AUDIT RESULTS SUMMARY REPORT

WCAP-16747-P "POLCA-T: SYSTEM ANALYSIS CODE WITH

THREE-DIMENSIONAL CORE MODEL"

WESTINGHOUSE ELECTRIC COMPANY

The Nuclear Performance and Code Review Branch staff has conducted an audit related to the review of the Westinghouse (Westinghouse) POLCA-T methodology described in licensing topical report WCAP-16747-P "POLCA-T System Analysis Code with Three-Dimensional Code Model." This audit was conducted at the Westinghouse Energy Center in Monroeville, PA between March 17, 2008 and March 20, 2008.

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Abbreviations and Acronyms

Acronym	**Definition**
1D	One-Dimensional
3D	Three-Dimensional
ACA	Apparent Cause Analysis
APRM	Average Power Range Monitor
ARMA	Autoregressive Moving Average
ATWC	Anticipated Transient Without Control Blades
ATWS	Anticipated Transient Without SCRAM
BISON	a Transient Systems Analysis Code with One-Dimensional Kinetics
BPWS	Banked Position Withdrawal Sequence
BWR	Boiling-Water Reactor
CAP	Corrective Action Program
CASMO	Two Dimensional Lattice Physics Code
CCFL	Countercurrent Flow Limit
CPR	Critical Power Ratio
CZP	Cold Zero Power
CRDA	Control Rod Drop Accident
DIVOM	Delta CPR versus Oscillation Magnitude
DP	Pressure Difference or Change in Nodal Power
DR	Decay Ratio
EPRI	Electric Power Research Institute
EPU	Extended Power Uprate
GOBLIN	a Thermal-Hydraulic Analysis Code
[ ]	**[ ]**
LHGR	Linear Heat Generation Rate
LPCI	Low Pressure Coolant Injection
LPRM	Local Power Range Monitor
LWR	Light-Water Reactor
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MATLAB	Mathematical Software
MELLLA	Maximum Extended Load Line Limit Analysis
MELLLA+	Maximum Extended Load Line Limit Analysis Plus
MLHGR	Maximum Linear Heat Generation Rate
MOX	Mixed Oxide
NRC	Nuclear Regulatory Commission
OLMCPR	Operating Limit Minimum CPR
OPRM	Oscillation Power Range Monitor
PB	Peach Bottom Nuclear Power Plant
PHOENIX	a Two-Dimensional Lattice Physics Code
POLCA	a Three-Dimensional Nodal Diffusion Code
POLCA-T	a Transient Systems Analysis Code with Three-Dimensional Kinetics
PROTEUS	PSI Critical Assembly Test Facility
PSI	Paul Scherrer Institute
PSU	Penn State University
Q/A	Quality Assurance
RADDA	Postulated Transient Without SCRAM or Boration

Acronym	Definition
RAI	Request for Additional Information
RAMONA	a Transient Systems Analysis Code with Three Dimensional Kinetics
RIGEL	a Thermal Hydraulic Analysis Code
RMS	Root-Mean-Squared
SE	Safety Evaluation
SLMCPR	Safety Limit Minimum CPR
SPERT	Special Power Excursion Test
SRV	a Safety Relief Valve
STAV	a Fuel Rod Thermal-Mechanical Code
[ ]	**[ ]**
TIP	Traversing In-core Probe
TS	Technical Specifications
TT	Turbine Trip
[ ]	**[ ]**
[ ]	**[ ]**
XS	Cross Section

1 SCOPE AND SUMMARY

The NRC staff has conducted an audit related to the review of the Westinghouse POLCA-T methodology described in topical report (TR) WCAP-16747-P "POLCA-T: System Analysis Code with Three-Dimensional Code Model." This audit was conducted at the Westinghouse Energy Center in Monroeville, PA between March 17, 2008 and March 20, 2008.

Review of the POLCA-T systems analysis code is being conducted in accordance with Section 15.0.2, "Review of Transient and Accident Analysis Methods," of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (SRP 15.0.2). The NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," directs the NRC staff to review the complete code documentation including, but not limited to: (a) the evaluation model, (b) the accident scenario identification process, (c) the code assessment, (d) the uncertainty analysis, (e) a theory manual, (f) a user manual, and (g) the quality assurance program.

SRP 15.0.2 Section III.3.d:

> The reviewers should ensure that all code closure relationships based in part on experimental data or more detailed calculations have been assessed over the full range of conditions encountered in the accident scenario.

SRP 15.0.2 Section III.3.f:

> The reviewers should confirm that the evaluation model is maintained under a quality assurance program that meets the requirements of Appendix B to Title 10 of the *Code of Federal Regulations* Part 50 (10 CFR 50). As a minimum, the program must address design control, document control, software configuration control and testing, and corrective actions. The reviewers should confirm that the quality assurance program documentation includes procedures that address all of these areas. The reviewers may conduct an audit of the implementation of the code developer's quality assurance program.

The audit included:

- Review of the code documentation
- Review of the quality assurance program documentation and procedures
- Review of the code change procedures and requirements
- Review of the code assessment database and analyses
- Review of the analysis method as coded
- Discussion of neutronic and thermal hydraulic code assessment
- Discussion of fuel performance and fuel models
- Discussion of staff requests for additional information (RAIs)

The NRC staff reviewed the information provided during the audit against applicable criteria specified in the SRP 15.0.2. The staff identified nine open items during the course of the audit. These open items were communicated at the exit meeting with Westinghouse representatives and the NRC staff via teleconference. To complete its review the NRC staff has issued RAI 4-11 requesting that each of these open items be resolved. The NRC staff review of the subject TR is ongoing.

The NRC staff and Westinghouse have agreed to take the following actions:

1. The NRC staff review of RAIs 2-3 and 3-2 will be deferred to the review of either the transient application of POLCA-T or application of POLCA-T to generate a **[ ]**

2. The NRC staff review of the subject matter of RAIs 5-4 and 5-5 will be deferred to review of the transient application of POLCA-T or application of POLCA-T to generate a **[ ]** Westinghouse has provided a commitment to provide responses to these RAIs at that time.

3. Prior to submitting the response to RAI 7-26 the NRC staff and Westinghouse will have a teleconference.

The nine identified open items are as follows:

1. Open item regarding RAI 3-5. Westinghouse will provide qualification data for the heat transfer correlations as a supplemental response.

2. Open item regarding RAI 4-8. Westinghouse will provide an integrated response regarding time step, node size, and time integration technique requirements for stability analysis in their response to RAI 6-26.

3. Open item regarding RAI 5-1. Westinghouse will provide qualification data for the transient application of the void-quality correlation as a supplemental response.

4. Open item regarding RAI 6-5. Westinghouse will provide a supplemental response clarifying the determination of the measurement uncertainty.

5. Open item regarding RAI 6-16. Westinghouse will provide a supplemental response specifying an acceptance criterion that includes a margin of **[ ]**

6. Open item regarding calculation of the fuel enthalpy for control rod drop accident (CRDA) analysis. Westinghouse will provide an update to the TR with corrected numerical results.

7. Open item regarding stability analysis. Westinghouse will provide an update to the TR with corrected numerical results, and address the methodology.

8. Open item regarding clad oxide thickness. Westinghouse will provide additional information regarding the means by which the oxide thickness is determined and input to POLCA-T.

9. Open Item regarding the evaluation of **[ ]** on transient analyses performed with RAMONA or BISON. Westinghouse will provide the documentation of this evaluation. This is a generic item, but does not affect POLCA-T.

2 AUDIT PARTICIPANTS

The audit team consisted of the NRC staff Peter Yarsky and Charles Harris. Jon Thompson was the cognizant project manager for the WCAP-16747-P review.

The participation in the audit is summarized in the following table. The attendance of each participant at the Opening meeting on March 17, 2008, or the Exit meeting on March 20, 2008, has been indicated.

Table 2-1: Audit Participants

Name	Affiliation	Opening	Exit
Anthony Mendiola	NRC	x	
Charles Harris	NRC	x	x
Jon Thompson	NRC		x
Peter Yarsky	NRC	x	x
George Roberts	USBWR		x
Anne Leidich	Westinghouse		x
Arnaldo Mingo	Westinghouse	x	x
Camilla Rotander	Westinghouse	x	
Dobromir Panayotov	Westinghouse	x	x
Ken Beatty	Westinghouse		
Michael Riggs	Westinghouse	x	x
Paul Schueren	Westinghouse		
Robert Sisk	Westinghouse	x	x
Thomas Rodack	Westinghouse	x	x
Ulf Bredolt	Westinghouse		x
William Harris	Westinghouse	x	x
William Slagle	Westinghouse		x

3 QUALITY ASSURANCE PROGRAM

Section III.3.f of SRP 15.0.2 directs the NRC reviewers to confirm that the evaluation model is maintained under a quality assurance program that meets the requirements of Appendix B to Title 10 of the Code of Federal Regulations Part 50 (10 CFR 50). As a minimum, the program must address design control, document control, corrective actions, and software configuration control and testing. The purpose of the NRC staff's audit includes confirmation that the quality assurance program documentation includes procedures that address all of these areas. The NRC staff has conducted an audit of the implementation of Westinghouse quality assurance program.

3.1 <u>Procedures for Design and Document Control</u>

3.1.1 Documented Internal Procedures

Design and document control are addressed by internal Westinghouse procedures for quality assurance. The Westinghouse quality assurance program for the POLCA-T code is described by the following procedures:

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The NRC staff conducted a detailed review of these procedures and found that the procedures meet the 10 CFR 50 Appendix B requirements for quality assurance, including meeting the minimum requirements for design and document control, software configuration control and testing, and corrective actions.

The NRC staff reviewed specific details of the corrective action plan tracking system, examples of corrective actions for the POLCA-T code, and the specific requirements for POLCA-T software testing. The results of the NRC staff's review of this information are detailed in the following sections.

3.1.2 UNITS

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3.1.3 10 CFR 50.59 Evaluation Process

The NRC staff performed a review of the procedures governing 10 CFR 50.59 evaluations. Particularly the NRC staff reviewed this element of the quality assurance program for code revisions and error corrections to ensure that Westinghouse did not perform self-evaluation against the 10 CFR 50.59 criteria and that the procedures direct Westinghouse staff to provide sufficient information to customers for them to provide a rigorous and independent evaluation against the applicable criteria.

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3.2 Corrective Actions

The NRC staff reviewed specific examples of corrective actions being performed currently for
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Open Item

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Open Item

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Open Item

Westinghouse will revise the TR documentation. Westinghouse will provide a description of the
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] It is acceptable for Westinghouse to respond to this open item by providing revised pages of the TR prior to final issuance of the revision with the NRC staff's SE attached.

3.3 Software Testing: POLCA-T Test Matrix

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3.3.1 Set A: Basic Models

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3.3.2 Set B: Component Models

3.3.2.1 Jet Pump

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3.3.2.2 Boron Transport

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3.3.2.3 Steam Separator Model

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3.3.3 Set C: Minor Integrated Problems

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3.3.3.1 Pumps

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3.3.3.2 Slave Channel Model

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3.3.4 Set D: Restart of the Computation

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3.3.5 Set E: Stability of Zero Transient Calculations

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3.3.6 Set F: Steady State Calculations

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3.3.7 Set G: Coupled Thermal Hydraulics with Neutron Kinetics

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3.3.8 Set H: Thermal Hydraulics with Control Systems without Kinetics

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3.3.9 Set I: Thermal Hydraulics with Control Systems with Kinetics

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3.3.10 Set J: Control System with Restart

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3.3.11 Set K: Break Flow and Rapid Depressurization

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3.3.12 Set L: Highly Compressible Flow

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3.3.13 Set M: Secondary Variables

3.3.13.1 Total Reactivity

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3.3.13.2 Fuel Rod Quantities

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3.3.13.3 Metal Water Reaction

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3.3.14 Revision 3 to the Test Matrix

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4 USER GUIDANCE

Manuals provide the necessary guidance to code users to implement the codes to perform licensing calculations. The guidance conferred through user manuals is considered part of the complete code documentation. It is audited by the NRC staff to ensure that the guidance is sufficiently thorough, ensuring that code users execute the code consistent with the options and limitations on the code.

The NRC staff reviewed documentation regarding the boiling-water reactor (BWR) reload design procedure to determine user guidance for the use of PHOENIX4 as an upstream analysis code in the POLCA-T code stream. The NRC staff reviewed this documentation as a follow-up to RAI 4-3 (see Section 6.6). The NRC staff also reviewed the user guide for POLCA-T. During the audit the NRC staff examined code input for full core and plant models and executed the code to ensure that the user guidance was sufficient in detail to describe the input, available execution options, and output.

In addition to the general user guide, which provides direction on how to activate particular code options or input, for specific analyses additional controls are required to ensure accuracy of the solution. In the particular area of stability, the calculational output of POLCA-T for stability evaluations is sensitive to: (1) time step, (2) node size, (3) time integration technique, (4) activation of higher harmonics, and (5) signal to noise ratio. The NRC staff also considered the stability methodology guidelines in its review of the POLCA-T application to stability analysis.

4.1 Boiling-Water Reactor Reload Design Procedure

The USBWR reload design procedure is described in the BWR – reload design procedure manual (Reference 11, Appendix A). The manual provides the procedure for developing POLCA7 input using the PHOENIX4 lattice physics code.

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4.2 POLCA-T User Guide

The NRC staff reviewed the POLCA-T User Guide (Reference 10, Appendix A) as directed in SRP 15.0.2 as part of the NRC staff's review of the complete code documentation. The NRC staff performed its review by comparing the user guide document against POLCA-T input decks and also exercised the POLCA-T code in order to understand the means for specifying particular analysis options. Westinghouse provided the NRC staff access to the C3 customer computing cluster in Vasteras, Sweden through a network connection to run the code.

4.2.1 Basic Input Structure

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4.2.2 Modeling Options and Constraints

4.2.2.1 Balance of Plant

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4.2.2.2 Intra-assembly Bypass Flow

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4.2.2.3 NTYPE

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4.2.2.4 Boundary Conditions

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4.2.2.5 Level Tracking

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4.2.2.6 Interfacial Heat Transfer

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4.2.2.7 Reactivity Feedback

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4.2.2.8 Limiting Cell Determination

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4.2.2.9 Error Checking

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4.2.2.10 Channel Lumping

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4.2.3 Steady State Calculations

The steady state calculation is performed in POLCA-T prior to any transient evaluations. The steady state solution is required as the thermal hydraulic models in POLCA7 and POLCA-T are different. The POLCA7 solver is incorporated directly; however, POLCA-T solves the thermal-hydraulic condition based on RIGEL models.

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4.2.4 Transient Simulations

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4.3 Calculational Controls

4.3.1 Convergence Criteria

The NRC staff reviewed the POLCA-T numerical solution convergence criteria. The NRC staff found two criteria and discussed these criteria with Westinghouse during the audit. The first criterion is the change in nodal power criterion. **[**

] Another criterion is applied for the core eigenvalue. The eigenvalue convergence criterion is typically **[** **]**

4.3.2 Disturbances

Disturbances are included at the end of a POLCA-T input file. Disturbances allow the code user to change any user input parameter during the course of a transient simulation. Disturbances do not allow the user to perturb state parameters that are calculated by POLCA-T. Disturbances allow for changes to parameters such as flow area, control rod position, or controller states for boundary conditions. Disturbances can also be used to control the time step size or convergence criteria to optimize code run time performance.

[ ]
The NRC staff reviewed an example disturbance for the trip of the recirculation pumps for an input deck to model **[ ]**

5 POLCA-T MODELING FEATURES

The NRC staff reviewed additional modeling features of POLCA-T relevant to the application of methodology to CRDA and stability analyses.

5.1 <u>Bypass Void Model</u>

The NRC staff requested information regarding the modeling of the neutronic effects of bypass voiding in RAI 6-6. Westinghouse provided a brief description of the available options for bypass void nuclear modeling in the response. During the course of the audit the NRC staff reviewed the POLCA-T User Guide (Reference 5, Appendix A) for information regarding these bypass void models.

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5.1.1 Detailed Model

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5.1.2 Simple Model

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5.2 Oxide Layer Model

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Open Item

Westinghouse will provide the NRC staff additional information detailing how the initial oxide layer thickness is determined. Westinghouse will also provide the staff with the details of the method for inputting the oxide layer thickness into the POLCA-T input.

5.3 Momentum Equation

The NRC staff requested additional information regarding the momentum equation in RAI 8-6 and RAI 8-7. During the audit, the NRC staff reviewed documentation regarding the momentum equation and had several discussions with Westinghouse regarding the single fluid momentum equation in POLCA-T.

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The NRC staff examined portions of the source code to verify that the momentum conservation equations were represented in the code consistent with the methodology as described in the TR. The NRC staff confirmed that momentum is appropriately conserved for cells with multiple flow connections.

5.4 Decay Heat Model

The decay heat model is described in the POLCA-T user guide (Reference 5, Appendix A). The POLCA-T decay heat model is based **[** **]** is widely applied for this purpose, and the NRC staff finds that **[** **]** is acceptable for decay heat modeling.

5.5 Delayed Neutron Model

The delayed neutron model is described in the POLCA-T user guide (Reference 5, Appendix A). The NRC staff reviewed the documentation and found that the POLCA-T neutron kinetics solver is based **[** **]** are widely used and have previously been approved by the NRC staff in similar applications. The NRC staff finds this model to also be acceptable.

6 ROUND 1 RAI RESPONSES

During the NRC staff acceptance review of the subject TR, the NRC staff identified several requests for information regarding the POLCA-T code. The NRC staff's acceptance review specified that two rounds of RAIs would be necessary for the NRC staff to complete its detailed technical review. The acceptance was transmitted with the first round of RAIs. Westinghouse provided responses to the first round of RAIs in References 19, 20, and 21. The NRC staff required clarification of a subset of these responses and discussed these RAI responses with Westinghouse during the audit.

The NRC staff issued several RAIs, that were divided into topical areas based on the precursory acceptance review. These areas were: (1) long cycle cores, (2) mixed cores, (3) expanded operating domains, (4) code legacy, (5) individual models and separate effects qualification, and (6) stability.

6.1 RAI 2-2

The NRC staff requested information regarding the uncertainty analysis for transition cores. The RAI was prompted by a condition in the NRC staff's approving SE for POLCA7 (Reference 9). The response states that "The potential for increased uncertainties in the thermal analysis of the Legacy fuel is resolved by utilizing thermal limits for the Legacy fuel that are non cycle-dependent limits established by the legacy fuel vendor or conservatively bounding limits." (Reference 19).

The POLCA-T application is intended for generic application for all forced recirculation boiling-water reactors. The applicable safety limits for a given plant application may include: the safety limit minimum critical power ratio (SLMCPR), the maximum linear heat generation rate (MLHGR) limit, or maximum average planar linear heat generation rate (MAPLHGR) limit, or any combination of the aforementioned limits.

The NRC staff agrees that **[**
] However, the NRC staff did not review the methodology for adopting these limits as part of the current TR review. MLHGR limits are generally determined according to deterministic fuel thermal mechanical performance codes which use bounding assumptions regarding key uncertainties to calculate conservative limits. The NRC staff did not perform a review to ensure that the MLHGR limits are conservatively adopted, particularly in light of the potential for increased nodal power uncertainties in the core monitoring software for legacy fuel designs.

The NRC staff discussed the reload licensing methodology presented in Reference 8 in regards to the application to legacy fuel. The methodology requires a conservative adder for the operating limit minimum CPR (OLMCPR) for transition cores; however, the NRC staff did not revisit the reload licensing methodology as part of the current review of POLCA-T.

Furthermore, the MAPLHGR safety limit is based on Loss-of-Coolant Accident (LOCA) phenomena, which is not within the scope of the POLCA-T application.

The response states that an approved methodology is used to include any legacy fuel associated uncertainties in the applicable safety limits.

The NRC Staff Action for Resolution

The NRC staff found that review of the reload licensing methodology was outside the scope of the subject TR and, therefore, will include a statement in the SE to this effect. The NRC staff recommends that the NRC staff review the safety limit determination for specific mixed core applications referencing the subject TR to ensure compliance with the approved methodology.

6.2 RAI 2-3

In RAI 2-3 the NRC staff requested additional information regarding the critical power ratio (CPR) correlations used in POLCA-T. The responses states that "Any CPR correlation to be incorporated in POLCA-T for any fuel design has to be reviewed by the NRC separately… for each fuel design for which approval is sought a CPR correlation will be submitted for approval."

The calculation of CPR is **[ ]**

The capability of POLCA-T to calculate CPR is **[ ]** These applications are outside the scope of the current review for CRDA and stability.

The NRC Staff Action for Resolution

The NRC staff will defer the review of the response to RAI 2-3 to the review of POLCA-T for either application to **[ ]** The NRC staff's SE will include specific language to this effect. Approval of POLCA-T for CRDA analysis or stability analysis will not constitute NRC acceptance of the response to RAI 2-3.

6.3 RAI 3-2

In RAI 3-2, The NRC staff requests that Westinghouse provide additional information regarding the effects of bypass void formation. Operation in expanded operating domains may include flatter radial power shapes in conjunction with higher powered bundles and lower bundle flows than those included in the qualification of the nuclear design methods in 1999, as documented in CENPD-390-P-A (Reference 10). Specifically, the NRC staff asks that Westinghouse: (1) quantify any potential for excessive bypass void formation as a result of direct moderator heating, or heating of the bypass due to heat released from structures such as the channels or control blades, (2) in light of the quantification, provide justification of the modeling of the bypass flow paths in the methods described in the Appendices to WCAP-16747-P, and (3) justify the applicability of nuclear instrumentation models based on the potential for increased bypass voiding relative to the original qualification under steady state or transient conditions.

The response **[ ]** the NRC staff's concerns. The **[ ]** at off normal conditions for **[ ]** The local power range monitors (LPRMs) are neutron sensitive devices and their response may be affected by the formation of voids in the bypass inter-assembly area. The average power range monitor (APRM) and oscillation power range monitor (OPRM) may be adversely affected by the presence of bypass voiding, or the transient variation in the bypass void fraction near LPRM locations during transients.

The modeling of [ ] is relevant to transient evaluations and to Option III stability licensing. CPR evaluations are not part of the current TR review. [ ] is therefore outside the scope of the current TR review.

Staff Action for Resolution

The NRC staff will defer the review of the response to RAI 3-2 to the review of POLCA-T for either application to [ ] The NRC staff's SE will include specific language to this effect. Approval of POLCA-T for CRDA analysis or stability analysis will not constitute NRC acceptance of the response to RAI 3-2.

6.4 RAI 3-5

RAI 3-5 requested that Westinghouse provide the NRC staff with qualification of the extension of the constitutive models (i.e. closure relationships) and heat transfer correlations to bundle power and flow conditions that bound those experienced in expanded operating domains.

The response does not fully answer the NRC staff's question. The response contains qualification data for the void-quality correlation only. The NRC staff requested qualification of the heat transfer correlations as well.

The NRC staff discussed the [ ] The [ ] were not provided to the NRC staff during the audit, [ ]

Open Item

Westinghouse will provide comparisons of the [ ] with POLCA-T calculations to qualify the heat transfer correlations as a supplemental response to RAI 3-5.

6.5 RAI 4-1

RAI 4-1 requested that Westinghouse provide a core follow reanalysis of a case contained in the original submittal of POLCA7 to demonstrate that changes made since the original review have not resulted in code drift over time. Code drift is a term referring to several code changes within a given code change acceptance criterion that, over time, result in incremental changes whose net effect is significant relative to the code qualification reviewed and approved by the NRC.

In the original response, the [ ] provided for Plant B appear to exhibit a consistently [ ] The code version originally used in the qualification analyses and the current production version were compared, the current production version resulted in [ ] differences of approximately [ ] for the code version used in the qualification submitted with the POLCA7 methodology TR.

To address NRC staff's [ ] Westinghouse provided Audit Reference 12 (contained in Appendix A: Audit documents of this report) for NRC review during the audit. The qualification studies of the PHOENIX4/POLCA7 codes against recent data collected in modern cores and critical experiments are contained in Reference 12.

Based on Reference 12, the [ ] is suspected to be the cause for [ ]

The [ ]

The NRC staff notes that the POLCA7 accuracy has been quantified using full scale data in a recent production method. The NRC staff, furthermore, notes that the POLCA-T test matrix has been expanded to ensure that its integration in POLCA-T does not adversely affect either stability analyses or complex transients (see Section 3.3.14).

The NRC staff also notes that a revision will be made to the final TR to update the numerical results to be consistent with the most recent release version of POLCA7, and that the POLCA-T release consistent with the updated POLCA7 code will be maintained under the updated POLCA-T Test Matrix. Therefore, the NRC staff finds that the release version described in the final revision to the TR will be adequately controlled by the quality control process as described in Section 3. Therefore, future improvements or changes to the POLCA7 or upstream codes will not adversely affect the reliability of the POLCA-T methodology.

The NRC staff considers the qualification of POLCA7 to adequately provide reasonable assurance that the extension of the neutronic methodology to [ ] does not result in an adverse increase in code uncertainty. Therefore, the NRC staff similarly concludes that the POLCA-T kinetics solver's efficacy is likewise unaffected at these conditions.

The NRC staff does not require additional information provided under a separate open item to address the technical concerns associated with RAI 4-1. However, the NRC staff notes that closure of RAI 4-1 relies on information to be provided under separately specified open items, namely the update to the TR numerical results to reflect the most recent POLCA-T production code (see Sections 3.2.1 and 3.2.2).

6.6 RAI 4-3

In RAI 4-3 the NRC staff requested information regarding the standard void and branch cases that are used to develop the cross section libraries using PHOENIX4. The upstream analyses to determine the cross sections affect the downstream efficacy of the transient analysis code to accurately determine neutron kinetics parameters.

Westinghouse responded to RAI 4-3 and provided details regarding the depletion steps and other information regarding the branch cases. In this response Westinghouse provided a reference to an internal Westinghouse guidance document. The response indicates that this guidance document is the basis for the selection of the void depletion cases that are used in production analyses.

Westinghouse provided a copy of the relevant guidance document to the NRC for review during the audit (Reference 4). The NRC staff reviewed the guidance document and documented its review in Section 4.1. The NRC staff has determined that no further additional information is required to resolve RAI 4-3.

6.7 RAI 4-5

RAI 4-5 requested additional information on how a bundle specific R-factor is determined. The response states that a specific R-factor is developed for each fuel product line. This response implies that all SVEA-96 Optima2 bundles would have the same R-factor. The NRC staff does not find this to be consistent with the Assembly R-factor calculation which is **[** **]** See CENPD-392-P-A as an example.

Westinghouse provided a sample R-factor method in WCAP-16081-P-A (Reference 39). The R-factor is calculated by **[** **]** Westinghouse confirmed that the bundle R-factor is calculated **[** **]** and is consistent, generally, with the technique described in Reference 39 for SVEA-96 Optima2 fuel bundles.

The NRC staff finds that the clarification and reference provided were sufficient to resolve RAI 4-5.

6.8 RAI 4-8, RAI 6-3 and RAI 6-20

RAI 4-8 requested additional information regarding the time step control algorithm. The NRC staff requested this information as time domain stability analyses are highly sensitive to node size, time step, and time integration technique.

In its discussion with Westinghouse, the NRC staff found that the POLCA-T time step control algorithm includes **[** **]** However, Westinghouse also discussed their methodology for selecting a **[** **]** to ensure adequate time step size.

The NRC staff has requested additional information separately for time step size control, nodalization, and time integration technique for stability; however, finds that these features of a time domain stability model must be controlled in tandem to ensure accuracy in the determination of the DR.

RAI 6-3 and RAI 6-20 deal with the areas of time step size, node size, and time integration technique. The NRC staff considers the means for time step size control to be integral to the overall performance of a time domain stability code, and therefore, requires additional information regarding the Westinghouse approach for adequate time step size control.

The NRC staff cannot complete its review of the POLCA-T application for stability analyses until appropriate controls are specified to ensure that the time step size, node size, and time integration techniques are acceptable for analyzing thermal hydraulic instabilities without resulting in numerical damping.

Open Item

In the response to RAI 4-8, Westinghouse has provided general information regarding the time step control algorithm in POLCA-T. However, the NRC staff requires information regarding the controls that will be in place for POLCA-T stability calculations.

In response to RAI 6-26, Westinghouse will provide an integrated response to address not only the axial nodalization controls, but also those controls that are required in addition to nodalization controls, that ensure accurate density wave oscillation modeling without numerical damping. The integrated response will address concerns expressed in RAI 4-8, RAI 6-3, RAI 6-20, and RAI 6-26, which each deal with separate elements of the overall numerical solution technique as applied for time domain stability analyses.

6.9 RAI 5-1

The NRC staff requested additional details of the qualification of the void-quality correlation to transient conditions. The NRC staff and Westinghouse discussed those tests performed during critical power testing that could be used to qualify the transient application of the void-quality correlation; however, Westinghouse explained that **[**

]

The NRC staff requested this information as transient application of the void-quality correlation affects the prediction of the void propagation time in stability analyses. The NRC staff and Westinghouse discussed the applicability of the **[** **]** and qualification provided in Appendix A to the TR for CRDA analysis. The **[**

] Westinghouse and the NRC staff discussed the possibility of supplementing the original response with **[** **]** to provide a high degree of confidence in the accuracy of the transient void calculation by **[**

]

Open Item

Westinghouse will supplement the response to RAI 5-1 with additional qualification information. This qualification information will contain additional details of **[** **]** The qualification analyses and discussion will be sufficient in scope and detail to indirectly provide qualification of the separate effect of transient void prediction using the void-quality correlation.

6.10 RAI 5-3

RAI 5-3 requests information regarding the qualification of POLCA-T and upstream neutronic codes for application to mixed oxide (MOX) fuel analyses. The original response specifies that **[** **]**

Staff Action for Resolution

The NRC staff will include a restriction in the conditions, limitations, and restrictions section of final SE regarding MOX. The statement will specify that POLCA-T is not approved for application to MOX fuel.

6.11 RAI 5-4 and RAI 5-5

RAIs 5-4 and 5-5 request information regarding the critical power calculations. The current application of POLCA-T for stability does not include calculation of the **[ ]** and therefore, critical power calculations are not required in the scope of the current application. The original Westinghouse responses specify that the information requested will be provided with Appendix C (application of POLCA-T to transients).

Staff Action for Resolution

The NRC staff interprets these responses as a commitment to provide the requested information with Appendix C of the TR. The NRC staff will include a statement in the SE to this effect.

The NRC staff will defer review of the subject matter of RAIs 5-4 and 5-5 until the NRC staff reviews the application of POLCA-T to **[ ]** Approval of POLCA-T for CRDA or stability does not constitute NRC acceptance of the responses to RAIs 5-4 or 5-5.

6.12 RAI 6-4 and RAI 6-22

RAI 6-4 requests that Westinghouse describe how the results of the stability analyses are used in current operating BWR plants in terms of their implications to mitigating measures

RAI 6-22 requests that Westinghouse describe how plant and cycle specific analyses are performed for Option III plants.

The response to RAI 6-4 states that stability solutions are implemented using plant specific procedures. The response to RAI 6-22 states that the Option III solution relies on analyses **[ ]**

The responses indicate that the scope of the current application is the approval of POLCA-T to predict the DR. The response to RAI 6-22 indicates that a future submittal will detail the application of POLCA-T to **[ ]** and that approval of POLCA-T for this purpose is not being pursued as part of the current application.

However, the response to RAI 6-4 indicates that **[ ]** rely only on the calculation of the DR at particular state points in the power to flow map.

The NRC staff and Westinghouse discussed the intent of the current application. Westinghouse is not seeking the NRC staff approval in the subject TR for the use of POLCA-T in all stability licensing calculations. In RAI 6-25 the NRC staff requested that Westinghouse describe the licensing analyses that would be performed by POLCA-T and specify the method by which the DR results are used in licensing.

The NRC staff has found that the response to RAI 6-22 is sufficient in that previously approved methods are referenced for **[ ]** licensing evaluations. The NRC staff does not require additional information in response to RAI 6-4 as the response to RAI 6-25 will provide descriptive details of how the DR calculations are used in other **[ ]** licensing frameworks.

6.13 RAI 6-5

RAI 6-5 requested clarification of the uncertainty bands in Figure B.7-2 of Reference 41. The original response states that the uncertainty bands represent a two-dimensional combination of both the measurement and calculational uncertainty.

The calculational uncertainty is based on uncertainty in **[ ]** noise measurements used to determine the DR. Westinghouse clarified that the bands appear larger than **[ ]** based on the calculational uncertainty because the bands extend by the **[ ]**

The NRC staff requested that Westinghouse describe how the measurement uncertainty was determined, as the NRC staff cannot determine the acceptability of the calculational uncertainty determination without understanding the acceptability of the process used to determine the measurement uncertainty.

Open Item

Westinghouse will supplement the response to RAI 6-5 with additional details describing the means by which the **[ ]** measurement uncertainty is determined.

6.14 RAI 6-16

RAI 6-16 requests that Westinghouse describe how applying a prediction uncertainty of **[ ]**

The response states that predicting DR less than unity ensures that power oscillations will be damped. Under conditions where the reactor is stable and the power oscillations "die out," the specified acceptable fuel design limits (SAFDLs) are not exceeded so long as the static SAFDLs are met.

The NRC staff has reviewed this response and agrees that if power oscillations are damped that SAFDLs are not exceeded so long as static SAFDLs are met. The NRC staff, however, is not reasonably assured that the reactor is stable if the predicted DR is **[ ]**

The NRC staff requires a margin of **[ ]** to be reasonably assured that calculating DR equal to the acceptance criterion demonstrates that the reactor is stable.

Open Item

Westinghouse will provide a supplemental response to RAI 6-16 specifying an acceptance criterion for the DR that is **[ ]** less than unity. The final revision of the TR will revise the DR acceptance criterion to reflect a margin of **[ ]**

6.15 RAI 6-17

The NRC staff notes that the qualification studies, contained in the Appendix B of the TR, for the POLCA-T application to stability include many more core wide oscillation tests than regional mode oscillation test. The primary qualification for regional mode oscillations is [ ]

RAI 6-17 requests that Westinghouse separately evaluate the uncertainty for each instability mode. The original response states that the driving physical phenomena for regional and core wide oscillations are the same, and therefore the uncertainty in the calculated DR is not expected to vary between the two modes.

In its review of the response, the NRC staff notes that the regional mode oscillations require modeling of density wave oscillations, similar to core wide oscillations, in one dimensional components, and therefore, agrees that the thermal-hydraulic modeling uncertainties are not expected to vary between the two modes.

However, the NRC staff notes that core wide power oscillations occur with a radial flux shape that is essentially the same as the fundamental radial flux shape. The regional mode oscillations result in power tilts along the next highest radial flux harmonic, and therefore, necessarily result in greater local radial flux gradients.

The higher flux gradients may result in errors in the prediction of peak bundle or nodal powers due to the constraints of the diffusion theory solution for large regional power oscillations or radial power shape perturbations.

The NRC staff requested that Westinghouse address the potentially increased uncertainty using the POLCA-T kinetics methods for high radial flux tilts. Westinghouse provided additional qualification information in Reference 5. Part of the qualification studies presented included direct comparisons of the PHOENIX4/POLCA7 methods to the LWR-PROTEUS experiment. A subset of these comparisons was also provided in response to RAI 1-1 (Reference 21).

The POLCA-T kinetics solver [ ] and therefore, demonstrated efficacy of the [ ] provides reasonable assurance that the POLCA-T kinetics solver provides accurate radial flux calculations.

The [ ] includes many gamma scan campaigns. Gamma scans provide the most accurate radial power distribution benchmarks by allowing comparison of the calculated bundle and sub bundle power distributions (as opposed to TIP measurements which do not provide measurement of the bundle powers in an instrument four bundle set).

Reference 5 provides specific qualification of the lattice physics methods and core simulator methods against detailed radial power distribution and axial power distribution measurements. The NRC staff reviewed the results of LWR-PROTEUS qualification of the lattice pin power calculations, as well as qualification of [ ]

Several measurements were performed at the LWR-PROTEUS test facility at the Paul Scherrer Institute on a 3x3 critical area of full scale SVEA-96 fuel bundles. The critical measurements included pin power measurements for the central fuel bundle. The central fuel bundle pin powers were compared to the PHOENIX4 infinite lattice calculated power distribution with good agreement. The alternative fuel configurations, including the insertion of several control rods to suppress power on two sides of the central fuel bundle, were also taken into account and reflected in the results. In these tests, the comparison of PHOENIX4 calculations to the measurements indicate only a small increase in the pin power distribution **[** **]** for a very steep radial flux tilt across the bundle.

The LWR-PROTEUS tests confirm that the PHOENIX4 lattice parameters are accurately predicted for even large radial power tilts. The PHOENIX4 lattice parameters input to **[** **]**, however, are based on infinite calculations and provides the basis for the pin power reconstruction model. The **[** **]** corrects the radial pin power distribution according to the calculated bundle flux tilt.

Gamma scan measurements performed at the **[** **]** were performed to qualify the **[** **]** According to Reference12 of Appendix A, some radial tilts were observed for a fresh fuel bundle in the gamma scan campaign. The measurements indicated a tilt relative to the calculation across the sub bundle as **[** **]** for one quadrant of the bundle. While this tilt was observed by the gamma scan measurement, the cause of the tilt has not been fully diagnosed, but could be due to **[** **]** that was not explicitly measured or modeled.

The qualification of the **[** **]** provides indirect qualification of the intranodal cross section model. The LWR-PROTEUS experiments demonstrated the accuracy of the PHOENIX4 infinite lattice solution, the **[** **]** provide qualification of the **[** **]** to characterize the variation in neutron flux across a node, and, therefore, to model steep radial flux gradients as may be present during regional mode oscillations.

The results for a once burnt fuel assembly indicate excellent agreement between pin gamma scans and the **]** However, for the fresh fuel assembly, **[** **]**

During regional mode oscillations, the radial power peaking is a combination of peaking due to both the fundamental and first harmonic flux shapes. The gradient in the first harmonic will be slightly greater than the fundamental mode. Qualification of the pin power reconstruction model with a high degree of accuracy for several gamma scans (excluding the fresh bundle scan) as well as accurate representation of the **[** **]**

This is further supported by the comparison of the **[** **]** recorded during the regional mode instability test as well as the calculation of the SPERT III E transient power as presented in the rod drop qualification, which is highly, radially peaked (Reference 41).

Therefore, the NRC staff has found that POLCA-T includes sufficiently sophisticated radial flux modeling capabilities that the NRC staff is reasonably assured that the degree of radial neutron flux peaking during regional mode oscillations will not be sufficiently egregious to invalidate the uncertainty analysis.

7 ROUND 2 RAI DISCUSSION

The NRC staff had extensive discussions with Westinghouse regarding the second round of RAIs. The intent of these discussions was to clarify the RAIs and to discuss Westinghouse approach for providing responses. This section provides the NRC staff's RAIs as well as a summary of the discussions with Westinghouse. The NRC staff's second round of RAIs builds from the first round (Section 6 of this report) and includes six topical areas: (6) stability, (7) control rod drop accident, (8) thermal hydraulics, (9) power calculations, (10) control systems, and (11) fuel rod modeling.

7.1 Request for Additional Information 6: Stability

7.1.1 RAI 6-25

RAI Text

Describe the process by which POLCA-T results are used to implement an approved licensing approach for long term stability solutions.

If POLCA-T is used to generate, or determine the **[ ]** then please provide this information as well as the response to staff RAI 5-4 and 5-5.

If POLCA-T is used to determine an exclusion region boundary, then how are the analysis points determined and is a fitting function employed? If so, what is the fitting function? What is the basis for the function if there is one?

Discussion Summary

Westinghouse stated that RAMONA-3B is currently used for **[ ]** and approval is not being sought for POLCA-T for this purpose currently. The POLCA-T methodology described in the TR is employed to calculate the DR. The DR calculations are used in the determination of exclusion regions. Westinghouse will describe how exclusion regions are determined for the relevant **[ ]**

7.1.2 RAI 6-26

RAI Text

Previously approved time domain stability methodologies (i.e. RAMONA-3B) are approved with limitations regarding the axial nodalization. Fully describe methods that are used to determine the acceptability of the axial nodalization for a plant model to be used in reload licensing analyses.

Discussion Summary

The intent of the RAI is to address modeling requirements for stability analyses regarding the nodalization. Time domain stability analyses are highly sensitive to the node size, time step size, and time integration technique. Inappropriate controls on the node size and time step may result in numerical damping of the transient response following excitations in the current methodology.

The NRC staff requested related information regarding the time step and time integration technique as well as time step controls in RAIs 4-8, 6-3, and 6-20. Westinghouse has agreed to address these three items in one integrated response to RAI 6-26. The NRC staff has documented this response as an open item, because it relates to RAI responses that have been previously submitted (see Section 6.8).

7.1.3 RAI 6-27

RAI Text

Stability evaluations are highly sensitive to the input specifications for plant models. Describe any additional uncertainty in the DR determination that may arise from specifying model input using standard production procedures as opposed to developing models specifically for benchmark analysis.

Discussion Summary

The intent of the RAI was to ensure that the uncertainties, determined for the DR quoted in Appendix B of the TR, are representative of the uncertainties for standard production analyses. Particularly, the NRC staff is concerned that additional care is taken in the accurate modeling of stability phenomena for the purpose of qualification, but may not be employed during licensing evaluations. The additional care may be revised nodalization, sensitivity studies, or additional controls on the time step size that were included in the qualification analyses, but are not required by procedure for standard production calculations.

In response to this RAI, Westinghouse will clarify that the qualification analyses and standard production analyses have the same pedigree, and therefore, the uncertainty determination is applicable to future standard production licensing evaluations.

7.1.4 RAI 6-28

RAI Text

The DR acceptance criterion is not consistent with the previously approved acceptance criterion for RAMONA-3B. Specifically, the standard deviation in predicted and measured DR is approximately the same for these two methodologies; however, the proposed acceptance criterion is significantly larger. The sensitivity study, provided in Appendix B, seems to indicate that uncertainties in key plant parameters may result in changes in the DR on the order of **[** **]** If a Monte Carlo assessment is performed on a cycle specific basis similar to the SLMCPR determination process, provide descriptive details on how uncertainties in plant parameters are captured in the determination of the decay ratio acceptance criterion. Are these effects captured in the design margin? If so, what is the process for determining the design margin? To quantify any uncertainty in the DR as a result of uncertainties in plant parameters, perform a sample Monte Carlo analysis using standard uncertainties in plant parameters for a sample core in the core wide oscillation qualification and determine the resultant standard deviation.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or a proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate. Westinghouse will provide a response to this RAI that describes how plant specific uncertainties are captured.

7.1.5 RAI 6-29

<u>RAI Text</u>

Describe the process by which a regional mode oscillation is established in the POLCA-T simulation if the reactor is highly susceptible to core wide oscillations (in other words, core wide oscillations are the dominant oscillation mode)?

<u>Discussion Summary</u>

When a disturbance is imposed on the POLCA-T plant model to initiate an oscillation for DR calculations many higher oscillatory modes are excited. These higher modes respond to the disturbance and rapidly decay during the early part of the transient response. Westinghouse stated that in its determination of the DR **[** **]** The response to this RAI will include specific details of the **[** **]** used to infer the DR.

The NRC staff understands that the disturbance may simultaneously excite a core wide and a regional oscillatory mode during the transient evaluations. Westinghouse stated that there is a **[** **]** transient responses for core wide and regional oscillations. Once the core symmetry plane is determined, **[** **]** and provides a transient response for the core wide mode only. Similarly, **[** **]** removes the core wide oscillation component and provides a transient response for the regional mode only.

The NRC staff asked how Westinghouse determines the **[** **]** Westinghouse stated that the **[** **]** may be determined by increasing the **[** **]** in the POLCA-T model until **[** **]** Once the **[** oscillations **]** are observed the **[** symmetry plane can be visually inferred **]** from the transient response.

Westinghouse will provide these details in response to RAI 6-29 including the methods for determining the **[** **]** techniques, and determining the **[** **]** for the DR determination.

7.1.6 RAI 6-30

<u>RAI Text</u>

Previous sensitivity studies performed following the Washington Nuclear Project 2 (WNP2) instability event show that the stability characteristics are sensitive to the fuel and core design, namely when multiple types of fuel are included in the core design. Studies performed with the NRC LAPUR code and the NRC approved RAMONA-3B codes have illustrated that the WNP2 stability characteristics were sensitive to the mixed nature of the core design.

The sensitivity is attributed to the relative void reactivity and density wave oscillation stability characteristics of the two fuel designs that were in WNP2. Demonstrate the capability of POLCA-T to capture these local effects by performing a similar sensitivity analysis.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. The NRC staff refers to Section 7.2.2 of CENPD-294-P-A (Reference 6). The previously approved RAMONA-3B based stability methodology included qualification against the WNP2 mixed core analysis. Westinghouse **[** **]** readily provide a reanalysis using POLCA-T. The NRC staff requested that a similar sensitivity analysis be performed. Therefore, an analysis of an alternative plant would be acceptable to the NRC staff. Westinghouse will perform a sensitivity analysis that is substantially similar to the WNP2 qualification study for another reactor plant and provide the results to the NRC in response to RAI 6-30.

7.1.7 RAI 6-31

RAI Text

For the core wide oscillations considered in the POLCA-T qualification provide a plot of the measured DR versus a dimensionless parameter that is shown below. Determine the slope of the trend line through these data. Provide a similar plot for the calculated DR and provide the slope of the trend line through these calculated points. Comment on any differences in this slope. Additionally comment on the extension of POLCA-T methods to higher values of the dimensionless parameter

Dimensionless Parameter = (Maximum Nodal Peaking Factor) x (Core Thermal Power) / (Core Flow Rate) / (Inlet Subcooling)

Discussion Summary

The NRC staff and Westinghouse discussed the intent of RAI 6-31. The NRC staff is concerned about gross trending in measured and predicted DR with parameters that are known to influence the reactor stability. Westinghouse specified that boiling length, orifice loss coefficient, and pressure drop also affect stability performance. For several core measurements and calculations these other parameters will vary and result in data scatter. The NRC staff understands that this scatter is expected due to the other factors affecting stability, however, still requires demonstration that POLCA-T predicts, in at least a gross sense, the expected trends in DR with first order factors impacting DR: power level, core flow, subcooling, and power peaking. Westinghouse will provide a response and comment on the indication of trends.

7.1.8 RAI 6-32

RAI Text

The NRC staff requires additional information regarding the calculational efficacy of POLCA-T to determine regional mode oscillation transient responses. Please provide the transient traces of mass flow rate in the bundles surrounding the following instrument strings: 40-17 and 16-41 of the [ ] Cycle 7 regional instability test. Provide specific details regarding the manner in which the model was perturbed to excite the oscillation if such a perturbation was applied.

RAMONA-3B was previously qualified based on [ ] Cycle 7 test data, specifically the same Record 5 reading. Please provide a figure comparing the RAMONA-3B predicted transient LPRM signal for LPRM 16-41A to that predicted by POLCA-T on the same scale as Figure 6.2-4 in CENPD-294-P-A (Reference 6).

Comment on the method for determining the appropriate magnitude of perturbations to excite out-of-phase oscillations in terms of eigenvalue separation of the yet higher harmonic modes. Compare the POLCA-T predicted void propagation time to the oscillation period for the highest oscillation magnitude bundles. Specify the drift flux correlation used for the [ ] analysis. Compare the drift flux correlation to the slip correlation model that was used in the RAMONA-3B qualification.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. In regards to the LPRM string 40-17 and 16-41 measurements, the NRC staff requested that Westinghouse provide the transient mass flow rates in the surrounding bundles. The NRC staff requires additional information to understand the coupling between the neutronic and thermal hydraulic response during the transient. The NRC staff also requested that Westinghouse verify if a disturbance was imposed to excite a regional mode oscillation or if POLCA-T predicted the onset of a regional mode oscillation under the conditions specified in the POLCA-T input without specific excitation. Westinghouse will provide this information in response to RAI 6-32.

7.1.9 RAI 6-33

RAI Text

Provide a stability phenomena identification and ranking table (PIRT).

Discussion Summary

Westinghouse will provide PIRT for stability for the NRC staff review.

7.1.10 RAI 6-34

RAI Text

The purpose of this RAI is to determine the efficacy of POLCA-T to model pressure wave phenomena. Referring to the Peach Bottom Unit 2 Turbine Trip (PB2 EOC2 TT) test qualification in Section A.3, is the initial core exit pressure response time sensitive to the POLCA-T nodalization, time step, or time integration technique? Please support this response with a sensitivity study comparing the predicted and measured initial core exit pressure response time based on changes in the nodalization, time step, and time integration method.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. The NRC staff understands that the accurate modeling of time domain oscillations requires precise tracking of density waves. The NRC staff is requesting that Westinghouse use data available from the PB2 EOC2 TT tests to provide qualification of the wave front tracking capability of POLCA-T for a pressure wave traveling through the steam line. While the qualification is not for a density wave traversing a fuel bundle, it provides indirect qualification of the code's ability to track wave fronts. Westinghouse will provide results of the requested analyses in response to RAI 6-34.

7.1.11 RAI 6-35

RAI Text

In response to RAI 6-12 the fraction of nominal flow rate was provided for **[ ]** however, the NRC staff requested that the absolute flow rate also be provided. See RAI 6-12. Please supplement the response to RAI 6-12 with the requested information in cases where it is available.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.1.12 RAI 6-36

RAI Text

The purpose of this RAI is to determine the efficacy of POLCA-T to model transient feedback effects that are important to modeling instability events. In the event of a dual recirculation pump trip transient, the core will become unstable following a reduction in feedwater temperature arising from decreased steam flow. Please describe the procedure for selecting an appropriate lower plenum nodalization to ensure sufficiently accurate modeling of mixing and flow distribution to the core.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. The NRC staff is requesting that Westinghouse evaluate if the DR is sensitive to the distribution of enthalpy (individual bundle inlet subcooling), considering flow effects in the lower plenum that may result in an uneven radial distribution of enthalpy. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.1.13 RAI 6-37

RAI Text

The purpose of this RAI is to understand the sensitivity of POLCA-T predicted DRs to potential uncertainty in gas gap properties. Please perform a sensitivity analysis to show the sensitivity of both the fuel thermal time constant and DR to the gas gap properties. If the results indicate that the DR is highly sensitive, please provide additional information regarding the qualification of STAV for high burnup.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. The gas gap properties are an important factor in the fuel thermal time constant, and is therefore a factor affecting the coupling between the neutron power and the fluid conditions. The coupling between the neutron power and fluid conditions has a direct impact on the determination of the DR.

7.2 Request for Additional Information 7: Control Rod Drop Accident

7.2.1 RAI 7-1

RAI Text

Provide specific details regarding the qualification of PHOENIX4 in regards to determining the Doppler worth attributed to plutonium absorption during CRDA at the end of cycle (EOC). First, describe specific qualifications of the PHOENIX4/POLCA7 code suite to determine the buildup of plutonium under voided depletion in the upper regions of a BWR code. Provide any sensitivity in the code's capability to conditions affecting spectrum hardness (control state, bypass voiding, high power density operation, and low flow conditions). Provide comparisons of the plutonium Doppler worth contribution against benchmarks or more sophisticated transport methods to demonstrate adequate cross section collapsing.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.2.2 RAI 7-2

RAI Text

Describe the xenon condition at the start of the CRDA transient analysis. Is the assumed xenon condition conservative?

Discussion Summary

Westinghouse described the control rod candidate selection process for determining limiting control blades. The screening criteria are based on the **[** **]** The **[** **]** are included to account for effects from limiting **[** **]** The **[** **]** in the bounding analyses are conservative.

Westinghouse will perform sensitivity calculations to demonstrate that the **[**

] Westinghouse will transmit the results of these analyses with the response to RAI 7-2.

7.2.3 RAI 7-3

RAI Text

Towards the EOC some BWRs have a positive moderator temperature coefficient at cold zero power conditions. Does the POLCA-T method account for this effect?

Discussion Summary

No modifications are made to the POLCA-T kinetics solver or conditions imposed on the fluid conditions during CRDA analyses. Therefore, the POLCA-T kinetics solver will explicitly track all reactivity feedback mechanisms and the POLCA-T thermal-hydraulic solver will calculate the change in moderator temperature during the transient simulation. **[**
] Therefore, any impact on the transient response from positive moderator temperature reactivity is explicitly calculated by POLCA-T during CRDA analyses. Westinghouse will provide a response to this effect.

7.2.4 RAI 7-4

RAI Text

The sensitivity study in A.5.1.3 concludes that the peak fuel enthalpy is insensitive to the delayed neutron fraction within 20 percent. The TR states that this is consistent with the previously approved method (RAMONA-3B SCP2). Please reconcile the statement in the subject TR with the figure produced in A.3-1 of CENPD-284-P-A (Reference 5). Refer to BNL-NUREG-66230 and BNL-NUREG-67430, describe those aspects of the POLCA-T methodology that result in insensitivity to delayed neutron fraction while previous sensitivity studies indicate a large sensitivity to delayed neutron fraction.

Discussion Summary

The NRC staff and Westinghouse had extensive conversations regarding the sensitivity of the dynamic response to the delayed neutron fraction. The Appendix B sensitivity study indicates that the POLCA-T dynamic response is insensitive to the delayed neutron fraction. In the NRC staff's opinion, the delayed neutron fraction is a measure of the responsiveness of the reactor power to changes in reactivity, a larger delayed neutron fraction results in power changes to reactivity changes that are milder than for cases with smaller delayed neutron fractions. Regarding CRDA and delayed neutron fraction, the NRC staff requires Westinghouse's clarification. For example, the NRC staff expects an increase in the delayed neutron fraction for a given control blade worth would result in a milder transient increase in local power during a CRDA, and subsequently lower fuel enthalpy.

Westinghouse attributes the difference in the sensitivity between POLCA-T and RAMONA to the RAMONA modeling of the delayed groups and nodal cross sections based on POLCA4/PHOENIX2 methods. Westinghouse stated that the delayed neutrons may be higher or lower in worth at cold conditions based on the spectrum. The NRC staff notes that the delayed neutron first flight spectrum is softer than the fission spectrum, however, finds that the predominance of the delayed neutrons are still very high in energy when released and that there is a significant slowing down source in-core during CRDA since the coolant is purely liquid. Based on the conditions – which minimize epithermal capture - the NRC staff requires additional explanation from Westinghouse.

Westinghouse will provide a detailed response to RAI 7-4 addressing the calculational results and including a discussion of the basic kinetic phenomena.

7.2.5 RAI 7-5

RAI Text

Considering that a reactor may experience an unplanned shutdown and subsequent startup from a mid-cycle core exposure condition, describe those aspects of the determination of the limiting initial conditions and candidate limiting control rods that accounts for core cycle exposure.

Discussion Summary

Westinghouse explained that the candidate selection process, provided as an example in the Appendix A of the TR, is the methodology for determining the limiting initial conditions and control blades. The selection process explicitly considers cycle exposure according to Section A.4.3.2 of the TR. Westinghouse will provide this clarification as a response to RAI 7-5.

7.2.6 RAI 7-6

RAI Text

CENPD-390-P-A (Reference 9) includes several cold critical eigenvalue calculations for various plants over several cycles. Using the cold critical eigenvalues and associated plant data, quantitatively justify the use of a 5 percent uncertainty value (at the 95 percent confidence level) for the control rod worth uncertainty in the subject uncertainty analysis.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. The NRC staff cannot find a technical basis to justify the control blade worth uncertainty of 5 percent used in the uncertainty analysis. The NRC staff requested that Westinghouse use available cold critical data to quantify the uncertainty in the worth calculation. Westinghouse did not provide the NRC staff additional information at the audit, however, indicated that local critical measurements are made at several European reactors and Westinghouse has access to some local cold critical experimental results.

7.2.7 RAI 7-7

RAI Text

Specify those aspects of the POLCA-T methodology that conservatively account for the negative reactivity during a SCRAM. Specifically address any assumptions regarding the rate of negative reactivity insertion. If a linear approximation is used, justify the use of this approximation.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. Westinghouse specified that SCRAM times are taken for plant specific applications from the plant specific maximum insertion times allowed by Technical Specifications. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.2.8 RAI 7-8

RAI Text

It is the NRC staff's understanding that the PHOENIX4/POLCA7 cross section library is based on ENDF/B-VI. How does the value of the delayed neutron fraction for the principle nuclides compare with what used in RAMONA-3B SCP2?

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.2.9 RAI 7-9

RAI Text

Describe any controls on the time step or other controls in the iterative solution technique that ensure sufficient nuclear power distribution iterations between thermal hydraulic iterations to ensure that the transient pin power distribution is adequately characterized to determine the integrated hot pin energy deposition during CRDAs.

Discussion Summary

Westinghouse explained that the flux and thermal hydraulic solutions are both **[** **]** Westinghouse will respond with additional information regarding the time step selection.

7.2.10 RAI 7-10

RAI Text

Provide descriptive details of the qualification of the POLCA-T pin power reconstruction model. For CRDA high radial peaking across a bundle is expected given the strong local reactivity perturbation as a result of the dropped rod and the highly decoupled nature of the reactor. Provide a confirmatory calculation using predicted CRDA transient results for the peak pin power and compare to the equivalent power predicted by PHOENIX4 using local nodal thermal-hydraulic and control conditions.

Discussion Summary

During a CRDA, the radial flux is expected to be sharply tilted in the bundles surrounding the dropped blade. Westinghouse will perform a color set analysis using PHOENIX4 and compare the results for POLCA-T calculations using pin power reconstruction to qualify the pin power reconstruction model for flux tilts typical of CRDAs. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.2.11 RAI 7-11

RAI Text

As part of the screening for potentially limiting control rods for CRDA does the methodology allow for analyzing an off-center control rod as a representative central control rod?

Discussion Summary

Westinghouse explained that the control blade worth for each rod is **[**

]

7.2.12 RAI 7-12

RAI Text

Recognizing that a larger transient increase in fuel temperature results in an increased Doppler feedback, how is a conservative gap conductance determined for the CRDA? Are the hot and average fuel pins in any particular node modeled using separate STAV calculations? Specifically, does POLCA-T track the fuel burnup dependent gap closure and fission gas release for each pin within a node separately? Comment on the conservatism of the gas gap conductance based on the modeling of the hot pin and the expected trends in Doppler feedback and heat transfer characteristics.

Discussion Summary

Westinghouse explained that POLCA-T includes a **[**
] The nodal reactivity feedback, however, is based on the POLCA7 calculated nodal eigenvalue response surface, which is calculated according to average nodal fuel temperature. In response to RAI 7-12 Westinghouse will provide details regarding the use of the POLCA-T hot rod model for CRDA analysis.

7.2.13 RAI 7-13

RAI Text

Since the Doppler reactivity feedback coefficient decreases in magnitude with increasing fuel temperature, are there potential conditions of operation where a nominal power level above cold zero power may potentially result in larger fuel enthalpies assuming a maximum inlet subcooling. If so, how are these more limiting power levels or conditions established in determining the limiting CRDA scenario?

Discussion Summary

Westinghouse and the NRC staff discussed possible approaches for resolving the RAI 7-13. Westinghouse may respond by providing sensitivity analyses to the initial conditions or by performing an analysis of the maximum change in Doppler coefficient based on a change in coolant temperature up to the point of saturation. The NRC staff finds both approaches to be acceptable.

7.2.14 RAI 7-14

RAI Text

Does the POLCA-T methodology account for changes in the pellet dimensions when determining the reactivity worth of Doppler feedback? Specifically, are radial and axial thermal expansion considered? If not, estimate the uncertainty associated with fuel pellet expansion on the predicted peak fuel enthalpy. This estimate may be based on an analysis using PHOENIX to determine a bias in the Doppler coefficient. Additionally, when evaluating the negative Doppler feedback, does POLCA account for increased resonance absorption in all nuclides? If so, are there any volatile nuclides in the fuel that contribute significantly to the negative reactivity feedback? If so are the release mechanisms for these volatile nuclides considered?

Discussion Summary

[

]

7.2.15 RAI 7-15

RAI Text

Provide additional descriptive details regarding the determination of the initial conditions. Specifically address what process is used to determine the worst single operator failure or which rods are bypassed.

Discussion Summary

During startup, deviations from the banked position withdrawal sequence (BPWS) are allowed. These deviations may be performed by the operator, including the potential to bypass certain blocks in the startup. The approved RAMONA-3B methodology assumes that **[** **]** Section 4.4.2 of Reference 5 describes the method for accounting for bypassed rods. The methodology generally **[** **]** Westinghouse stated that the same method will be adopted for POLCA-T CRDA analyses. Westinghouse will provide a response to RAI 7-15 that describes the method for conservatively capturing the effects of operator actions on CRDAs.

7.2.16 RAI 7-16

RAI Text

Explain the differences between a power and flux SCRAM. Specifically explain what calculation in POLCA-T yields the core power. Is the power based on the integrated total of the rod heat fluxes? Does power refer to simulated thermal power?

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. Westinghouse will provide a response to RAI 7-16 clarifying the definition of these terms.

7.2.17 RAI 7-17

RAI Text

Please clarify the footnote in Table A.3-6. Does the measured peak power in the footnote refer to the time at which the peak power was measured during the experiment? Is the integrated energy based on the integral of the POLCA-T predicted power up until the time that was measured?

Discussion Summary

The fuel enthalpy is calculated based on the integrated power during the transient. The calculated time of peak and the measured time of peak is the time after the drop at which the peak reactor power occurs. For the values in the table, the upper value is the integrated POLCA-T calculated power up until the time when POLCA-T predicts peak power and the lower value is the integrated measured power up until the time when the measured power is highest. Westinghouse will provide this description as a response to RAI 7-17.

7.2.18 RAI 7-18

RAI Text

The NRC staff requires some more details regarding the POLCA-T qualification against SPERT(Special Power Excursion Test)-III-E-core experiments.

Section A.3.2.2 states that the POLCA-T predicted power shapes agree with the SPERT-III-E-core measured power shapes. Please provide the results of the comparison performed as part of this qualification in regards to the comparison of SPERT-III-E-core power shapes.

Additionally, provide a figure that is substantially similar to the graphs in Figure A.3-10 that show the transient results for the case 18 test.

Provide a figure similar to Figure 5.3.16 of CENPD-284-P-A (Reference 5) with data points predicted using POLCA-T.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. Westinghouse will provide the requested figures as a response to RAI 7-18.

7.2.19 RAI 7-19

RAI Text

The NRC staff requires additional clarification in regards to the sensitivity analysis performed on the core mass flow rate. Specifically, is the base case evaluated for a critical control rod pattern? If so, is the control rod pattern adjusted to accommodate criticality at the same power level for the increased mass flow rate? The peak fuel enthalpy is sensitive to the initial power.

Provide a sensitivity analysis to mass flow rate that considers a base case critical rod pattern and nominal flow rate. Without adjusting the rod pattern determine the sensitivity of the peak fuel enthalpy to a small increase in the core mass flow rate.

Discussion Summary

Westinghouse stated that the evaluations were performed at CZP. The core is sufficiently subcritical at the initial conditions that the reactor power does not respond to changes in the core mass flow rate. Westinghouse will provide this clarification as a response to RAI 7-19.

7.2.20 RAI 7-20

RAI Text

In step 1 of the CRDA analysis methodology have different screening criteria been selected for the POLCA-T method, relative to the RAMONA-3B SCP2 method, for concluding that dynamic analyses are not necessary? If so, provide the POLCA-T criteria.

Discussion Summary

Westinghouse stated that the approach for POLCA-T will **[** **]** the RAMONA-3B approach. **[**

] Westinghouse provides description of the methodology as an example in Appendix A of the TR. Westinghouse will clarify the criteria for dynamic evaluations in response to RAI 7-20.

7.2.21 RAI 7-21

RAI Text

The NRC staff requires clarification of the PB2 EOC2 TT test qualification analysis.

(1) How were the axial power profiles in Figures A.3-4 and A.3-5 generated? Is the P1 edit the adapted core power shape as determined by the core monitor? Is the PHOENIX XS plot based on a purely predictive cycle follow calculation using POLCA7?

(2) What is meant by APRM Probes 1 and 2? Does this refer to particular APRM channels?

(3) The NRC staff does not understand table A.3-5 based on the units for each value. Does "m/sec" mean milliseconds?

(4) What is meant by "measured" in Figure A.3-6?

Discussion Summary

For item (1) Westinghouse explained that the **[**

]

The PHOENIX4 cross section data are more accurate than the Penn State University (PSU) XS data because the cross sections incorporate the **[** **]** The PSU XS cross sections were generated for the Organisation for Economic Co-operation and Development (OECD) benchmark analysis. They were developed as a basis for the code validation database. For the benchmark comparisons all participants used the same PSU cross sections. Because of restrictions that universities have regarding the use of CASMO, PSU mapped the core with 38 channels and nodalized the core axially in 24 nodes. The PSU cross sections are not directly generated by CASMO but are instead determined as a response surface based on SIMULATE calculations to capture the effects of depletion. The PSU cross sections were not depleted with explicit modeling of each node, after the first calculations the cross sections were grouped by depletion. The set included results generated for 435 compositions. For more advanced core simulators, depletion is tracked in the 764x24 nodes to model the entire core. The PSU XS case has been presented for "information only."

The PHOENIX4 cases presented are intended to demonstrate the efficacy of the Westinghouse methodology using the upstream cross section generation and POLCA7 full core models. In the analysis Westinghouse started with Cycle 1 and depleted both cycles, so the axial power profile in the figure is based purely on Westinghouse calculational methods.

PHOENIX4/POLCA7 calculations were performed in a purely predictive fashion. Westinghouse examined the code performance against Traversing In-core Probe (TIP) data. The TIP data comparisons were considered as TIP measurements are performed when the reactor power is held at a steady state for a considerable duration. Westinghouse did not use the TIP data to improve the accuracy of the predicted power shapes presented in the TR.

Westinghouse will provide a discussion to this effect as a response to RAI 7-21 item (1).

For item (2) Westinghouse explained that the TR uses language directly the Electric Power Research Institute (EPRI) report on the PB2 EOC2 TT tests. In response to the RAI item, Westinghouse will define these terms.

For item (3) Westinghouse confirmed that m/sec is milliseconds. Westinghouse will provide a response to this effect for RAI 7-21 item (3).

For item (4) Westinghouse will provide a response stating which results are presented based on LPRM measurements.

7.2.22 RAI 7-22

RAI Text

In order to assist the NRC staff in understanding the dynamic reactivity feedback modeling, please provide figures that are substantially similar to Figures A.3-6 through A.3-9 except please shift the curves, so that each transient response is plotted according to a time “zero” that is defined as the time of the initial core exit pressure response.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. Westinghouse will provide the requested figure as a response to RAI 7-22.

7.2.23 RAI 7-23

RAI Text

Section A.3 2.1 paragraph 2 states that POLCA-T simulations were performed for the third turbine test (TT3) test. Please provide the results of this simulation.

Discussion Summary

Westinghouse will revise the statement in paragraph two of the Section A.3.2.1 to state that transient simulations of the TT3 test were not performed. It is acceptable for Westinghouse to provide the revised pages in response to RAI 7-23 prior to issuance of the final revision of the TR. Westinghouse intends to provide results of the TT3 test simulation for the Appendix C transient application.

7.2.24 RAI 7-24

RAI Text

Compute the nodal root-mean-squared (RMS) difference in core power between the POLCA-T generated axial power shape using PHOENX4 cross section with spectral interaction to the P1 edit. Compare this RMS difference to previously established values for nodal power differences quoted in CENPD-390-P-A (Reference 9).

Discussion Summary

In the discussion regarding RAI 7-21, Westinghouse explained that the **[ ]** The P1 edit, therefore, is expected to include some uncertainty associated with the calculational methods employed by the core monitoring software. The intent of the NRC staff’s RAI is to determine whether the inclusion of the **[ ]** adversely affects the uncertainty determination provided in CENPD-390-P-A (Reference 9). In response to RAI 7-24, Westinghouse will verify that the established uncertainties were either (1) determined using the **[ ]**, or (2) remain applicable when the **[ ]**

7.2.25 RAI 7-25

RAI Text

Please describe the methods that are used to evaluate the radiological consequences resulting from fuel failure during CRDAs.

Discussion Summary

The intent of RAI 7-25 is to establish the method by which acceptable radiological consequences are determined. The NRC staff does not intend to review previously approved approaches for determining radiological consequences. The NRC staff understands that the POLCA-T methodology for CRDA analysis calculates the number of damaged fuel rods. Westinghouse will explain in the response to RAI 7-25 how the number of damaged fuel rods as calculated by POLCA-T is used to make a determination regarding the acceptability of the radiological consequences.

7.2.26 RAI 7-26

RAI Text

The fuel cladding damage criterion of 170 cal/gm in Section A.2.4 is applicable only to fuel rods that are below system pressure, please revise the TR to specify an acceptance criterion of 150 cal/gm for fuel rods with internal rod pressures that exceed the system pressure. Please refer to the Appendix B of SRP 4.2 (Reference 31). Provide a description of the aspects of the POLCA-T method that will ensure that uncertainty in the calculated internal rod pressure is conservatively accounted for when determining the number of damaged fuel rods.

Discussion Summary

Westinghouse will revise the TR to include cladding damage criteria that are consistent with the most recent revision of the SRP 4.2. It is acceptable for Westinghouse to provide the revised pages prior to issuance of the final TR revision. The NRC staff discussed the calculation of the rod internal pressure and the comparison of the rod pressure to the system pressure. The NRC staff requested that Westinghouse discuss the draft response with the NRC staff prior to formally submitting a response to RAI 7-26. Particularly, the NRC staff and Westinghouse discussed the uncertainties in the calculation of the rod pressure and the response will address how the criterion for cladding damage is selected based on calculated pressure.

7.3 Request for Additional Information 8: Thermal Hydraulics (T/H)

7.3.1 RAI 8-1

RAI Text

Verify that the critical power correlations included in the POLCA-T dryout correlation library are based on experimental data and not simulated results. Verify that the uncertainties in these correlations are determined from experimental data. The NRC staff will not accept the use of critical power correlations that are not based on experimental data collected from an appropriate full scale test facility. If correlations that are not approved by the NRC exist in the dryout correlation library, what controls exist to ensure these correlations are not used in licensing calculations? Please provide a table which contains (1) the dryout correlations in the library, (2) the fuel design that the correlation is applicable to, (3) whether this correlation has been reviewed and approved by the NRC, and (4) the source of the experimental data used to determine the correlation.

Discussion Summary

The NRC staff's RAI 8-1 is related to the calculation of the CPR. As the current application of POLCA-T does not extend to transients or **[ ]** the NRC staff does not require the requested information to complete its review of the application of POLCA-T to CRDA or stability analyses. Westinghouse will provide a commitment to address RAI 8-1 in the Appendix C transient submittal or the POLCA-T TR **[ ]**

7.3.2 RAI 8-2

RAI Text

The NRC staff requires additional information regarding the H1 and H6 heat transfer coefficient correlations. The film temperature is determined using a different method. Please comment on the different implementation of these models for POLCA-T relative to GOBLIN.

Discussion Summary

Westinghouse explained that the film temperature calculation in POLCA-T is based on the **[ ]** whereas the GOLBIN calculated film temperature is based on the **[ ]** The GOBLIN code constrained the vapor temperature at **[ ]** and did not allow calculation of superheated vapor. The POLCA-T model is more flexible in its **[ ]** Therefore, the update is required to account for cases where the POLCA-T predicted **[ ]** Westinghouse will provide a response to this effect to resolve RAI 8-2.

7.3.3 RAI 8-3

RAI Text

Please provide a more detailed heat transfer regime map. In general, the flow regime changes within each temperature range will dictate the heat transfer characteristics, please provide a more detailed figure, or series of figures, that in each temperature range shows the applicable heat transfer coefficient correlation as a function of the Reynolds number as well as void fraction. Specify the applicable range for each correlation and mark where interpolation is performed between different Reynolds numbers.

Discussion Summary

Westinghouse and the NRC staff discussed the heat transfer regime map currently provided in the TR Figure 11.1-1. The NRC staff requires more detail to understand the execution of the POLCA-T methodology. Particularly, certain areas of the current map state that several heat transfer correlations are used. **[**

] but the map does not describe how these correlations are selected or if they are ever interpolated. Westinghouse will provide a more detailed description of the heat transfer correlation use in POLCA-T as a response to RAI 8-3.

7.3.4 RAI 8-4

<u>RAI Text</u>

The NRC staff does not find that the current countercurrent flow limitation correlation adequately bounds the available data to justify use of the correlation for SVEA-96 Optima2 fuel designs. Please refer to WCAP-16078-P-A (Reference 39). The hydraulic diameter definition in POLCA-T is consistent with earlier versions of GOBLIN, but is not consistent with the conservative approach proposed in the most recent application. Please revise this model to be consistent with the NRC staff's most recently approved model.

<u>Discussion Summary</u>

Westinghouse agrees that the **[**

] Westinghouse will revise the TR to include the hydraulic diameter model approved in WCAP-16078-P-A (Reference 39). It is acceptable for Westinghouse to provide the revised pages prior to issuance of the final revision.

7.3.5 RAI 8-5

<u>RAI Text</u>

Please compare the DF01 and DF02 void quality correlations to the AA78 void quality correlation, please compare the extent of the database in terms of void fraction, pressure, and mass flux used in the development of each correlation. Please refer to WCAP-16606-P-A (Reference 40). Using the same SVEA-96 test data quantify the uncertainty in the DF01 and DF02 void quality correlations and provide tables substantially similar to Table 3-3. Please also comment on the expected range of pressures that these correlations are applicable to. Justify the future application of the DF01 and DF02 void quality correlations to void fractions above 90 percent and to pressures above 9MPa.

<u>Discussion Summary</u>

The NRC staff and Westinghouse discussed the intent of RAI 8-5. The NRC staff is concerned that extrapolation of the DF01 and DF02 correlations to higher void fractions and pressure may result in an increased error in the predicted void fraction relative to the established uncertainty values. In its review of WCAP-16606-P-A (Reference 40), the NRC staff approved a method for evaluating the extension of the AA78 void quality correlation in BISON. Westinghouse will provide a response to RAI 8-5 adopting the same approach to likewise justify the extension of the DF01 and DF02 void quality correlations.

7.3.6 RAI 8-6

RAI Text

Please provide additional details regarding the formulation of the momentum conservation equation.

(a) Describe the momentum conservation equation, as formulated, when calculating pressure losses along a flow direction that is not vertical.
(b) Describe the models in POLCA-T that calculate the pressure drop across a volume cell representing an elbow in a pipe.
(c) Describe the models in POLCA-T that calculate pressure drops and flow fractions for volume cells that are attached to more than two neighboring cells, specifically explain these models in terms of linked volume cells where flow exiting the volume cell may be either vertical through one exit path or horizontal through another exit path (i.e. a tee).
(d) Describe the application of the momentum equation for mixing volumes, such as a lower plenum with potentially many connecting parallel volume cells.
(e) Please describe how the single fluid formulation of the momentum equation captures the virtual mass effect.
(f) Please rewrite the momentum equation in terms of the two phases, explain how the equation is solved based on volume cell state parameters (such as void fraction, pressure, and phase velocities). It is not clear to the NRC staff how the single fluid properties are determined.
(g) Please describe how interfacial shear is treated.
(h) Please describe how the momentum equation is solved when counter current flow is predicted.
(i) Under countercurrent flow conditions the NRC staff does not understand how the one fluid momentum equation allows for accurate convection of momentum and energy between fluid volumes, please provide additional details regarding the momentum and energy associated with each phase and how it is convected.
(j) Please explain how the wetted perimeter fractions are determined.
(k) Please explain the basis, qualification, and coefficient values for the velocity distribution correction factor based on void fraction.
(l) Please provide validation of the single fluid momentum formulation for cases where a large sudden pressure drop results in void formation downstream of the local loss.

Discussion Summary

The NRC staff had several detailed discussions regarding the momentum equation in POLCA-T with Westinghouse. These are summarized in Section 5.3. Westinghouse will provide responses to items (a) through (l).

7.3.7 RAI 8-7

RAI Text

The NRC staff has several questions regarding the momentum equation (see RAI 8-6). To assist the NRC staff in understanding the momentum equation and solution technique please provide a sensitivity analysis that will help the NRC staff to determine whether the model potentially results in momentum errors. This analysis should take a complex model, as included in the qualification studies in the Appendices. Please initialize this model such that there are no energy sources (set core power to zero, set all boundary conditions to no flow boundary conditions, and remove all pump work), additionally please set the initial fluid conditions to purely liquid at uniform pressure with a relatively high degree of subcooling with zero initial velocity. Under these conditions there should not be a driving force for fluid flow. Please run a transient calculation. Verify that there are no residual momentum sources by checking the mass flow rate. If there is a feature in POLCA-T that would allow a similar calculation to address the NRC staff's concern, it is acceptable to provide the results of this alternative analysis.

<u>Discussion Summary</u>

Westinghouse stated that several calculational cases were compared to analytical results during POLCA-T testing. Westinghouse stated that several of these cases may be provided in the response to RAI 8-7 as verification that residual momentum sources do not appear in the POLCA-T models. The NRC staff specifically requested that a complex model be evaluated – such as a full plant model. Westinghouse agreed that the calculation requested in RAI 8-7 would serve to demonstrate that the momentum equation did not produce residual momentum sources. Westinghouse will evaluate potential means for addressing the NRC staff concern and supply a response to RAI 8-7.

7.3.8 RAI 8-8

<u>RAI Text</u>

The NRC staff has several questions regarding the use of the component models that were previously reviewed and approved as part of the BISON methodology.

With use of the PARA steamline model, the user has the flexibility of modeling valves and control system functions through the use of user supplied tables and control systems. Modeling of these systems greatly affects the amount of conservatism in the transient outcome for certain event analysis. Provide justification for these user controlled items to assure conservatism in licensing applications.

In regards to the recirculation pump model, provide verification that all previously imposed conditions, limitations, and restrictions are maintained for its use in POLCA-T.

In regards to the steam separator, please compare the POLCA-T model to the BISON model with increased L/A or previously referenced qualification data, such as **[**
]

<u>Discussion Summary</u>

Westinghouse will provide additional details regarding the use of historical models in response to RAI 8-8. Westinghouse will also provide the results of full scale testing performed on steam separators to qualify the POLCA-T model.

7.4 Request for Additional Information 9: Power

7.4.1 RAI 9-1

RAI Text

Please provide additional descriptive details of the power generation model. Following a reactor SCRAM the power generation includes sources from transient fission power (during the rod insertion and from delayed neutrons), fission product decay, actinide decay, decay of structural activation products, heat transfer from vessel internals, and exothermic energy release from metal-water reactions. Please discuss the models and capabilities of POLCA-T in regards to each of these heat sources.

Discussion Summary

Westinghouse provided documentation of the implementation of the **[** **]** in POLCA-T (see Section 5.4). Westinghouse will provide a response to RAI 9-1, describing the heat capacity models for structural components. The NRC staff will defer to the review of the metal water reaction calculations to the Appendix D ATWS review.

7.5 Request for Additional Information 10: Control Systems

7.5.1 RAI 10-1

RAI Text

Please provide additional details regarding the modeling of control systems. In particular please describe how POLCA-T models control systems with proportional integral derivative controllers.

Discussion Summary

Westinghouse will provide additional descriptive details in response to RAI 10-1. The details will also describe how mathematical manipulations are performed on signals in the control system model.

7.5.2 RAI 10-2

RAI Text

For most BWR designs, the feedwater control system has an option for three element control, how are similar control systems (with more than one input signal) modeled in POLCA-T?

Discussion Summary

Westinghouse will provide a discussion of the control system model equations in response to RAI 10-2 and will in particular describe the means for modeling three element control systems for feedwater control.

7.6 Request for Additional Information 11: Fuel Rod Model

7.6.1 RAI 11-1

RAI Text

Section 14. (First paragraph)

The introductory paragraph states: “This simulation only uses the thermal hydraulic environment for the average rod to calculate maximum temperatures when an internal peaking factor is set for this hot rod.”

Please clarify use of average environment for maximum temperature. Is it not possible for the local “hottest rod” environment to be hotter than the average environment?

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff’s understanding that the information supplied to respond to this RAI will be adequate.

7.6.2 RAI 11-2

RAI Text

Section 14.1.1

1. Please verify if surface temperature of the cladding (T_C) refers only to the surface in contact with the fuel (i.e. the inner surface of the cladding), or if the temperature is modeled as a constant across the cladding thickness.
2. Equation 14.2 is incorrect.
    (a) Please demonstrate that this is, or is not, a typographical error.
    (b) Provide documentation that the error does not exist anywhere in the source code.

Please present calculations and corresponding test data for comparison

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response.

Westinghouse performed a preliminary investigation of this issue during the audit. They determined that there is a typographical error in equation 14.2 in the TR. Therefore, if this information is provided as the response to this RAI, the remedy will require a submission or a revised TR to correct the error. It is the NRC staff’s understanding that the information supplied to respond to this RAI will be adequate if it is accompanied by submission of a TR revision to correct any typographical errors in equation 14.2. It is acceptable for Westinghouse to respond to this RAI by providing revised pages of the TR prior to final issuance of the revision with the NRC staff's SE attached.

7.6.3 RAI 11-3

RAI Text

Section 14.1.3 and 14.2 states POLCA-T can be applied to either UO_2 or (U,Gd) O_2.

1. For $(U,Gd)O_2$, please present relevant fuel cracking data inputs to the code to demonstrate that POLCA-T predicts correct results for this fuel.
2. If the code is intended for MOX or any other fuel, please present similar information.
3. Please justify why pellet cracking is important to section 14.1.3, yet in section 14.2, " Pellet cracking is not considered explicitly."
4. Please explain how the effect of pellet cracking is taken into account. Be specific for each fuel, UO_2 and $(U,Gd)O_2$.
5. Please enumerate code limitations due to the non-consideration of fuel restructuring.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

There was some clarification provided by the NRC staff that question 11-3 (5) is similar to the preceding question 11-3 (4) and the responses may be similar in content.

7.6.4 RAI 11-4

RAI Text

Section 14.2.3

1. Will the POLCA-T code be applied to $UGd_{>12\%}O_2$?
2. If so, please present the justification including the correct use of the coefficient of thermal expansion at transient temperatures.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.6.5 RAI 11-5

RAI Text

Section 14.2.4

1. Please identify where the degree of pellet cracking is applied in the calculation of fission gas release from the pellet.
2. If it is not considered, please justify the reasoning.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.6.6 RAI 11-6

RAI Text

Section 14.3

1. The material is stated to be zircalloy. Please identify all specific alloys to which POLCA-T will be applied.
2. If Zirlo, Optimized Zirlo, or any alloys other than Zircaloy-2 and Zircaloy-4:
   (a) Please explain hydrogen pick-up in cladding as modeled in POLCA-T.
   (b) Present test data to verify code predictions.
   (c) Please show test data to explain any hydrogen pick-up data differences between Westinghouse results and similar tests performed at Argonne National Laboratory.
3. Please explain why thermal expansion is anisotropic, while elasticity, plasticity, creep and growth are all isotropic.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.6.7 RAI 11-7

RAI Text

Section 14.3.1

1. An equation (14.60) is given for the "alpha phase." Please identify if the alpha phase is for zirconium, zircalloy-4 or something else.
2. Are there no other phases or metastable phases present in any materials to which POLCA-T will be applied?

3. If other phases are present, then please explain why this single equation is sufficient to properly calculate thermal expansion.
4. Equation 14.60 is stated to be valid from room temperature to 1073K. Please verify that POLCA-T will not be used to predict phenomenon above 1073K. If it is used higher temperatures, please justify its use.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.6.8 RAI 11-8

RAI Text

Section 14.3.2

1. Please explain the cold work parameter, C_3.
2. C_3 appears to be a constant value, not a variable. Please explain if it is constant or variable, and justify its use as such especially in reference to time-temperature annealing of cold work.
3. Please state why cold work has a default value of zero.
4. After equation (14.68), to what does the term "(3.23)" refer? Please explain.
5. Again, please explicitly identify "zircaloy" in these equations.
6. Please provide test data to compare with calculations.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.6.9 RAI 11-9

RAI Text

Section 14.3.3: Poisson's ratio for isotropic materials is employed for cladding.

1. If this equation is employed in the code, demonstrate (provide metallographic and/or directional mechanical properties test data) that POLCA-T modeled claddings are isotropic (i.e. any forming processes such as rolling, extrusion, pilgering, or others do not introduce any anisotropic properties, such as, in particular, texture).
2. Please compare code calculations to experimental data.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.6.10 RAI 11-10

RAI Text

Section 14.3.4:

> Please justify the three dimensional validity of equation (14.70), especially in regard to the statement that thermal expansion is anisotropic, while all other properties are not.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response.

In light of the physical properties issues raised in RAI 11-6 (3), the NRC staff has determined **[**

] It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.6.11 RAI 11-11

RAI Text

Section 14.3.5:

1. The subscript, φ, is not clearly defined. Please explain what it represents.

2. Since POLCA-T is a 3-D code, please explain why cladding elastic deformation is modeled in only two dimensions.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response.

Westinghouse provided a satisfactory, verbal explanation of this question, and it is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.6.12 RAI 11-12

RAI Text

Section 14.4:

1. Cladding reaction with coolant is alloy-specific. Please appropriately identify any and all alloys.
2. For each alloy identified in (1) immediately above, please verify the validity of this section's equations versus experimental data.
3. Please justify why the Baker-Just model is adequate for POLCA-T.

4. Is the Cathcart-Pawel model not applicable or necessary?
5. The first sentence of this section refers to Baker-Just; the second to last sentence of this section refers to Cathcart-Pawel for values of constants. Please clarify.
6. Please explain why cladding thermal properties do not change as oxide layers develop.

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

7.6.13 RAI 11-13

RAI Text

Section 14.5:

1. Please explain the values for "a" and "b" in equation 14-84, which are taken from Reference 14.8. Why are they appropriate?
2. Please explain the data fit in the alpha region.
3. Justify the linear interpolation in "a" and "b" when used in the lower and upper halves of the ά+β region.
4. For the sentence, "The burst stress for the double layer has been determined from a data point in Reference 14.4 that implicitly gives the value 113 MPa at 1170 °C and assuming the same decay constant "b" as for 3-phase zircaloy."
   (a) Please identify the data point.
   (b) Explain if the data point is justifiably used because it is one point in a well obtained data set.
   (c) Since this is a double layer, why is only the β-phase constant value for "b" assumed?
   (d) Does not the constant "b" vary between alloys?
   (e) To which alloys is this application of the constant "b" being made?

Discussion Summary

Westinghouse had discussions with the NRC staff to ensure that there were no unclear issues with this question, or proposed response. It is the NRC staff's understanding that the information supplied to respond to this RAI will be adequate.

8 FINDINGS

The NRC staff has documented several findings in this audit results summary report. This section provides a summary of those findings. The NRC staff's findings are organized according to: (1) deferred review items, (2) TR revisions, (3) open items and request for additional information, and (4) quality assurance.

8.1 Deferred Reviews

Deferred review refers to information that the NRC staff has requested that was found to be irrelevant to the scope of the current review. In many cases the NRC staff requested information regarding items involving the determination of the CPR. During the audit, Westinghouse clarified that the scope of the current TR application of POLCA-T for stability does not extend to **[ ]** and therefore, the calculation of the CPR is peripheral to the current application.

Therefore, the NRC staff defers the review of responses to RAIs regarding critical power to review of either the Appendix C transient application or to review of the application of POLCA-T to **[ ]** The NRC staff review and approval of the TR will not constitute NRC staff acceptance of the responses provided to the RAIs listed in this section.

8.1.1 RAI 2-3

RAI 2-3 is in regards to the CPR correlations. The basis for the NRC staff deferral of review is documented in Section 6.2.

8.1.2 RAI 3-2

RAI 3-2 is in regards to the APRM and OPRM response under bypass void conditions. The basis for the NRC staff deferral of review is documented in Section 6.3.

8.1.3 RAI 5-4 and RAI 5-5

RAI 5-4 and RAI 5-5 are in regards to burnup and power distribution sensitivities of the minimum critical power ratio. The basis for the NRC staff deferral of review is documented in Section 6.11.

8.1.4 RAI 8-1

RAI 8-1 is in regards to the dryout correlation library in POLCA-T. The response to RAI 8-1 is not required for the staff to complete its detailed technical review considering the scope of application of POLCA-T for stability analysis. Westinghouse will address the NRC staff's RAI in the application to transients in Appendix C or to the application of POLCA-T for **[ ]** The basis for the NRC staff deferral of review is documented in Section 7.3.1.

8.1.5 RAI 9-1

RAI 9-1 is in regards to the models for predicting the transient power. Several sources of heat are present during transient evaluations. In the scope of the current review for CRDA analyses and for stability evaluation, significant fuel heat up resulting in exothermic metal water reactions does not occur. Therefore, the NRC staff does not require the specific model details for the metal water reaction to complete its detailed technical review of POLCA-T application for CRDA analyses or stability evaluations. The NRC staff does require, however, that all other heat sources be addressed in response to RAI 9-1. Therefore, the NRC staff partially defers review of the metal water reaction portion of RAI 9-1 to the review of POLCA-T for ATWS in Appendix D. The basis for the NRC staff deferral of review is documented in Section 7.4.1.

8.2 <u>TR Revisions</u>

The NRC staff identified several errors in the TR documentation during the course of its audit. In some cases, the errors were in the representation of mathematical descriptions of the physical models. In other cases, the numerical results of the calculations performed in the qualification of the POLCA-T code were found to be in error. These items must be revised for the TR to be consistent with the methodology and qualification under review by the NRC staff.

In all cases, the revisions to the TR may be provided as RAI responses indicating the revision on selected pages of the TR. The final revision may be issued with the NRC staff's SE attached.

8.2.1 Stability Applicability

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Section 3.2.1 provides the basis for the TR revision.

8.2.2 Control Rod Drop Fuel Enthalpy Calculation

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] Section 3.2.2 provides the basis for the TR revision.

8.2.3 Decay Ratio Acceptance Criterion

Westinghouse will provide a supplemental response to RAI 6-16 specifying an acceptance criterion for the DR that is at least **[** **]** less than unity. The final revision of the TR will revise the DR acceptance criterion to reflect a margin of at least **[** **]** Section 66.14 provides the basis for the TR revision.

8.2.4 Peach Bottom Turbine Trip Test 3

The TR contains a misleading statement regarding the Peach Bottom qualification in Appendix A. The statement will be revised in the updated TR. Section 7.2.23 provides the basis for the TR revision.

8.2.5 Fuel Damage Criteria

The fuel damage criteria in the TR Appendix A are not consistent with the criteria specified in SRP 4.2. The TR revision will specify consistent criteria. Section 7.2.26 provides the basis for the TR revision.

8.2.6 Hydraulic Diameter Calculation

During its review the NRC staff identified an **[**
] Section 7.3.4 provides the basis for the TR revision.

8.2.7 Radiation Heat Transfer

During its review the NRC staff identified an error in Equation 14.2 describing radiation heat transfer. Correction of this error will require revision to the TR. Section 7.6.2 provides the basis for the TR revision.

8.3 <u>Open Items and RAIs</u>

The NRC staff has marked the open items identified during the course of its audit in the body of this report. This section provides a summary of those open items. The NRC staff has identified a total of nine open items. The NRC staff has issued RAI 4-11 requesting that Westinghouse address these open items. The open items are presented in this section in the order they are documented in this report. The open items were assigned numbers based on the order they were discussed at the audit exit meeting held on March 20, 2008.

8.3.1 Stability Applicability (Open Item 7 listed in Section 1)

Open Item from Section 3.2.1: Westinghouse will revise Appendix B of the TR to **[**

] The update to the TR will also address the precise time domain stability methodology in greater detail due to the sensitivity of the analyses to particular modeling options and inputs. It is acceptable for Westinghouse to respond to this open item by providing revised pages of the TR prior to final issuance of the revision with the NRC staff's SE attached.

8.3.2 POLCA7 Code Changes (Open Item 9 listed in Section 1)

Open Item from Section 3.2.1: Westinghouse will provide an assessment of the impact of the POLCA7 code changes on the results of analyses performed using the approved BISON and RAMONA codes to ensure that these codes are not adversely affected.

8.3.3 Control Rod Drop Fuel Enthalpy (Open Item 6 listed in Section 1)

Open Item from Section 3.2.2: Westinghouse will revise the TR documentation. Westinghouse will provide a description of the **[**

] It is acceptable for Westinghouse to respond to this open item by providing revised pages of the TR prior to final issuance of the revision with the NRC staff's SE attached.

8.3.4 POLCA-T Oxide Layer Thickness (Open Item 8 listed in Section 1)

Open Item from Section 5.2: Westinghouse will provide the NRC staff additional information detailing how the initial oxide layer thickness is determined. Westinghouse will also provide the NRC staff with the details of the method for inputting the oxide layer thickness into the POLCA-T input.

8.3.5 RAI 3-5 (Open Item 1 listed in Section 1)

Open Item from Section 6.4: Westinghouse will provide comparisons of the **[ ]** with POLCA-T calculations to qualify the heat transfer correlations as a supplemental response to RAI 3-5.

8.3.6 RAI 4-8, RAI 6-3, and RAI 6-20 (Open Item 2 listed in Section 1)

Open Item from Section 6.8: In the response to RAI 4-8, Westinghouse has provided general information regarding the time step control algorithm in POLCA-T. However, the NRC staff requires information regarding the controls that will be in place for POLCA-T stability calculations.

In response to RAI 6-26, Westinghouse will provide an integrated response to address not only the axial nodalization controls, but also those controls that are required in addition to nodalization controls, that ensure accurate density wave oscillation modeling without numerical damping. The integrated response will address concerns expressed in RAI 4-8, RAI 6-3, RAI 6-20, and RAI 6-26 which each deal with separate elements of the overall numerical solution technique as applied for time domain stability analyses.

8.3.7 RAI 5-1 (Open Item 3 listed in Section 1)

Open Item from Section 6.9: Westinghouse will supplement the response to RAI 5-1 with additional qualification information. This qualification information will contain additional details of integral test qualifications. The qualification analyses and discussion will be sufficient in scope and detail to indirectly provide qualification of the separate effect of transient void prediction using the void-quality correlation.

8.3.8 RAI 6-5 (Open Item 4 listed in Section 1)

Open Item from Section 6.13: Westinghouse will supplement the response to RAI 6-5 with additional details describing the means by which the **[ ]** is determined.

8.3.9 RAI 6-16 (Open Item 5 listed in Section 1)

Open Item from Section 6.14: Westinghouse will provide a supplemental response to RAI 6-16 specifying an acceptance criterion for the DR that is at least **[ ]** less than unity. The final revision of the TR will revise the DR acceptance criterion to reflect a margin of at least **[ ]**

RAI 4-11

The staff has issued RAI 4-11. The RAI text is provided for completeness below.

RAI Text

Please address all open items listed in the summary of the POLCA-T audit conducted by NRC between March 17, 2008 and March 20, 2008.

8.4 Review Results of the Quality Assurance Program

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The NRC staff conducted a detailed review of these procedures and found that the procedures meet the 10 CFR 50 Appendix B requirements for quality assurance, including meeting the minimum requirements for design control, document control, software configuration control and testing, and corrective actions.

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Appendix A : Audit Documents

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