOCA conditions, provisions are required to protect the containment structure against possible damage from external pressure conditions. During the review of the LTR NEDC-33911P, BWRX-300 Containment Performance,” the staff raised concerns about the lack of information on this subject. In response, GEH stated that “The BWRX-300 containment structural design evaluation to withstand the maximum expected external pressure to demonstrate compliance to 10 CFR 50, Appendix A, GDC 38 and GDC 50 will be provided during future licensing activities.” They also revised NEDC-33911P, Revision 0, Section 5.1.17 accordingly to reflect the future submittal of the maximum external containment pressure structural design evaluation with sufficient margin to account for uncertainties from a full spectrum of postulated accidents. The staff was unable to identify any such information included in the present LTR on how the applicant would conduct a detailed evaluation of the maximum expected external pressure analyses to confirm that the final BWRX-300 containment design satisfies the external pressure acceptance criterion.

GEH: LBLOCA and SBLOCA inside containment are included in this LTR. This LTR does not cover other events.

7. To confirm compliance with GDC 16, 38, and 50 relevant to the containment design basis and guided by SRP Sections 6.2.1.1.A and 6.2.1.3, the LTR needs to clarify whether the containment evaluation methodology is based on the consideration of a full spectrum of postulated DBEs and enveloping the results of the range of analyses. No such assurance is documented in the LTR.

GEH: Understand they are regulatory requirements. However, other events do not discharge mass and energy into containment. Therefore, the existing SBLOCA and LBLOCA are bounding. Containment Performance LTR covered this.

8. NEDC-33922P, Section 1.3 states that "containment remains isolated for 72 hours during a design basis event or accident." SCPB staff noted that this statement might not be valid because of the previous NRC staff finding in the SER for LTR NEDC-33911P, "BWRX-300 Containment Performance," on the bypass of containment isolation from a postulated LOCA outside containment. BWRX-300 ICS containment penetration design uses closed loop piping in lieu of outboard containment isolation valves (CIVs) to satisfy GDC 55 for reactor coolant line containment penetration. The staff found the design to be an acceptable alternative for satisfying GDC 55, because keeping the flow path always open without the outboard isolation valve to ensure Emergency Core Cooling System (ECCS) function is more risk-significant than providing the valve to meet explicit GDC 55 requirements. However, as a result of this design, the ICS pipe failure outside containment without outboard containment isolation valve needs to be evaluated. The consequences of this newly identified reactor coolant pipe failure outside containment are not bounded by the identified bounding break (main steam or feedwater line) identified in NEDC-33922, which has outboard containment isolation valves to satisfy GDC 55 and to eliminate such postulated break outside containment. In this case, the reactor coolant in the proposed closed loop piping outside containment could be the source of dynamic and environmental effects including radiological consequences. The dose consequences of the pipe failures outside containment resulting from the ICS steam supply and condensate return piping have not been evaluated. Therefore, the statement regarding containment remaining isolated for 72 hours may not be valid. (This statement should be removed from this LTR.)

GEH: ICS break outside of containment is not part of the scope of the LTR. Propose that the wording changes be made to clarify.

9. NEDC-333922P, Section 5.2.4, "Isolation Condenser Modeling and Radiolytic Gases," and Section 6.10.3 "Containment Mixing for Combustible Gases," describe the combustible gases analyses.

    - RG 1.7, "Control of Combustible Gas Concentrations in Containment," states that all containment types should have an analysis of the effectiveness of the method used for providing a mixed atmosphere. This analysis should demonstrate that combustible gases will not accumulate within a compartment or cubicle to form a combustible or detonable mixture. However, the LTR did not provide sufficient information on the analysis methodology and assumptions to demonstrate that containment atmosphere is sufficiently mixed for combustible gases such that deflagration or detonation does not occur inside containment. Specify the criteria such as the deflagration limit being used for this determination.

- The LTR analyzed a small steam pipe break inside containment. It is not clear why a small ICS line break inside or outside containment is not analyzed for the combustible gas control. ICS line break outside containment bypass the containment isolation and not having inert environment, could have more significant consequences.

GEH: We calculated the H2 and O2 in the core and track the concentration in the reactor pressure vessel (RPV) up to ICS. The criteria was not documented because it is a very small concentration.

After each public portion of the meetings, detailed discussions of the LTR were resumed on the closed bridge-line, to discuss the proprietary information aspects of the questions. Other six questions were discussed but the questions and answers contained proprietary information. The December 23rd meeting was closed as the remaining topics were proprietary.

After these closed discussions, the meeting was adjourned.

Meeting participants: See the following page.

December 9, 2020, Meeting Attendees

Open	Closed	Name	Affiliation
X	X	Marieliz Johnson	NRC
X		Greg Cranston	NRC
X	X	Syed Haider	NRC
X	X	Jason Huang	NRC
X	X	Scott Krepel	NRC
X	X	Yueh-Li Li	NRC
X	X	Rebecca Patton	NRC
X	X	Ann Marie Grady	NRC
X	X	Carl Thurston	NRC
X	X	Andrew Proffitt	NRC
X	X	Shanlai Lu	NRC
X	X	Brian Wittick	NRC
X	X	Chang Li	NRC
X		Rani Franovich	NRC
X	X	Kevin Fice	Canadian Nuclear Safety Commission (CNSC)
X	X	Chantal Morin	CNSC
X	X	Aleksander Delja	CNSC
X	X	Charles Heck	GE-Hitachi Nuclear Energy Americas LLC (GEH)
X	X	David Hinds	GEH
X	X	Louis Lanese	GEH
X	X	Necdet Kurul	GEH
X	X	Christer Dahlgren	GEH
X	X	Ray Lewis	GEH
X	X	George Wadkins	GEH
X	X	Frostie White	GEH
X	X	Bernard Gilligan	Hitachi-GE Nuclear Energy Ltd. (HGNE)
X	X	Jun Matsumoto	HGNE
X	X	Yutaka Yoshie	HGNE
X	X	Hideaki Sadamatsu	HGNE
X	X	Ray Schiele	Tennessee Valley Authority (TVA)
X	X	Kevin Casey	TVA

December 15, 2020, Meeting Attendees

Open	Closed	Name	Affiliation
x	x	Marieliz Johnson	NRC
x	x	Greg Cranston	NRC
x	x	Syed Haider	NRC
x	x	Scott Krepel	NRC
x	x	Yueh-Li Li	NRC
x	x	Ryan Nolan	NRC
x	x	Mike Dudek	NRC
x	x	Carl Thurston	NRC
x	x	Andrew Proffitt	NRC
x	x	Shanlai Lu	NRC
x	x	Brian Wittick	NRC
x	x	Chang Li	NRC
x	x	Rani Franovich	NRC
x	x	James Shea	NRC
x	x	Kevin Fice	Canadian Nuclear Safety Commission (CNSC)
x	x	Jana Ene	CNSC
x	x	Aleksander Delja	CNSC
x	x	Charles Heck	GE-Hitachi Nuclear Energy Americas LLC (GEH)
x	x	David Hinds	GEH
		Louis Lanese	GEH
x	x	Necdet Kurul	GEH
x	x	Christer Dahlgren	GEH
x	x	Ray Lewis	GEH
x	x	George Wadkins	GEH
x	x	Frostie White	GEH
x	x	Bernard Gilligan	Hitachi-GE Nuclear Energy Ltd. (HGNE)
x	x	Jun Matsumoto	HGNE
		Yutaka Yoshie	HGNE
x	x	Hideaki Sadamatsu	HGNE
x	x	Steve Hilmes	Tennessee Valley Authority (TVA)
	x	Alex Young	TVA
	x	Ray Schiele	TVA

December 23, 2020, Meeting Attendees

Closed	Name	Affiliation
x	Marieliz Johnson	NRC
x	Syed Haider	NRC
x	Yueh-Li Li	NRC
x	Carl Thurston	NRC
x	Shanlai Lu	NRC
x	Chang Li	NRC
x	Thomas Scarbrough	NRC
x	James Shea	NRC
x	Getachew Tesfaye	NRC
x	Antonio Barrett	NRC
x	Angela Buford	NRC
x	Rebecca Patton	NRC
x	Michael Dudek	NRC
x	Chantal Morin	Canadian Nuclear Safety Commission (CNSC)
x	Aleksander Delja	CNSC
x	Samuel Gyepi-Garbrah	CNSC
x	Charles Heck	GE-Hitachi Nuclear Energy Americas LLC (GEH)
x	David Hinds	GEH
x	Louis Lanese	GEH
x	Necdet Kurul	GEH
x	Ray Lewis	GEH
x	George Wadkins	GEH
x	Frostie White	GEH
x	Hideaki Sadamatsu	Hitachi-GE Nuclear Energy Ltd. (HGNE)
x	Jun Matsumoto	HGNE
x	Yutaka Yoshie	HGNE
x	Steve Hilmes	Tennessee Valley Authority (TVA)
x	Ray Schiele	TVA
x	Saad Khan	Ontario Power Generation (OPG)