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LTR-NRC-19-24

May 15, 2019

Subject: Submittal of Proprietary Markings for U.S. NRC Regulatory Audit Report For Westinghouse Topical Report WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Revision 0, "POLCA-T: System Analysis Code With Three Dimensional Core Model, Appendices C and D" (EPID L-2018-TOP-0003) (Proprietary/Non-Proprietary)

Enclosed are the proprietary and non-proprietary versions of the Submittal of Proprietary Markings for U.S. NRC Regulatory Audit Report For Westinghouse Topical Report WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Revision 0, "POLCA-T: System Analysis Code With Three Dimensional Core Model, Appendices C and D" (EPID L-2018-TOP-0003) (Proprietary/Non-Proprietary).

This submittal contains proprietary information of Westinghouse Electric Company LLC ("Westinghouse"). In conformance with the requirements of 10 CFR Section 2.390, as amended, of the Nuclear Regulatory Commission's ("Commission's") regulations, we are enclosing with this submittal an Affidavit. The Affidavit sets forth the basis on which the information identified as proprietary may be withheld from public disclosure by the Commission.

Correspondence with respect to the proprietary aspects of the this submittal or the Westinghouse Affidavit should reference AW-19-4892 and should be addressed to Camille T. Zozula, Manager, Infrastructure & Facilities Licensing, Westinghouse Electric Company, 1000 Westinghouse Drive, Building 1, Suite 165, Cranberry Township, PA 16066.

A handwritten signature in black ink, appearing to read "K. Hosack", written over a circular stamp or seal.

Korey L. Hosack, Manager
Product Line Regulatory Support

cc: Ekaterina Lenning (NRC)
Dennis Morey (NRC)

Enclosures:

1. Affidavit AW-19-4892
2. Proprietary Information Notice and Copyright Notice
3. Submittal of Proprietary Markings for U.S. NRC Regulatory Audit Report For Westinghouse Topical Report WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Revision 0, "POLCA-T: System Analysis Code With Three Dimensional Core Model, Appendices C and D" (EPID L-2018-TOP-0003) (Proprietary)
4. Submittal of Proprietary Markings for U.S. NRC Regulatory Audit Report For Westinghouse Topical Report WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Revision 0, "POLCA-T: System Analysis Code With Three Dimensional Core Model, Appendices C and D" (EPID L-2018-TOP-0003) (Non-Proprietary)

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

COUNTY OF BUTLER:

- (1) I, Korey L. Hosack, have been specifically delegated and authorized to apply for withholding and execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse).
- (2) I am requesting the proprietary portions of LTR-NRC-19-24 be withheld from public disclosure under 10 CFR 2.390.
- (3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged, or as confidential commercial or financial information.
- (4) Pursuant to 10 CFR 2.390, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.
 - (i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse and is not customarily disclosed to the public.
 - (ii) Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar technical evaluation justifications and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.
- (5) Westinghouse has policies in place to identify proprietary information. Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

AFFIDAVIT

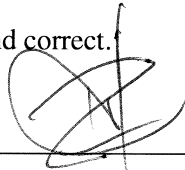
- (a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.
 - (b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage (e.g., by optimization or improved marketability).
 - (c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.
 - (d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.
 - (e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.
 - (f) It contains patentable ideas, for which patent protection may be desirable.
- (6) The attached documents are bracketed and marked to indicate the bases for withholding. The justification for withholding is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (5)(a) through (f) of this Affidavit.

AFFIDAVIT

I declare that the averments of fact set forth in this Affidavit are true and correct to the best of my knowledge, information, and belief.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: 20190515



Korey L. Hosack, Manager
Product Line Regulatory Support

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and non-proprietary versions of a document, furnished to the NRC in connection with requests for generic review and approval.

In order to conform to the requirements of 10 CFR 2.390 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the Affidavit accompanying this transmittal pursuant to 10 CFR 2.390(b)(1).

COPYRIGHT NOTICE

The reports transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.390 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

Enclosure 4

**Submittal of Proprietary Markings for U.S. NRC Regulatory Audit Report For Westinghouse
Topical Report WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Revision 0,
“POLCA-T: System Analysis Code With Three Dimensional Core Model,
Appendices C and D” (EPID L-2018-TOP-0003)**

(Non-Proprietary)

May 2019

**Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, PA 16066**

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OFFICIAL USE ONLY – PROPRIETARY INFORMATION**U. S. NUCLEAR REGULATORY COMMISSION****REGULATORY AUDIT REPORT FOR REVIEW OF WESTINGHOUSE ELECTRIC COMPANY****TOPICAL REPORT****WCAP-16747-P/WCAP-16747-NP, REVISION 0, “POLCA-T: SYSTEM ANALYSIS CODE****WITH THREE DIMENSIONAL CORE MODEL APPENDICES C AND D”****(EPID L-2018-TOP-0003)****A. Background**

Westinghouse Electric Company (Westinghouse) submitted Topical Report (TR) WCAP-16747-P-A, Revision 0, “POLCA-T: System Analysis Code with Three-Dimensional Core Model” containing Appendices A and B (WCAP-16747-P/WCAP-16747-NP, Appendices A and B, Reference 1) to the United States Nuclear Regulatory Commission (NRC) for review and approval. That application was approved for application to control rod drop accidents (CRDA) in Appendix A and stability analysis in Appendix B for Boiling Water Reactors (BWR). On submitted WCAP-16747-P, Revision 0, “POLCA-T: System Analysis Code with Three-Dimensional Core Model, Appendices C and D (WCAP-16747-P/WCAP-16747-NP, Appendices C and D) to the NRC for review and approval for application to Anticipated Transients Without Scram (ATWS) and Anticipated Operational Occurrences (AOO) in BWR models 2 through 6 designs (BWR/2-6).

WCAP-16747-P/WCAP-16747-NP, Appendices A and B provided a detailed description of the POLCA-T transient analysis code that included a description of the Westinghouse’s methodology for the analysis of CRDA in Appendix A and stability analysis in Appendix B. WCAP-16747-P/WCAP-16747-NP, Appendices C and D expands upon WCAP-16747-P/WCAP-16747-NP, Appendices A and B by describing the Westinghouse’s methodology for the analysis of AOOs (limiting, non-limiting, moderate frequency, and infrequent events) and ATWS.

The NRC Office of Nuclear Reactor Regulation and the contractor, Energy Research, Inc. (ERI), performed a technical review of WCAP-16747-P/WCAP-16747-NP, Appendices C and D, in order to determine its acceptability using the guidelines and criteria delineated in the Standard Review Plan (SRP). The review is intended to ensure that the method adequately predicts BWR/2-6 neutronic and thermal-hydraulic performance, and that the assumptions utilized in the models are consistent with the NRC regulations and various regulatory guidance. Subsequent to the initial review, ERI prepared a list of preliminary Requests for Additional Information (RAI) in the form of audit issues (AI) that describe questions and concerns regarding WCAP-16747-P/WCAP-16747-NP, Appendices C and D. The NRC staff initiated an audit of the Westinghouse’s submittal in order to efficiently resolve some of the issues that have resulted from the NRC staff review of the submittal to date.

This audit followed the guidelines in Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, “Regulatory Audits,” and was conducted during June 11-12, 2018, at the Westinghouse office in Rockville, Maryland.

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Participants in the audit were:

NRC Staff

Mathew Panicker

Ekaterina Lenning

Energy Research, Inc. (The NRC Contractor)

Mohsen Khatib-Rahbar

Michael Zavisca

Morgan Libby

Westinghouse

Edward Mercier

Bradley Maurer

Patricia Quaglia

Ulf Bredholt

Camilla Rotander

B. Regulatory Audit Bases

This audit was based on consideration of the following:

1. 10 CFR 50, Appendix A, General Design Criteria 10 “Reactor Design”
2. 10 CFR 50, Appendix A, General Design Criteria 12, “Suppression of Reactor Power Oscillations”
3. 10 CFR 50, Appendix A, General Design Criteria 14, “Reactor Coolant Pressure Boundary”
4. 10 CFR 50, Appendix A, General Design Criteria 16, “Containment Design”
5. 10 CFR 50, Appendix A, General Design Criteria 29, “Protection Against Anticipated Operational Occurrences”
6. 10 CFR 50, Appendix A, General Design Criteria 35, “Emergency Core Cooling”
7. 10 CFR 50, Appendix A, General Design Criteria 38, “Containment Heat Removal”
8. 10 CFR 50, Appendix A, General Design Criteria 50, “Containment Design Basis”
9. 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors”
10. 10 CFR 50.62, “Requirements for reduction of risk from anticipated transients without scram (ATWS) events for light-water-cooled nuclear power plants”
11. Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, compiled 2007 (Rev. 2):

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- a. Section 4.3 - Nuclear Design
- b. Section 4.4 - Thermal and Hydraulic Design
- c. Chapter 15 - Transient and Accident Analyses, including specific attention to:
 - i. Section 15.0.2 - Review of Transient and Accident Analysis Methods
 - ii. Section 15.8 - Anticipated Transients Without Scram
 - iii. Section 15.9 - Boiling Water Reactor Stability

C. Regulatory Audit Scope or Methodology

WCAP-16747-P/WCAP-16747-NP, Appendices C and D, was reviewed against the guidelines outlined in the regulatory bases above and specifically the applicability of the evaluation model was assessed to determine its ability to acceptably evaluate BWR system performance in support of applications dealing with AOO and ATWS issues.

The NRC staff and contractor discussed with the Westinghouse technical and licensing staff the issues raised in the audit issues (AI) with the objective to ascertain an efficient method for understanding the technical issues that are required to satisfy the NRC regulations and applicable guidance.

D. Audit Issues, the Means for Resolution, and their Status

The audit covered several technical topics corresponding to the AIs that had previously been provided to Westinghouse in the NRC Audit Plan.

Westinghouse announced at the outset of the audit their intention to revise/update and resubmit WCAP-16747-P/WCAP-16747-NP, Appendices C and D for further consideration by the NRC staff. This was based upon their review of the AIs, and their stated realization that the original submittal had been intended for application to BWR/2-6 as well as the Advanced Boiling Water Reactors (ABWRs)¹. Hence, Westinghouse presentation slides addressed the AIs for which they required further information in order to implement their modifications to the submittal. The process also allowed ample time for questions and discussions by the NRC staff and Westinghouse. The material presented during the audit was complete, accurate, and compliant with the applicable NRC regulations and guidance. The resolutions proposed were satisfactory and if fully implemented as described will serve to address the concerns that prompted the audit. Following the presentations and discussions, the NRC staff and Westinghouse agreed on the means by which AIs will be dispositioned or where applicable, RAIs may be issued.

The text below summarizes each of the AIs raised and any resolution and status information that is pertinent to the audit. The NRC staff presented an exit summary including action items at the end of the audit.

¹ Westinghouse stated verbally that it intends to submit a revision to WCAP-16747-P/WCAP-16747-NP, Appendices C and D that will be applicable to supporting operation of BWR/2-6 only.

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Audit Issues Raised by the NRC Staff:

1. WCAP-17203-P/WCAP-17203-NP established the Westinghouse’s basis for employing phenomena identification and ranking tables (PIRTs) to assign uncertainty categories. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.2.7 identifies []^{a,c} to anticipated operational occurrences (AOO). These phenomena were determined and are documented in Reference 2 to WCAP-16747-P/WCAP-16747-NP, Appendices C and D. However, during the review of WCAP-17203-P/WCAP-17203-NP []^{a,c} in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, (i.e., D7 []^{a,c}). Based on the above applicable sections of the submittal that would require a revision (WCAP-16747-P/WCAP-16747-NP, Appendices C and D, (e.g., Table C.6-1 need to be identified (e.g., the text of WCAP-16747-P/WCAP-16747-NP, Appendices C and D, example calculations, graphics, and relevant conclusions).

Resolution: Westinghouse proposed in their presentation slides to []^{a,c}. They will also revise the text in []^{a,c} sections of WCAP-16747-NP, Appendices C and D including new example calculations, graphics, and conclusions. In addition, Westinghouse will update various sections of WCAP-16747-P/WCAP-16747-NP, Appendices C and D for the high ranked phenomena.

Status: *Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.*

2. WCAP-17203-P/WCAP-17203-NP established the basis for the Westinghouse uncertainty methodology whereby a 95/95 confidence level is established. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.3.1.3 states (Figures C.3-1 thru C.3-3), "The POLCA-T comparison against these measurements shows that []^{a,c}
 - a. []^{a,c}
 - b. []^{a,c}
 - c. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Figure C.3-4 []^{a,c}

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[]^{a,c}. As far as it is possible to make out from Figure C.3-4, []

] ^{a,c}

Resolution: Westinghouse answered parts (a) and (c) of this audit issue through discussion (not reflected in the presentation slides). Westinghouse presented no questions concerning part (b).

Status: Parts (a) and (c) of this audit issue are considered resolve, and no further action is required. **Westinghouse did not address part (b), which remains open.**

3. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.3.1.4 states that, []

[]^{a,c} Figures C.3-8 and C.3-9 appear to show that []^{a,c} Using the approach described in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.3.1.4 to determine []

Review the cited figures and clarify whether the assertion of []^{a,c}.

] ^{a,c}.

Resolution: Westinghouse presented no questions concerning this issue.

Status: **Westinghouse proposed no actions regarding this issue.**

4. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.3.2 states:

[]

] ^{a,c}

a. []

] ^{a,c}

b. The plots provided in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.5.3 are not legible. Provide the graphics on an expanded scale so that the reviewers can discern the material being presented. []

] ^{a,c}**OFFICIAL USE ONLY — PROPRIETARY INFORMATION**

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[

] ^{a,c} Characterize the initial conditions applicable to each test.

- c. Confirm [] ^{a,c} described in WCAP-17202-P-A/WCAP-17202-NP-A, Revision 0-1, is used in POLCA-T or any of the supplied analyses in WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

Resolution: Westinghouse responded [

] ^{a,c}

Status: Westinghouse proposed in their presentation slides to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

5. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.3.3 states that [

] ^{a,c} For an AOO where the dynamic response is important, compare graphically using plots, the performance of [

] ^{a,c}

Resolution: Westinghouse explained using presentation slides that the [] ^{a,c} for AOO analysis. The presentation included an example of a comparison between the transient behavior using [] ^{a,c}. Westinghouse indicated that a RAI may need to be issued by the NRC staff requesting [

] ^{a,c}.

Status: Some of the information required for the review was provided; however, NRC may issue a RAI after the review of the revised submittal if it is warranted.

6. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.3.4 describes [

] ^{a,c} This text [] ^{a,c} within WCAP-16747-P/WCAP-16747-NP, Appendices C and D,

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Section C.5. There are statements in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section 5 regarding [

WCAP-16747-NP, Appendices C and D, Section C.5.3.10 describes []^{a,c}. WCAP-16747-P/
] ^{a,c}.

- a. For qualification tests where []^{a,c}, WCAP-16747-P/WCAP-16747-NP, Appendices C and D, needs to be updated to indicate whether []^{a,c}.
- b. Describe where []^{a,c}, as mentioned in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.3.4, is validated and provide the supporting information.
- c. []^{a,c}

Resolution: Westinghouse explained using presentation slides that [

] ^{a,c}. At this time, it is stated that for AOO licensing analysis []^{a,c}.

Status: The information required for the review was provided and the issue is resolved pending receipt of the revised submittal containing new validation studies.

7. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.2 identifies the []^{a,c} in Table C.4-1. Explain whether []^{a,c} should be included in that list or if it is considered already in another parameter such as []^{a,c}.

Resolution: Westinghouse defined how []^{a,c}.

Status: The information required for the review was provided and the issue is resolved.

8. The guidance in SRP Section 15.0.2.11.5 states that, “uncertainty analysis must address all important sources of code uncertainty.” WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.4 provides a discussion of [

] ^{a,c}.

Resolution: Westinghouse provided a graphic showing []^{a,c}. The NRC

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reviewers indicated that the information from the presentation needs to be added to the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

Status: The information required for the review was provided, and if the information from the presentation slides are added to the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D, the issue will be considered resolved.

9. The guidance in SRP Section 15.0.2, states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.5 states that [

] ^{a,c} from CENPD-390-P-A, "The Advanced PHOENIX and POLCA Codes for Nuclear Design of BWRs." The NRC staff notes that RMS differences will by definition always be positive. However, one may expect that measured values will be higher than calculated on some occasions and lower on others. An explanation of whether the data used refers to [

] ^{a,c}. The data used should be supplied in a simple tabular format.

Resolution: Westinghouse did not address this AI and did not raise any questions concerning this issue.

Status: Following the receipt of the revised submittal, NRC may issue a RAI to resolve this issue if it is warranted.

10. The guidance in SRP Section 15.0.2.II.5 states that, "uncertainty analysis must address all important sources of code uncertainty." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.7 describes [

] ^{a,c}. It is not clear whether this also includes [

] ^{a,c}. This needs to be explained and clarified.

Resolution: Westinghouse explained using presentation slides that [

] ^{a,c}.

Status: The information required for the review was provided and the issue is resolved.

11. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.B describes [

] ^{a,c}.

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- a. It is unclear from WCAP-16747-P/WCAP-16747-NP, Appendices C and D, []^{a,c}.
- b. Table C.4.3 cites measured and calculated values of []^{a,c}. Clarify what the results are using the indicated values.
- c. Explain the basis for concluding that a []^{a,c}.
- d. []^{a,c}.
- e. []^{a,c}, then explain what the distribution is appropriate.
- f. Also review WCAP-16747-P/WCAP-16747-NP, Appendices C and D, sections C.5.1.7 and C.5.2.4 and revise any statements necessary to address the above.

Resolution: Westinghouse explained using presentation slides that []^{a,c} the POLCA-T and they proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to use the variable []^{a,c}. Westinghouse stated that []^{a,c}. Furthermore, use of a []^{a,c}. Westinghouse stated that []^{a,c}. Westinghouse is reconsidering this position after discussions during the audit as using []^{a,c}.

Status: Westinghouse proposed in their presentation slides to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D, to include this information.

- 12. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.10 describes []^{a,c}. No values are cited for either parameter that []^{a,c} described in WCAP-17203- P/WCAP-17203-NP.

Resolution: Westinghouse explained using presentation slides that []^{a,c} as described in the response to audit issue 11.

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Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

13. The guidance in SRP Section 15.0.2.II.5 states that uncertainty analysis "must include a sample uncertainty evaluation for a typical plant application."

WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.11 describes the use of comparisons between [

] ^{a,c}.

a. A confirmation of our interpretation that this translates into [

] ^{a,c}.

b. An explanation is needed as to why [

] ^{a,c} (CENPD-390-P- A, "The Advanced PHOENIX and POLCA Codes for Nuclear Design of BWRs" Figures 5.30-5.32).

c. Westinghouse needs to provide an estimate of [

] ^{a,c}.

Resolution: Westinghouse confirms [

] ^{a,c}. Westinghouse committed to include [] ^{a,c} in the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D. This may be added as a condition by NRC after the review of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

14. WCAP-17203-P/WCAP-17203-NP established Westinghouse's basis for employing PIRTs to assign uncertainty categories. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.11 states that [

] ^{a,c}
The NRC staff notes that [

] ^{a,c} using different types of tests and comparisons. An explanation is needed of the reasoning [

] ^{a,c}. Furthermore, it should be demonstrated how the specific bounds of [] ^{a,c}.

Resolution: Westinghouse proposed in their presentation slides to update WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include [] ^{a,c}.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

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15. The guidance in SRP Section 15.0.2.II.5 states that "uncertainty analysis must address all important sources of code uncertainty." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.12 discusses []^{a,c}.

a. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.12 states that []^{a,c} from Addendum 2 to WCAP-16081-P-A is []^{a,c}. However, the SE for the D4.1.1 correlation (the subject of WCAP-16081-P-A) requires []

[]^{a,c}. It needs to be explained why the associated []^{a,c}.

b. It is not clear why []^{a,c}. Please provide a justification.

c. The data and comparison for []^{a,c} in the SE for WCAP-16081-P-A, quantify []

[]^{a,c}.

Resolution: Westinghouse did not address this AI and did not raise any questions concerning this issue.

Status: Following the receipt of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D, a RAI may be issued to resolve this issue.

16. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. WCAP-16747-P/WCAP-16747-NP, Appendices C and D Section C.5.1.6 describes []^{a,c}. The parameter []^{a,c} in WCAP-16747-P/WCAP-16747-NP, Appendices C and D equation C.5-1 is []

[]^{a,c}. Provide an explanation of how []^{a,c} is determined.

Resolution: Westinghouse explained using presentation slides the use of []^{a,c} within equation C.5-1. They explained that []

[]^{a,c} to support license amendment request (LAR) submittals.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

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17. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.5.2.2 describes []^{a,c}. The text suggests that [

]^{a,c} shown in Figures C.5-15 and C.5-16. Clarify whether the reported measurement uncertainty is unidirectional or bidirectional and []^{a,c}.

Resolution: Westinghouse explained using presentation slides that [

]^{a,c}.

Status: The information required for the review was provided and the issue is resolved.

18. The guidance in SRP Section 15.0.2.II.4 states that "testing must be performed to demonstrate that the interactions between different physical phenomena and reactor coolant system components and subsystems are identified and predicted correctly." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.5.2.3 describes []^{a,c}. Figures C.5-17 and C.5-18 both indicate that POLCA-T [

]^{a,c} documented in Section C.5.2.3 and justify []^{a,c}.

Resolution: Westinghouse explained using presentation slides that [

]^{a,c}.

Westinghouse further explained that [

]^{a,c}.

Westinghouse explained using presentation slides that [

]^{a,c}. However, the NRC staff is concerned about the differences between the measurements and the POLCA-T predictions, [

]^{a,c}. Therefore, this issue may merit a RAI after the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D is received.

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Status: The information required for the review was partially provided; however, a RAI may be issued after the receipt of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

19. The guidance in SRP Section 15.0.2.II.4 states that "testing must be performed to demonstrate that the interactions between different physical phenomena and reactor coolant system components and subsystems are identified and predicted correctly." Beginning in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.5.3.7

[

] ^{a,c}. Provide details of the model [] ^{a,c}.

Resolution: Westinghouse proposed in their presentation slides to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D by [

] ^{a,c}.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D, to include this information.

20. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Sections C.5.3.1 through C.5.3.10 [

] ^{a,c}. However, the documentation of the features of the POLCA-T model is not of sufficient detail to support the present review. Describe in greater detail the features of the model including [

] ^{a,c}

Resolution: Westinghouse proposed in their presentation slides to supplement [

] ^{a,c} in a

revision of WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

21. The SRP Chapter 15 guidance identifies analysis parameters that are always to be treated conservatively (i.e., reactor power, scram characteristics, core burnup, etc.). WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Table C.6-1 identifies the "high" ranked phenomena and how they will be treated in the uncertainty analysis. Confirm that for licensing analysis the SRP guidance regarding such parameters for each event type will be used for uncertainty analysis or identify any deviations.

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Resolution: Westinghouse confirms that the parameters cited are always treated conservatively for licensing analysis. In addition, the future LAR to be submitted by a licensee to utilize this methodology may require conservatism in some other plant parameters. Westinghouse states that High ranked PIRT parameters where uncertainties are not included will be set to conservative values.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

22. SRP Section 15.2 provides guidance concerning loss of load analysis for licensing purposes. The guidance states that "for a BWR a 0.8 design conservatism multiplier on the predicted reactivity insertion rate" should be used unless otherwise justified. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.7.1.2 identifies conservative models and parameters used in the demonstration analysis; however, it does not address this topic specifically. Explain how the reactivity insertion rate is used in the demonstration case and how it will be used in any future licensing analysis.

Resolution: Westinghouse explained using presentation slides that all existing plants operate under the requirement to measure rod insertion time as part of the cycle startup test or regular plant verification programs. As part of a LAR this plant data is used to [

] ^{a,c}. NRC may issue a RAI requesting additional clarification following receipt of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

Status: The information required for the review partially provided; however, NRC may issue a RAI following the review of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D when it is received in November 2018.

23. Table 1 below illustrates how the Title 10 Code of Federal Regulations (CFR) 50.62 (i.e., the ATWS Rule) acceptance review is being applied to POLCA-T. The ATWS Rule specifically applies three criteria for BWR technologies as illustrated in the first column. SRP Section 15.8 includes consideration of the broader requirements of other regulations and how they affect the review of ATWS analysis in the second column. The submitted Toshiba-Westinghouse design control document (DCD) addresses the criteria by separating them into two sections, one for plant equipment and another for the performance of that equipment under ATWS conditions as shown in the third and fourth columns. The POLCA-T criteria identified in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.2.5 are illustrated in the fifth column where only (4) of the eight (8) criteria cited in the SRP are acknowledged.

- a. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.2.4 describes what it refers to as "scenarios" to mitigate ATWS but does not acknowledge that

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these are SRP acceptance criteria. Confirm that the POLCA-T ATWS acceptance criteria includes all rods in (ARI), auto standby liquid control system (SLCS) injection, and auto-trip of all re-circulating pumps (RCPs), and describe the models used by the POLCA-T evaluation model to represent ATWS protective functions.

- b. Identify the suppression method for the control and mitigation of ATWS power oscillations and confirm that it (they) are included in the POLCA-T evaluation model. For the mitigation of oscillations, confirm compliance with the SRP 15.9 Acceptance Criteria 1.4.B.
- c. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.2.5 states that the "reactor pressure vessel integrity is assured by limiting the maximum primary stress within the reactor coolant pressure boundary to the emergency limits as defined in the American Society of Mechanical Engineers (ASME) Code, Section III" which is a general statement lacking the specificity of the SRP guidance. Please confirm compliance with the SRP guidance ("reactor coolant system pressures should not exceed ASME Service Level C limits (approximately 10.3 MPa (1500 psi))").
- d. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.2.4 states that one of the ATWS "scenarios" includes reactor shutdown by manual or automatic activation of the SLCS. SRP 15.8 Specific Acceptance Criteria 1.D requires that the SLCS activation is automatic. Confirm that only automatic actuation of the SLCS will be utilized for licensing calculations applicable to ATWS.

Resolution: Westinghouse informed the NRC reviewers that their methodology focuses on using the information in any future LAR to determine the methods used. Westinghouse stated that POLCA-T has all of the required capabilities for suppressing oscillations and boron injection can be represented by manual or automatic methods.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

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TABLE 1 ATWS Criteria (Abbreviated Descriptions)

	SRP 15.8.II (Regulations Cited)	DCD (Plant Capability)	DCD (Performance Requirements)	POLCA-T
Alternate rod injection (ARI) system	1. 10 CFR 50.62 design features: ARI auto SLCS auto trip of all RCPs	redundant hydraulic scram and scram follow function auto SLCS auto RCP trip		
Auto standby liquid control system (SLCS)				
Auto re-circulating pump (RCP) trip				
	2. 10 CFR 50.46 - clad temp (2200°F) and oxidation (.17 initial)		Peak cladding temperature not exceeding 1204°C, and oxidation not exceeding 17%	Peak cladding temperature not exceeding 1204°C, and oxidation not exceeding 17%
	3. GDC 12 - oscillations			
	4. GDC 14 - reactor coolant system (RCS) pressures < ASME Service Level C limits (~1500 psi)		Maximum primary stress within the reactor coolant pressure boundary (RCPB) does not exceed the emergency limits as defined in the ASME Code, Section III.	Maximum primary stress within the reactor coolant pressure boundary (RCPS) does not exceed the emergency limits as defined in the ASME Code, Section III.
	5. GDC 16 - containment design limits		Maximum containment pressure shall not exceed the design pressure	Maximum containment pressure shall not exceed the design pressure
	6. GDC 35 - fuel-clad coolability and clad-water reactions		Reactor shall be brought to a safe shutdown condition, and be cooled down and maintained in a cold shutdown condition	Reactor shall be brought to a safe shutdown condition, and be cooled down and maintained in a cold shutdown condition
	7. GDC 38 - containment pressure and temp.		Maximum containment pressure shall not exceed the design pressure	Maximum containment pressure shall not exceed the design pressure
	8. GDC 50 - leak rate		Maximum containment pressure shall not exceed the design pressure	Maximum containment pressure shall not exceed the design pressure

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24. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.3 states that the supplied text provides descriptions of ATWS models not previously described in Reference 1.

- a. Please provide a description of the control rod participation in the EM for BWR/2- 6 ATWS events. Include in this response information regarding how [

]^{a,c} Also describe testing results that demonstrate the proper calibration of this model and the appropriate uncertainties for it.

- b. Provide a description of the SLCS model for BWR/2-6, a nodalization scheme similar to the one displayed in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Figure C.5-21, and indicate where the SLCS injection location is modeled.
- c. Describe the function of the RCP/RIP trip model and confirm that the 10 CFR 50.62 requirement for tripping all RCPs/RIPs is included, or justify any other implementation (i.e., runback of selected RIPs).

Resolution: Westinghouse explained using presentation slides that:

- a. for BWR/2-6 the ATWS analysis does not include the control rod insertion model because it is assumed (by definition) that control rods fail to insert,
- b. the SLCS schematic is provided in the response showing the injection port in the lower plenum,
- c. demonstration of applicability to a specific plant is accomplished as part of the LAR documentation.

Status: The information required for the review was provided and the issue is resolved.

25. The guidance in SRP Section 15.0.2.II.4 states that "models need to be assessed over the entire range of conditions encountered in the transient or accident scenario." In the base description of WCAP-16747-P/WCAP-16747-NP, Appendices A and B, that []^{a,c}, which in

Section 2 states:

[

]^{a,c}

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[]^{a,c}

Later in the same report it is stated:

[]^{a,c} (Section 3.2)

[]^{a,c} (Section 3.3)

The basic equations determine []

The basic equations are the mass, energy, and momentum conservation equations. They are derived []^{a,c} (Section 7)

This equation is applied to []

[]^{a,c}. (Section 7.2)

[]^{a,c} (Section 10)

[]^{a,c} (Section 13)

a. Provide a description of how these []

[]^{a,c}

b. Identify all []

[]^{a,c}

Resolution: In a draft handout that is not part of the presentation slides, Westinghouse showed some examples of []^{a,c} represented in POLCA-T.

Status: The information required for the review was provided; however, the information discussed during the audit need to be reflected in the revised submittal.

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26. General Design Criteria (GDC) 12, of Appendix A to 10 CFR Part 50, requires that oscillations are either not possible or can be reliably and readily detected and suppressed. WCAP-16747- P/WCAP-16747-NP, Appendices C and D, Section D.2.6 identifies figures of merit (FoM) for ATWS analysis but they do not directly address the issue of oscillations. Identify how the POLCA-T methodology provides a FoM for this purpose. The NRC staff is using the FoM definition from SRP Section 15.0.2 which is:

Quantitative standards of acceptance that are used to define acceptable answers for a safety analysis (e.g., departure from nucleate boiling ratio limits and fuel temperature limits).

Resolution: Westinghouse stated that their response to AI 39 should address this item also, and they did not raise any further questions concerning this issue.

Status: Following the receipt of the revised submittal, a RAI may be issued to resolve this issue.

27. The guidance in SRP Section 15.0.2.II.2 states that "models must be present for all phenomena and components that have been determined to be important or necessary to simulate the accident under consideration." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.3.1 refers to Section 7.1.1 of WCAP-16747-P/WCAP-16747-NP, Appendices A and B, as providing [

] ^{a,c}. That document describes the method employed to calculate

[

a. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, does not mention any consideration of [

] ^{a,c}.

Explain whether the POLCA-T ATWS EM considers these phenomena, and how their impacts are captured in the analysis.

b. Clarify what, if any, modifications are made to [

] ^{a,c}.

Resolution: Westinghouse responded by directing the NRC reviewers to consider WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.3.1 for this explanation. Westinghouse also stated that the information will be added in Appendix D for [

] ^{a,c}.

Status: The information required for the review was provided; however, the issue will be revisited after the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D is received in November 2018.

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28. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. Clarify whether the bypass being considered in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Sections D.3.3.1 and D.3.3.2 refers only to [

is the latter, explain the method for determining []^{a,c}. If it

] ^{a,c}.

Resolution: Westinghouse explained using presentation slides that []^{a,c} and the information in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.3.2 is fully applicable to both. Westinghouse further explained that [

] ^{a,c} is provided by user input. []^{a,c}. NRC

may issue a RAI following the receipt of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D in November 2018.

Status: Most of the information required for the review was provided; however, NRC staff may issue a RAI following the receipt of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D in November 2018.

29. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.3.3 states that POLCA-T has the ability to model [

] ^{a,c}. In response to RAI 6-33S1 on Appendix A of WCAP-16747-P-A Westinghouse provided information on the methodology for [] ^{a,c}. Comment on and clarify application of that methodology to simulating ATWS events using POLCA-T. Please consider the likelihood of [

] ^{a,c} (e.g., for the simulations shown in Section D.5.3).

Resolution: Westinghouse explained using presentation slides that the objective in an ATWS model is to [

] ^{a,c}
Westinghouse stated that [] ^{a,c} is addressed in the response to audit issue 25. Westinghouse also provided a typical nodalization graphic that is applicable to BWR/3-6.

Status: The information required for the review was provided and the issue is resolved.

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30. The guidance in SRP Section 15.0.2.II.5 states that "uncertainty analysis must address all important sources of code uncertainty." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.4.5 describes []^{a,c}. The basis for []^{a,c} is not cited in the text. It appears that []^{a,c} is discussed in WCAP-16747-P/WCAP-16747-NP, Appendices A and B, and CENPD-284-P-A. In WCAP-16747-P/WCAP-16747-NP, Appendices A and B, the commitment is to use bounding values for []^{a,c} in WCAP-16747-P/WCAP-16747-NP, Appendices C and D is inconsistent. []^{a,c}. Please provide a technical assessment of this uncertainty.

Resolution: Westinghouse requested an explanation for the audit issue so that they could better understand how to respond. The NRC staff discussed the issue with Westinghouse. Westinghouse agreed to use []^{a,c} in a revision to WCAP-16747-P/WCAP-16747-NP, Appendices C and D which is consistent with open literature.

Status: **Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.**

31. The guidance in SRP Section 15.0.2.II.2 states that "models must be present for all phenomena and components that have been determined to be important or necessary to simulate the accident under consideration." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.4.6 describes []^{a,c} and D.4.7 discusses []^{a,c}. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, states that POLCA-T can track []^{a,c}

- a. Explain what criteria are used in the ATWS methodology to determine that the core has reached the required shutdown reactivity and what value of that reactivity (in pcm) is used to characterize the consequences as having been acceptably met.
- b. Characterize the impact of various phenomena (i.e., the potential for vaporization of the borated water, plate-out of boron on upper internals, transport of boron out of the reactor vessel via steam lines/acceleration due to the significant(ADS), transport into the lower plenum, counter current flow limitation (CCFL) at the upper tie plate, etc.) on boron concentration (including associate transport delays) in the core region.

Resolution: Westinghouse explained using presentation slides that:

- a. The criteria used in their ATWS methodology is that []^{a,c}

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b. Not addressed.

Status: The information required for the review was provided for item 'a' and the issue is resolved. Item b remains open.

32. The guidance in SRP Section 15.0.2.II.2 states that "models must be present for all phenomena and components that have been determined to be important or necessary to simulate the accident under consideration." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.4.7 discusses boron settling. It states that the boron settling model is not used for designs that have upper plenum SLCS injection.

a. During the simulation of upper plenum SLCS injection, some of the borated water may sink to the bottom of the reactor core via the bypass region. Under conditions of low water level, it may be possible for the water to flow from the bypass into the lower plenum and subsequently into the fuel region (due to the by head afforded by water in the bypass region). Explain whether POLCA-T is capable of modeling such a condition.

b. Explain why not modeling of boron settling for upper plenum SLCS injection will []^{a,c} as stated in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.4.7 since, according to the discussion in Section D.3, [

] ^{a,c}

c. Clarify whether the boron mixing model differentiates between the mixing of the boron upon injection and the re-mixing of the borated water.

Resolution: Westinghouse demonstrated via presentation of an example ATWS calculation how POLCA-T is capable of modeling [

] ^{a,c}. Westinghouse further explained that this is an ABWR issue and it is not applicable to BWR/2-6.

Status: The information required for the review was provided and the issue is resolved.

33. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.4.8.1 states that [] ^{a,c}, as documented in WCAP-17202-P, against [

] ^{a,c}. According to the NRC review of WCAP-17202-P-A/WCAP-17202-NP-A, Revision 0-1, and [] ^{a,c}. Reconcile these statements.

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Resolution: Westinghouse proposed in their presentation slides to replace Figure D.4-2 and reword the text to []^{a,c}.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

34. The guidance in SRP Section 15.0.2.II.5 states that "uncertainty analysis must address all important sources of code uncertainty." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.4.8 states that [

] ^{a,c} in WCAP-17202-P- A/WCAP-17202-NP-A, Revision 0-1, introduced the concept of best-estimate and conservative approaches to using these models for prediction purposes. The response to the RAI 15.00.02-42 for WCAP-17202-P-A/WCAP-17202-NP-A, Revision 0-1, clearly states the difference between these approaches. In response to that RAI Westinghouse cites the methodology in WCAP-17203-P/WCAP-17203-NP to determine which approach is used in the analysis and provides the range of uncertainty variation for the best-estimate approach. These models in WCAP-17202-P-A/WCAP-17202-NP-A, Revision 0-1, and WCAP-16747-P/WCAP-16747-NP, Appendices C and D, are purported to be identical and use the same experimental data for validation.

- a. Explain what approach (best-estimate or conservative) is used for the results presented in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.4.8.
- b. Justify []^{a,c} considering the response to RAI 15.00.02-42 for WCAP-17202-P-A/WCAP-17202-NP-A, Revision 0-1.

Resolution: Westinghouse did not address this AI and did not raise any questions concerning this issue.

Status: Following the receipt of the revised submittal, a RAI may be issued to resolve this issue.

35. The guidance in SRP Section 15.0.2.11.5 states that "uncertainty analysis must address all important sources of code uncertainty." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.4.10 discusses [

] ^{a,c}, D.4.11 discusses [] ^{a,c}, D.4.13 discusses [] ^{a,c}, D.4.14 discusses [] ^{a,c}, D.4.15 discusses [] ^{a,c}, D.4.16 discusses [] ^{a,c}, and D.4.17 discusses [] ^{a,c}.

It is stated several times that plant-specific input parameters need not be adjusted to account for modeling uncertainties. [

] ^{a,c} Since SRP guidance

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is to "address all important sources of code uncertainty," the NRC staff concludes, and the Westinghouse's PIRT in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Reference 2 supports the position, that these are parameters that are ranked "high" and thus uncertainties in their values should be explicitly included. Similar text is in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section 6.2.

- a. Explain []^{a,c}
- b. Explain []^{a,c}
- c. Describe the process for selecting a conservative value if one cannot determine the nominal value.
- d. Explain []^{a,c}

Resolution: Westinghouse did not address this AI and did not raise any questions concerning this issue.

Status: Following the receipt of the revised submittal, a RAI may be issued to resolve this issue.

36. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. The WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.4.12 states that for ABWR the risk of boron settling is small (presumably the same assumption is also applicable to BWRs) which is inconsistent with the "high" rank assigned for ATWS (B11) in WCAP-17203-P/WCAP-17203-NP. Explain the inconsistency noted.

Resolution: Westinghouse explained using presentation slides that the cited case is ABWR related and for BWR/2-6 there is little opportunity for boron settling and consequently the rank assigned is "Not Applicable."

Status: The information required for the review was provided and the issue is resolved provided the text in the revised submittal reflects this understanding.

37. The guidance in SRP Section 15.0.2.II.4 states that "testing must be performed to demonstrate that the interactions between different physical phenomena and reactor coolant system components and subsystems are identified and predicted correctly." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.5.1.6 states that the results presented in Section D.5.1 of WCAP-16747-P/WCAP-16747-NP, Appendices C and D, demonstrate that POLCA-T can predict [

] ^{a,c} Clarify what results are being used to justify reaching the stated conclusion.

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Resolution: Westinghouse proposed in their presentation slides to reword the identified conclusion to state the actual capabilities of POLCA-T more accurately to support ATWS analysis.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

38. The guidance in SRP Section 15.0.2.II.4 states that "testing must be performed to demonstrate that the interactions between different physical phenomena and reactor coolant system components and subsystems are identified and predicted correctly." WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.5.2 provides comparison of POLCA-T [

] ^{a,c}

a. Explain [

] ^{a,c}

b. Explain [

]^{a,c} describe the details of the tests and provide sufficient details, so that the NRC staff can independently validate the selection process.

c. In the conclusion Westinghouse notes [

]^{a,c}. Even though Westinghouse mentions the experimental uncertainties, there is no discussion of how, or whether, these uncertainties are translated [

]^{a,c}. In addition, there are appreciable differences in WCAP-16747- P/WCAP-16747-NP, Appendices C and D, Figure D.5-7 [

]^{a,c}. Justifications should be provided to rectify the consequences of these observations.

d. The test data used for the qualification test in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.5.2 is [

]^{a,c} (see for example WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Figure D.7-2). Provide qualification data for POLCA-T for two-phase natural circulation at high pressures or justify the use of the qualification data shown in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.5.2 at higher pressures.

Resolution: Westinghouse explained using presentation slides that [

]^{a,c}. Westinghouse stated that this validation is required to fully defend the use of POLCA-T under conditions [

]^{a,c}. Westinghouse indicated that they will search for any additional

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test data that would be more relevant to BWR natural circulation conditions, and if such data can be identified, assessment cases will be documented in the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D. Also, it was stated that the regarding item c above, the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D needs to have a discussion of the differences as provided in the slides. Furthermore, the information provided in response to item d above needs to be added to the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

Status: The revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D will include any additional data that is identified and found to be applicable. In addition, the information provided during the audit in response to items c and d will be included in the revised submittal.

39. GDC 12, found in Appendix A to 10 CFR Part 50, requires that oscillations are either not possible or can be reliably and readily detected and suppressed. WCAP-16747- P/WCAP-16747-NP, Appendices C and D, Section D.5.4 states that []^{a,c} presented in WCAP-16747-P/WCAP-16747- NP, Appendices A and B. The NRC staff reviewed WCAP-16747-P/WCAP-16747- NP, Appendices A and B, and the associated NRC SE. In WCAP-16747-P/WCAP-16747-NP, Appendices C and D, there is brief information regarding the calculation of the decay ratio (DR), the FoM for instability. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, states that:

DR is defined as the ratio between consecutive oscillation amplitudes.

Oscillation frequency is an important parameter for stability monitoring and detection but of limited importance with regard to fuel integrity.

The reactor is considered stable if the calculated DR for all three common stability modes (global, regional, and channel) [

] ^{a,c}.

However, the calculation procedure for DR and oscillation frequency in the POLCA-T evaluation model is not provided.

- a. Provide detailed information regarding the calculation of the DR and oscillation frequency in the POLCA- T evaluation model.
- b. The reviewers are aware of the Westinghouse's acceptance of the revised DR acceptance criteria [] ^{a,c}. Explain how this

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requirement is implemented in the POLCA-T evaluation model and confirm that it is appropriate for ATWS analysis.

Resolution: Westinghouse provided graphics and equations that explain the basis of the DR and explained that the calculation of the DR is the result of post-processing POLCA-T results. This information will be discussed in the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

Status: The information required for the review was provided and the issue is resolved pending revision to WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

40. The guidance in SRP Section 15.0.1.6.8 states that the review shall verify acceptability of the stated sequence of events used. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.7.2 provides a cursory description of the sequence of events (SOE) for an ATWS case. The description states that [

] ^{a,c}

- a. State (1) the shutdown reactivity required to achieve the objective of the calculation, (2) the boron concentration that corresponds to that reactivity, and (3) the time after initiation of the ATWS at which 95% of that concentration is reached throughout the active core region.
- b. Explain what instability suppression methods are modeled in POLCA-T and used in this demonstration calculation, and whether they are modeled using SAFIR.
- c. Please explain how instabilities are detected by POLCA-T, or the user of POLCA-T, so as to establish that the suppression method is acceptably employed.
- d. The ECCS activation can result in the dilution of the borated water injected into the RCS by SLCS. Please discuss how the ATWS methodology will establish the required negative core reactivity for safe shutdown, and how that minimum reactivity will be maintained even in the event of ECCS activation.
- e. The applicable regulation (10 CFR 50.62(c)(5)) requires each boiling water reactor to have equipment to trip recirculation pumps under conditions indicative of ATWS. Provide a justification for [

] ^{a,c}.

Resolution: Westinghouse explained using presentation slides that the premise of parts (a) and (e) of the audit issue pertain to ABWR and are not pertinent to BWR/2-6 (NRC reviewers continue to consider the underlying concern in part {a} also applicable to BWR/2-6). Parts (b), (c), and (d) remain relevant to BWR/2-6 application; however, Westinghouse did not address these parts of the audit issue, nor raise any questions about them. Westinghouse indicated

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that the information in WCAP-16747-P/WCAP-16747-NP, Appendices C and D will be replaced by a section on the results for a BWR ATWS calculation.

Status: Part (e) - the NRC reviewers find this position acceptable and no further action will be required if revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D, properly addresses this issue.

Parts (a), (b), (c), and (d) may be included as a RAI following receipt and review of the revised TR.

41. The guidance in SRP Section 15.0.I.6.B states that the review shall verify acceptability of the stated sequence of events used. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.7.2 provides a cursory description of the SOEs for an ATWS case. However, that case only assesses the main steam isolation valves (MSIV) closure with failure of rod insertion. Please provide ATWS analysis for the inadvertent MSIV closure at limiting conditions for scenarios in which (1) ARI does not function and SLCS activates; and (2) ARI does not function and SLCS activates while ECCS (but not ADS) is credited. Where both SAFIR and internal models are available, use the combination that you are requesting NRC approval for licensing applications and indicate what combination is used. Provide graphic results for each scenario that replicate Figures D.7-1 through D.7-6.

Resolution: Westinghouse proposed in their presentation slides to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D, to add the analysis of a BWR/6 case where ARI does not function and SLCS activates and where ARI does not function while ECCS (but not ADS) are credited. Westinghouse also committed to provide the revised graphics. However, since NRC may undertake confirmatory calculations, NRC may issue a RAI requesting that analyses be performed for a U.S. BWR (e.g., Quad Cities), with all the specific assumptions, fuel design, and operating conditions to be documented to support confirmatory analyses.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information. Consequently, NRC may issue a RAI requesting details of the design and operating conditions as well as all the analysis assumptions.

42. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.3.1.2 describes []^{a,c} reported in WCAP-16081-P-A. Section 8 states certain ranges of applicability of [

] ^{a,c}:

- a. Either (i) demonstrate that the spectrum of AOOs to be analyzed using POLCA-T all fall within these ranges, or (ii) provide alternate description of how any deviations would be analyzed, for BWR/2-6.

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b. Verify that [

] ^{a,c}.

c. Verify that the scenario of the demonstration analysis documented in WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.7 encompasses these ranges.

Resolution: Westinghouse did not address this AI and did not raise any questions concerning this issue.

Status: Following the receipt of the revised submittal, a RAI may be issued to resolve this issue.

43. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.5.3.5, validation [

] ^{a,c}. Explain this observation.

Resolution: Westinghouse proposed in their presentation slides to supplement [] ^{a,c} with the additional relevant examples in a revision to WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

44. In WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.7.1.2 it is stated that the demonstration analysis used a [

] ^{a,c}. Explain why [] ^{a,c} for AOOs and ATWS for licensing analysis.

Resolution: Westinghouse presented no questions concerning this issue.

Status: This issue may be included as a RAI following receipt of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

45. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.3.3.1 states that [

in this section, it is remarked that, following the NRC staff review of

] ^{a,c}. Later**OFFICIAL USE ONLY – PROPRIETARY INFORMATION**

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WCAP-16747-P/WCAP-16747- NP, Appendices A and B, both NRC staff and Westinghouse found that the simpler approach was acceptable. Clarify whether approval is being sought for the general model as documented in Section D.3.3.1 or only the simple version of the model, and, if the former, provide additional documentation validating the more complex version of the model.

Resolution: Westinghouse explained using presentation slides that they seek approval for using the simple model of []^{a,c}. Westinghouse stated that they may (1) remove the description of all other models from WCAP-16747-P/WCAP-16747-NP, Appendices C and D or (2) NRC may decide to limit approval to only the simple model.

Status: The NRC reviewers commented that it is desirable for Westinghouse to remove models for which approval is not sought from WCAP-16747-P/WCAP-16747-NP, Appendices C and D, in order to clarify the scope.

46. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. In the SE for WCAP-16747-P/WCAP-16747-NP, Appendices A and B, the NRC staff cited certain issues related to POLCA-T that were beyond their review of CRDA and stability analysis, but which are of some potential importance to AOOs and ATWS.

a. In the NRC staff SE for WCAP-16747-P/WCAP-16747-NP, Appendices A and B, a condition was placed stating that [

] ^{a,c}.

b. In the NRC staff SE for the WCAP-16747-P/WCAP-16747-NP, Appendices A and B, TR it was noted that the TR does not describe [

] ^{a,c}.

c. As documented in WCAP-16747-P/WCAP-16747-NP, Appendices A and B Section 14.4, [

] ^{a,c}.

Resolution: Westinghouse presented no questions concerning this issue.

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Status: This issue may be included as a RAI following receipt of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

47. As stated in Section 3.1.2.2 of the SE for WCAP-16747-P/WCAP-16747-NP, Appendices A and B), the NRC staff did not evaluate the non-condensable gas model in POLCA-T since it is not required for analysis of BWR control rod drop accidents or BWR time domain stability. The PIRT for AOO and ATWS referenced from WCAP-17203-P/WCAP-17203-NP [

]^{a,c}. Since the DCD performance requirements allow the possibility of localized oxidation as high as 17%, non-negligible amounts of hydrogen might be present in ATWS scenarios. Although POLCA-T includes a non-condensable gas hydraulic model [

]^{a,c}, from the description of the Metal-Water Reaction Model in Section 14.4 of WCAP-16747-P/WCAP-16747-NP, Appendices A and B, [

]^{a,c}

- a. Clarify []^{a,c} the POLCA-T evaluation model for ATWS.
- b. Document potential sources of non-condensable gas ingress to the reactor anticipated during possible ATWS scenarios (e.g., from connected tanks and vessels), and state whether the non-condensable gas model in POLCA-T would be used for such conditions.
- c. Justify all of the gas-phase heat transfer correlations in POLCA-T in the presence of potential quantities of non-condensable gases in ATWS analyses or demonstrate that the steam-only correlations documented in WCAP-16747-P/WCAP-16747-NP, Appendices A and B, would conservatively bound them.
- d. Document the effect on the results of uncertainty in non-condensable gas concentration and the effects of this on gas-phase flow and heat transfer, including potential stratification or pocketing of these gases (i.e., not necessarily 100 percent efficient mixing with steam).

Resolution: Westinghouse presented no questions concerning this issue.

Status: This issue may be included as a RAI following receipt of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

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48. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. In WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.9, Westinghouse discusses []^{a,c} the demonstration of acceptability in WCAP-16747-P/WCAP-16747-NP, Appendices A and B, Appendix A by achieving []^{a,c} with a uniform distribution. In WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section A.5.1.2 []^{a,c}, and the following equation is given:

[

]^{a,c}

Explain:

- The derivation of the stated equation and the basis for the dependencies cited.
- The units of []^{a,c} and how this factor is utilized in the analysis.
- How []^{a,c} is determined for a core having depleted fuel that perhaps uses diverse designs, enrichments, and Gadolinia loadings.
- How this methodology is qualified, and demonstrate the source of []^{a,c} stated in WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

Resolution: In response to items a through c, Westinghouse explained using presentation slides that [

]^{a,c} based on the
available information in the literature.

Status: The information required for the review was provided and the issue is resolved.

49. The guidance in SRP Section 15.0.2 states that the evaluation model documentation shall be scrutable, complete, unambiguous, accurate, and reasonably self-contained. In WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.7.1.2, Westinghouse states that "high" ranked phenomena are treated conservatively. However, in the review of the WCAP-17203-P/WCAP-17203-NP, Westinghouse agreed to change the ranking of phenomena A 11 (i.e., the initial stored energy of the fuel) from "medium" to "high" for ATWS. This parameter is not mentioned in the cited WCAP-16747-P/WCAP-16747-NP, Appendices C and D section. Provide the conservative value applicable to the demonstration case and provide the results using this change.

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Resolution: Westinghouse proposed in their presentation slides to update WCAP-16747-NP, Appendices C and D, to change the demonstration case to include the new ranking for initial stored energy. Westinghouse indicate that will also incorporate other similar observations made by the NRC staff in the review of the Fast Transient TR.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D, to include this information.

50. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section D.5.3 provides a description of analysis performed using POLCA-T for the ATWS event with SLCS initiation for []^{a,c}. Based on Figure D.5-12 it appears that the analysis determines that re-criticality [

] ^{a,c}. Even though the graphic also displays the boron concentration, it is unclear what control volume/location this concentration corresponds to. It is also [

] ^{a,c}. Explain the sequence of events for this transient and elaborate on the underlying reason for prediction of re-criticality.

Resolution: Westinghouse provided a detailed SOE describing the ATWS analysis for Olkiluoto 2. Westinghouse stated that Figure D.5-12 shows [

] ^{a,c} thus altering the boron concentration rapidly.

Status: Westinghouse proposed to revise WCAP-16747-P/WCAP-16747-NP, Appendices C and D to include this information.

51. WCAP-16747-P/WCAP-16747-NP, Appendices C and D, Section C.4.3 indicates that Licensing application analyses are carried out with sufficient burnup frequency during an operating cycle to identify the limiting burnup and operating point. Thus, uncertainties in burnup and control rod pattern are conservatively handled by the selection of a limiting operating point. (1) Explain how the uncertainties in burnup and control rod pattern are determined and (2) Define what are meant by burnup frequency limiting burnup.

Resolution: Westinghouse explained using presentation slides that []^{a,c}. Westinghouse stated that [

] ^{a,c}. Westinghouse further stated that the limiting burnup is the value that gives the most unfavorable result on the figure of merit.

Status: The information required for the review was provided and the issue is resolved.

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E. Overall Audit Summary & Action Items:

The following action items were agreed to jointly by the participants:

- The WCAP-16747-P/WCAP-16747-NP, Appendices C and D, will be revised by removing any references to ABWRs and including the additional updated information as committed to by Westinghouse or recommended by the NRC staff during the audit.
- The revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D, will provide example calculations for ATWS and AOOs using a typical BWR/2-6 plant (e.g., Quad Cities), including all modeling assumptions, initial and boundary conditions, as well as detailed results with supporting explanations.
- Westinghouse will submit the presentation slides to be docketed by NRC².
- Westinghouse will provide a schedule for the submission of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D to NRC in the very near future³.
- Clarification discussions can be held if requested by Westinghouse.
- Additional audit meetings may be required following the NRC staff review of the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D.

F. References

WCAP-16747-P-A, "POLCA-T: System Analysis Code with Three-Dimensional Core Model," September 14, 2010 (ADAMS Accession No. ML102770087).

WCAP-16747-P, Appendices C and D, "POLCA-T System Analysis Code with Three-dimensional Core Model, Appendices C and D," October 2010 (ADAMS Accession No. ML103060251).

Letter from Edmond Mercier (Westinghouse) to U. S. Nuclear Regulatory Commission, "Proprietary Westinghouse Information Regarding the NRC Audit of WCAP-16747-P, Appendices C and D, 'POLCA-T: System Analysis Code with Three-Dimensional Core Model, Appendices C and D' (Proprietary)," LTR-NRC-18-39, Revision 1, dated June 18, 2018 (ADAMS Accession No. ML18171A227).

Submittal of WCAP-17203-P/WCAP-17203-NP, Revision 0, "Fast Transient and ATWS Methodology," South Texas Project, Westinghouse Electric Company, dated June 30, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML101830262).

Submittal of WCAP-17203-P/WCAP-17203-NP, Revision 0-2, "Fast Transient and ATWS Methodology," South Texas Project, Westinghouse Electric Company, dated October 20, 2014 (ADAMS Accession No. ML14301A278).

² Since the completion of the audit, Westinghouse has submitted the presentation slides under the docket (ML18171A227).

³ Since the completion of the audit, Westinghouse has informed the NRC that the revised WCAP-16747-P/WCAP-16747-NP, Appendices C and D will be submitted in November, 2018.

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