From: Shea, James
Sent: Wednesday, August 4, 2021 2:55 PM
To: GEH-BWRX-300RAIsPEm Resource
Subject: BWRX-300 Request for Additional Information (Non-Proprietary / Public) Letter No. 16 LTR NEDC-33922P, Containment Evaluation Method (eRAI 9854, 9856, 9857, & 9862)
Attachments: GEH BWRX-300 Request for Additional Information Letter No. 16 Containment Evaluation Method LTR Non-Proprietary-Final.docx

James Shea
NRR/DNRL/NRLB
ABWR DC Renewal PM

Hearing Identifier: GEH_BWRX300_RAIs_Public
Email Number: 18

Mail Envelope Properties (BLAPR09MB6899943870745298D0DB2CAD94F19)

Subject: BWRX-300 Request for Additional Information (Non-Proprietary / Public) Letter No. 16 LTR NEDC-33922P, Containment Evaluation Method (eRAI 9854, 9856, 9857, & 9862)
Sent Date: 8/4/2021 2:54:58 PM
Received Date: 8/4/2021 2:55:02 PM
From: Shea, James

Created By: James.Shea@nrc.gov

Recipients:
"GEH-BWRX-300RAIsPEm Resource" <GEH-BWRX-300RAIsPEm.Resource@usnrc.onmicrosoft.com>
Tracking Status: None

Post Office: BLAPR09MB6899.namprd09.prod.outlook.com

Files	**Size**	**Date & Time**
MESSAGE	67	8/4/2021 2:55:02 PM
GEH BWRX-300 Request for Additional Information Letter No. 16 Containment Evaluation Method LTR Non-Proprietary-Final.docx	52741	

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

Request for Additional Information Letter No. 16 (eRAI 9854, 9856, 9857, & 9862)
Issue Date: 08/05/2021
Application Title: GEH BWRX-300 Pre-Application Licensing Topical Reports (LTRs)
GEH BWRX-300 LTR NEDC-33922P, Containment Evaluation Method
Operating Company: GE Hitachi Nuclear Energy (Wilmington, NC)
Docket No. 99900003

QUESTIONS:

SRP-Review Section: 06.02.01 - Containment Functional Design Application Section:

06.02.01-01 (eRAI 9862) [Audit Issue 1]

Requirement

General Design Criterion 50 – *Containment design basis*. Requires the reactor containment structure, including access openings, penetrations, and the containment heat removal system be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident (LOCA).

General Design Criterion 38 -- *Containment heat removal*. A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

General Design Criterion 16 -- *Containment design*. Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

Issue

Guided by the Standard Review Plan (SRP) Section 6.2.1 and the General Design Criteria (GDCs) 50, 38, and 16 of Appendix A to 10 CFR Part 50 relevant to the containment design basis, the staff is reviewing the applicant's analytical model and assumptions used in the GEH LTR NEDC-33922P, Revision 0, BWRX-300 Containment Evaluation (CE) Method. An important objective of this LTR review is to assess the conservativisms and non-conservatisms associated with the presented GOTHIC model, in order to determine whether the CE methodology would be acceptably conservative and physically meaningful with respect to the containment thermal-hydraulic response. The staff needs to ensure that the BWRX-300 CE methodology incorporates sufficient conservatism to analyze the short-term and long-term containment thermal hydraulics response to the limiting design basis events (DBEs) to offset the inherent methodology uncertainties. In this regard, the applicant is requested to provide the following additional information regarding the precedent-setting BWRX-300 containment nodalization approach used in the GOTHIC code.

Request

1. In the GEH LTR NEDC-33922P, a containment nodalization study is presented for the large steam line break (LBLOCA) event. [1][[..]]. However, LTR Figure 6-12 shows that a [[ ]] for the LBLOCA base case. This demonstrates that [[..]] result in more conservative results. In this backdrop, the applicant is requested to justify that the default [[..]] choice is sufficiently conservative to bound the uncertainties in the LBLOCA containment analysis, or provide an upper bound on the non-conservatism inherent in finer nodalizations for conservative LBLOCA case.

   The plots in Figures 6-26 and 6-27 show the [[..]] for the conservative LBLOCA case, though they are not documented in the LTR as such. As they are among the most important parameters predicted by the CE methodology, the staff requests documenting the limiting PCP and maximum shell temperature values for the conservative case in the LTR as updated by the break location and break flow direction sensitivity studies requested in RAI 06.02.01-03. This information is needed by the staff to establish the overall conservatism in the containment evaluation (CE) methodology for LBLOCA.

2. The small break LOCA (SBLOCA) and LBLOCA are different DBEs that involve different phenomenological concerns. However, the staff noted that no containment nodalization study is presented in the LTR for the SBLOCA. As the break flow is [[..]]. As shown by Figure 6-17, [[..]]. LTR Figures 6-12 and 6-13 show [[..]]. These phenomena are equally applicable to SBLOCA. With the complex SBLOCA phenomenology involving the novel PCCS design and Reactor Cavity pool heat-up in the later stage of transient, [[..]].

   Therefore, the applicant is requested to provide information to confirm that the nodalization is adequate for SBLOCA, consistent with the information provided for LBLOCA. For this purpose, the staff requests GEH to provide similar justification for nodalization used in the limiting SBLOCA analysis up to 72 hours to demonstrate that the predicted limiting containment pressure and temperature responses remain conservative and insensitive to nodalization changes, and to quantify the conservatisms in the [[..]]. The associated PCCS temperature plots (similar to LTR Figure 6-32), PCCS heat removal rate plots, and the containment steam volume fraction plots (similar to Figure 6-17) in the SBLOCA nodalization study should be included and discussed.

06.02.01-02 (eRAI 9862) [Audit Issue 2]

Requirement

General Design Criterion 50 – *Containment design basis*. Requires the reactor containment structure, including access openings, penetrations, and the containment heat removal system be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident (LOCA).

General Design Criterion 38 -- Containment heat removal. A system to remove heat from the

[1] **[[..]] –** GEH Proprietary Information based on LTR submittal and GEH Confirmation dated 08/04/21

reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

General Design Criterion 16 -- Containment design. Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

Issue

GEH LTR NEDC-33922P, Revision 0, BWRX-300 Containment Evaluation (CE) Method, presents TRACG and GOTHIC results for the conservative case of the small steam pipe break design basis event (DBE), as the limiting small break LOCA (SBLOCA) for BWRX-300. According to the LTR, this break in a pipe of [[..]] attached to the RPV dome bounds all small steam pipe breaks that remain unisolated. Figure 5-18 through Figure 5-22 show various in-vessel TRACG results for the post-accident 72 hours, including power, RPV pressure, RPV level, PCT, break flow rate and enthalpy. The LTR also includes the necessary GOTHIC results for the same DBE in Figure 6-31 through 6-40 to demonstrate the resulting containment thermal hydraulic response, steam stratification, radiolytic gas accumulation inside the containment/dome, and PCCS/reactor cavity pool environment characteristics.

However, GEH LTR NEDC-33922P presents only TRACG results for the conservative case of the small liquid pipe break DBE. Figure 5-23 through Figure 5-27 show similar in-vessel TRACG calculation results for the small liquid pipe break DBE, as the aforementioned Figure 5-18 through Figure 5-22 for the small steam pipe break DBE. However, no related GOTHIC results are presented for the small liquid pipe break DBE in the LTR similar to Figure 6-31 through 6-40 for the small steam pipe break DBE. Therefore, the results presented in the LTR for the small liquid pipe break DBE are an incomplete set of the similar results presented in the LTR for the small steam pipe break DBE. In the absence of this information, the staff is unable to make a reasonable assurance finding for the bounding nature of the conservative case for the small steam pipe break.

Request

The applicant is requested to provide the GOTHIC results for the BWRX-300 containment for the conservative case of the small liquid pipe break similar to those provided for the small steam pipe break, and justify how the limiting small steam pipe break with the conservative case assumptions also bounds the most limiting small liquid pipe break.

06.02.01-03 (eRAI 9862) [Audit Issue 5]

Requirement

General Design Criterion 50 – *Containment design basis*. Requires the reactor containment structure, including access openings, penetrations, and the containment heat removal system be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident (LOCA).

General Design Criterion 38 -- *Containment heat removal*. A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

General Design Criterion 16 -- *Containment design*. Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

Issue

Figure 6-11 in GEH LTR NEDC-33922P, Revision 0, BWRX-300 Containment Evaluation Method, presents the vertical and horizontal cross-sectional views of various 3-D GOTHIC grids used in the BWRX-300 containment nodalization studies. The LTR Figure 6-11 [[..]]. The LTR Figure 6-11 [[..]].

As recognized in LTR Section 6.6.1, [[..]]. The staff is concerned that the increased velocity and higher steam concentration near [[..]] that increase the condensation heat transfer, would enhance the heat removal to the [[..]]. While this has the desired effect of maximizing the shell temperature, it would have an adverse impact on the peak containment pressure. Therefore, the staff considers the current break location to be a non-conservative assumption embedded in the BWRX-300 GOTHIC model for the purpose of predicting the peak containment pressure.

The staff also needs to evaluate that, as based on the COPAIN test data presented in the LTR, the convection and condensation heat transfer coefficients [[..]]. So, GOTHIC's qualifications need to be justified for using the flow-direction/convection-mode dependent conservatisms used in the BWRX-300 CE methodology.

Request

1. The applicant is requested to provide the results for a break location sensitivity study for the BWRX-300 containment main steam pipe break (LBLOCA) using the conservative GOTHIC containment model to justify that the chosen break location is bounding for all break locations, or identify the most limiting break locations with respect to peak containment pressure and maximum wall temperature. Please perform the sensitivity study for the default [[..]] for 24 hours, along the radial, axial, and azimuthal directions, or justify why some or all of the sensitivity cases are not needed.

2. The applicant is also requested to perform a 180 degree break flow orientation sensitivity study for the limiting location, i.e., the break flow coming out of the pipe upward, horizontal toward the containment wall, and downward directions, for the most limiting break location, as identified in Part 1, for the default [[..]] conservative cases of the large steam break LBLOCA as well as the small steam break SBLOCA. The requested break orientation sensitivity study results for 24 hours for LBLOCA and 72 hours for SBLOCA, along with the information requested in Part 3, will help the staff make a reasonable assurance finding regarding the conservative biases used in modeling convection and condensation to cover the uncertainties in the COPAIN test data, as documented in the LTR. The staff needs to evaluate the [[..]] biases used for the convection and condensation heat transfer correlations.

3. [[..]], the applicant is requested to provide justification for GOTHIC's qualification to predict the flow direction in the near wall region in a subdivided volume, or provide evidence that in the limiting cases GOTHIC's prediction of flow direction is in the conservative direction in the

near wall region of the subdivided containment. Otherwise, present the limiting LBLOCA and SBLOCA results using [[..]].

Please update the LTR if the responses to the above questions result in a change to the methodology as described in the LTR.

06.02.01-04 **(eRAI 9862)** [Audit Issue 36]

Requirement

General Design Criterion 38 -- *Containment heat removal*. A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

General Design Criterion 16 -- *Containment design*. Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

Issue

Section 2.0 of the GEH LTR NEDC-33922P, Revision 0, BWRX-300 Containment Evaluation (CE) Method, states that [[..]]. The GOTHIC models submitted with this application, the sensitivity studies, results, and descriptions documented in the LTR, the correlations the BWRX-300 CE methodology relies on, as well as the staff review and confirmatory analyses are all based on [[..]]. The study presented in the LTR for the effect of nodalization on a single PCCS unit's performance is also based on [[..]].

However, the LTR also mentions a [[..]] design option, and LTR Section 6.1 states [[..]]) to establish the applicability of the BWRX-300 PCCS phenomenology independent of the PCCS design configuration. The staff is concerned that without a supplementary review of any new PCCS design configuration, the associated model for secondary side heat transfer to the reactor cavity pool, and supporting containment/PCCS results, the staff may not be able make a reasonable assurance finding about the applicability of the BWRX-300 CE methodology to the new PCCS design.

Request

The applicant is requested to provide justification to extend the BWRX-300 CE methodology that was reviewed for the [[..]] without a supplementary NRC review. Otherwise, please remove all LTR references to the [[..]].

06.02.01-05 (eRAI 9862) [Audit Issue 37]

Requirement

General Design Criterion 38 -- *Containment heat removal*. A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

General Design Criterion 16 -- *Containment design*. Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

Issue

Table 6-2 of the GEH LTR NEDC-33922P, Revision 0, BWRX-300 Containment Evaluation (CE) Method, presents the Phenomena Identification and Ranking Table for BWRX-300 containment. The table recognizes [[..]].

[[..
]]

These phenomena are pertinent to the first 24 hours of LBLOCA and first 72 hours of SBLOCA. However, the staff found a lack of information in the LTR about the safety-related assumptions and modeling details about [[..]]. Therefore, the applicant is requested to address the following questions about [[..]] modeling.

Request

1. Section 6.10.2 of the GEH LTR NEDC-33922P, Revision 0, BWRX-300 Containment Evaluation (CE) Method, states "the calculations conservatively assume no heat loss from the reactor cavity pool to the surroundings." In addition, the LTR on Page 59 refers to [[..]]. However, LTR Figure 6-1 shows [[..]] So, the LTR does not recognize [[..]] The applicant is requested to provide a clarification regarding [[..]] and document the reactor cavity pool's exposure to the ambient atmosphere as a part of the CE methodology described in the LTR.

2. Please provide and justify the assumptions made in the BWRX-300 CE methodology about modeling the above-mentioned [[..]] PIRT phenomena as identified in the LTR Table 6-2 and describe how they were addressed in the model. A review of the GOTHIC model submitted with the application shows [[..]] The LTR does not include these CE methodology details and justifications, lacks information on the ambient temperature and initial humidity conditions, and is unclear as to whether [[..]] is a part of the model. The applicant is requested to document the modeling details as part of the BWRX-300 CE methodology description.

3. Even though the LTR does not explicitly state as such, the staff infers that the BWRX-300 CE methodology review scope is limited to the first 72 hours after the initiation of the postulated design basis events (DBEs). [[..]]. Therefore, the staff requests the applicant to clarify the staff's understanding regarding the LTR review scope being limited to the first 72 hours of the postulated DBEs. Otherwise, provide additional information to justify that the BWRX-300 containment design would remain safe with sufficient cooling mechanisms beyond 72 hours.

06.02.01-06 (eRAI 9857) [Audit Issue 38]

Requirement

General Design Criterion 50 – Containment design basis, requires the reactor containment structure, including access openings, penetrations, and the containment heat removal system be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident (LOCA).

Issue

In order to determine the conservative mass and energy discharge to the containment, a computer code and the associated evaluation model needs to have the capability to model relevant physical phenomenon during a LOCA with a conservative treatment of uncertainties. Standard Review Plan (NUREG-0800) Section 6.2.1.3, "Mass and Energy Release Analysis for Postulated Loss-of-Coolant Accidents (LOCAs)," notes that "calculations of the mass and energy release rates for a LOCA should be performed in a manner that conservatively establishes the containment internal design pressure (i.e., maximizes the post-accident containment pressure and the containment sub-compartment response)."

The pipe lay out of BWRX-300 Isolation Condensers (ICs) return line is different from that of GE ESBWR design. [[..]].

Request

Therefore, the staff is requesting additional information regarding the modeling capability of TRACG to simulate the ICS return line clearing, in particular, the conservatism of the existing TRACG SBLOCA model regarding the impact of clearing on the overall ICS heat removal capacity.

06.02.01-07 (eRAI 9862) [Audit Issue 40]

Requirement

General Design Criterion 50 – *Containment design basis*. Requires the reactor containment structure, including access openings, penetrations, and the containment heat removal system be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident (LOCA).

General Design Criterion 38 -- *Containment heat removal*. A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

General Design Criterion 16 -- *Containment design*. Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

Issue

In the course of the staff's review of the GEH LTR NEDC-33922P, Revision 0, BWRX-300 Containment Evaluation (CE), GEH submitted a deliverable package on the docket, dated December 8, 2020. The package included original (NEDC-33922P-R0) and updated (UPDATE) sets of TRACG and GOTHIC models, along with some parameter comparisons between the original and updated models for the large break and small steam break LOCA conservative cases. However, no calculation results were included in the package to demonstrate the impact of changes made to the original TRACG/GOTHIC models to update them. The results presented and discussed in LTR NEDC-33922P, Revision 0, pertain to the original TRACG/GOTHIC models. According to GEH, the future LTR revision will be based on the calculation results from the updated TRACG/GOTHIC models.

During the course of confirmatory analyses, the staff also executed the submitted updated TRACG model and compared the resulting mass and energy release with the original TRACG model results presented in LTR Revision 0, and found significant differences in the break flow of the conservative large steam break LOCA. Without a complete review of the updated TRACG/GOTHIC model results, the staff cannot determine whether the updated models introduce any additional phenomena that were not captured in the original models, and thereby potentially adversely impact the major CE methodology conclusions based on the original models.

Request

1. Present and explain the prediction differences between the original and updated models in terms of the magnitude and sequence of events during the transient due to the changes in the updated models. Provide justification that no new phenomena were caused by the model/code changes in the updated models. This would involve the key CE methodology parameters, e.g., RPV pressure, downcomer level, fuel temperature, mass and energy release, containment pressure, shell temperature, and PCCS exit and reactor cavity pool temperatures. Address the above requests for both the limiting large break and small break LOCA.

2. Justify that the updated TRACG/GOTHIC models remain bounding, and no major CE methodology conclusions regarding the limiting transients, rapid cooling requirements, nodalizations, and modeling uncertainties are adversely impacted compared to the original models.

3. Confirm that the LTR will be updated to reflect calculation results based on verified updated TRACG/GOTHIC models for all the demonstration transients.

06.02.01-08 **(**eRAI 9862**)** [Audit Issue 43]

Requirement

General Design Criterion 38 -- *Containment heat removal*. A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

General Design Criterion 16 -- *Containment design*. Reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

Issue

Table 6-2 of the GEH LTR NEDC-33922P, Revision 0, BWRX-300 Containment Evaluation (CE) Method, presents the Phenomena Identification and Ranking Table for BWRX-300 containment. The table recognizes [[..]].

> [[..
>]]

These phenomena are pertinent to [[..]], during the first 24 hours of LBLOCA and first 72 hours of SBLOCA. As presented in the LTR, the BWRX-300 CE methodology uses a [[..]]. The staff has two primary concerns in this regard.

- Several correlations are being used in a manner that may not accurately capture the PCCS geometry and flow conditions, and

- As the same [[..]], the applicable flow and heat transfer regimes may not be accurately captured by the model. The staff needs to make a reasonable assurance finding regarding the single-phase heat transfer modeling inside the PCCS tubes. No test data were presented for the PCCS channels thermal performance either as a separate effect or an integral experiment, so the modeling is dependent on use of appropriate theoretical models to capture the phenomena within the PCCS tubes. Therefore, the applicant is requested to address the following questions about the PCCS tube-side heat transfer and flow-rate modeling and the related assumptions.

Request

1. Section 6.5 of the GEH LTR NEDC-33922P, Revision 0, BWRX-300 Containment Evaluation (CE) Method, presents a PCCS tube-side heat transfer model, as captured by the following three equations on the LTR Page 65.

$$Nu_{FC} = 0.023Re^{0.8}Pr^{0.3} \qquad (1)$$

[[..]] (2)

[[..]] (3)

Equation 3 [[..]]. Even though, “alternate calculation.docx” file GEH submitted as a part of Package-3 in the DBR-0055078-R0 folder, does provide additional thermosyphon modeling details, the staff was not able to find a reference for using the three equations for modeling natural convection flow and heat transfer [[..]]. The applicant is requested to provide a citation for this modeling approach and its separate-effect validation basis [[..]] used in BWRX-300. The staff has following specific concerns about the potential non-conservatisms in the three-equation [[..]] formulation that need to be addressed.

a. [[..]]. The applicant is requested to justify the applicability of the [[..]]. Also justify why

[[..]].

b. This model does not appear to appropriately and consistently model all expected flow conditions that would occur during the postulated events, including [[..]]. Unlike the [[..]] (Figures 6-18 & 6-20), no such criteria are used to identify the applicable natural, forced, or mixed convection mode inside the PCCS tubes.

   Please justify the three-equation based model's presumption of [[..]] even during conditions that are expected to be laminar, which is expected to be non-conservative. In this backdrop, also justify the use of Dittus-Boelter correlation (Equation 1) for turbulent forced-convection that is expected to be non-conservative in the initial phase until the Reynolds number exceeds a certain threshold.

2. There is almost no information provided in the LTR on how the resulting density-driven single-phase flow recirculation gets imposed [[..]], except the statement that "Wall friction is calculated from the Colebrook relationship for smooth wall." The staff requests a summary of the flow modeling details be included in the LTR describing the related BWRX-300 CE methodology.

3. The applicant is requested to provide the LBLOCA and SBLOCA short-term and long-term plots for PCCS flowrate, total heat transfer, and temperatures [[..]] to demonstrate that the PCCS model predicts the physically consistent trends in overcoming the initial thermal inertia of the single-phase thermosyphon, as well as the long-term PCCS thermal performance characteristics. Also provide representative plots of the applicable non-dimensional numbers (e.g. Reynolds, Rayleigh) to support the choice of heat transfer correlations and convection regimes, or show that the [[..]] will yield the same or more conservative results compared to a generally accepted correlation that is more directly applicable. For this study, use the limiting break location [[..]] that was identified in response to RAI (06.02.01-03). The results would help the staff make a reasonable assurance finding regarding the modeling of PCCS single-phase heat transfer modeling in general and understand the Figure 6-32 trends better.

Please update the LTR with any information needed to clarify modeling details necessary to perform the containment evaluation analyses.

06.02.01-9 (eRAI 9856) [Audit Issue 21]

Requirement

General Design Criterion 50 – Containment design basis, requires the reactor containment structure, including access openings, penetrations, and the containment heat removal system be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident (LOCA).

Issue

In order to determine the conservative mass and energy discharge to the containment, a computer code and the associated evaluation model needs to have the capability to model relevant physical phenomenon during a LOCA with a conservative treatment of uncertainties. Standard Review Plan (NUREG-0800) Section 6.2.1.3, "Mass and Energy Release Analysis for

Postulated Loss-of-Coolant Accidents (LOCAs)," notes that "calculations of the mass and energy release rates for a LOCA should be performed in a manner that conservatively establishes the containment internal design pressure (i.e., maximizes the post-accident containment pressure and the containment sub-compartment response)."

In response to staff RAI #9817, GEH proposed a conceptual design change to limit the non-condensable gas volume concentration [[..]] below a safe threshold value. Possible conceptual changes include [[..]], the combustible gas recombining could generate heat upon the actuation of Isolation Condensers. The current SBLOCA and LBLOCA TRACG model including the Isolation Condenser model [[..]].

Request

Therefore, the staff is requesting additional information regarding the potential heat addition [[..]] and the potential impact on the ICs heat removal capacity when the non-condensable gas concentration in the lower drum is maintained up to the safe threshold value.

SRP-Review Section: 06.02.05 - Combustible Gas Control in Containment

06.02.05-01 (eRAI 9854) **[Audit Issue 14]**

Requirement

The NRC regulations in 10 CFR 50.44(c) set forth combustible gas control requirements for future water-cooled nuclear power reactor designs. In accordance with SRP Section 6.2.5, the NRC staff reviewed the BWRX-300 containment design for consistency with 10 CFR 50.44 (c).

Issue

To meet 10 CFR 50.44 (c), Section 6.10.3 of the LTR (NEDC-33922P, Revision 0) states that the calculated hydrogen and oxygen volume fractions are far below the "deflagration limits." In addition, the BWRX-300 is designed to have an inert containment such that the oxygen concentration must be limited. GEH indicated in electronic reading room (eRR) [[..]] to meet the definition of inerted atmosphere in 10 CFR 50.44(c). [[..]]

Request

Since these quantitative limits are necessary for the combustible gas control in containment and the audit files in the eRR are not on docket nor are referenced in the LTR, the applicant is requested to confirm or specify the quantitative hydrogen and oxygen concentration limits being used to ensure the compliance of 10 CFR 50.44(c) for combustible gas control in containment on docket.