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May 14, 2004

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U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Sir / Madam:

Subject: VIRGIL C. SUMMER NUCLEAR STATION
DOCKET NO. 50/395
OPERATING LICENSE NO. NPF-12
ECCS EVALUATION MODEL REVISIONS ANNUAL REPORT

Attached is the 2003 Emergency Core Cooling System (ECCS) Evaluation Model Revisions Annual Report for the Virgil C. Summer Nuclear Station (VCSNS). This report is being submitted pursuant to 10CFR50.46, which requires licensees to notify the NRC on at least an annual basis of corrections to or changes in the ECCS Evaluation Models.

Summary sheets describing changes and enhancements to the ECCS evaluation models for 2003 are included in Attachment I.

Peak Clad Temperature (PCT) sheets are included in Attachment II. All necessary revisions for any non-zero, non-discretionary, PCT change to Section C have been included. Any plant specific errors in the application of the model for 2003 will also be provided in Section C with discussion enclosed or cited.

If you have any questions, please call Mr. Arnie J. Cribb, Jr. at (803) 345-4346.

Very truly yours,

Stephen A. Byrne

AJC/SAB/dr
Attachments

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DMS (RC-04-0072)

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Document Control Desk
Attachment I
L-99-0152
RC-04-0072
Page 1 of 17

Attachment 1

Changes and Enhancements to the ECCS Evaluation Models for 2003

Document Control Desk
Attachment I
L-99-0152
RC-04-0072
Page 2 of 17

Non-Discretionary Changes with PCT Impact
NOTRUMP Bubble Rise/Drift Flux Model Inconsistencies

Non-Discretionary Changes with No PCT Impact
BART Quench Model Calculations
BASHER Calculation of BASH Metal Heat Inputs
Inconsistencies in Vessel Geometric Input Data
LOCBART Fuel Rod Plenum Modeling
LOCBART Grid Mass Balance
NOTRUMP Drift Flux Model Inconsistencies
NOTRUMP Inverted T-Node Sign Convention
NOTRUMP Vapor Region Formation Logic
SBLOCTA Burst Logic
SBLOCTA ZIRLO™ Cladding Creep Constants

Enhancements/Forward-Fit Discretionary Changes
SATIMP/SPADES Updates
SBLOCTA Oxide-to-Metal Ratio
SBLOCTA Gap Conductance Model
General Code Maintenance (Appendix K)

NOTRUMP BUBBLE RISE/DRIFT FLUX MODEL INCONSISTENCIES

Background

NOTRUMP was updated to resolve some inconsistencies in several drift flux models as well as the nodal bubble rise/droplet fall models. In summary, these changes include: bubble rise and droplet fall model calculations were made consistent with flow link calculations. Corrections were made to limits employed in the vertical counter-current flooding models. Checking logic was added to correct situations where drift flux model inconsistencies could result (i.e. prevent liquid flow from an all-vapor node and vapor flow from all-liquid node). Also, a more rigorous version of the Yeh Drift Flux Model was implemented since the previous version of this model was incorrectly restricted to a 50% void fraction limit. These changes represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

Representative plant calculations using the NOTRUMP code demonstrate that the implementation of these corrections leads to a bounding 35°F increase of the calculated PCT for 10 CFR 50.46 purposes.

Plant Specific Text

An evaluation was performed to identify PCT margin in previously assigned model assessment and safety evaluation PCT allocations. This evaluation was based on plant-specific calculations and current computer code versions. The evaluation demonstrated that there is conservatively 35°F of available PCT margin in previously assigned model assessment and safety evaluation PCT allocations. Since 35°F of margin is available to offset the 35°F NOTRUMP Bubble Rise / Drift Flux Model Inconsistency Corrections PCT penalty, SPIKE calculations are not required and the previous Burst-and-Blockage / Time-in-Life PCT penalty remains applicable. The margin recovery benefit is reported in Section E.

Document Control Desk
Attachment I
L-99-0152
RC-04-0072
Page 4 of 17

BART QUENCH MODEL CALCULATIONS

Background

BART is used to perform the core reflood heat transfer calculations in BASH and LOCBART. The BART portions of BASH and LOCBART were updated to resolve some minor logic problems that led to anomalous behavior in the quench model. These changes represent Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

Sample BASH and LOCBART calculations demonstrated that these changes have either no effect or a negligible effect on the core inlet flooding rate and PCT and will be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

BASHER CALCULATION OF BASH METAL HEAT INPUTS

Background

BASHER is used to generate the plant-specific input models for BASH. Some minor errors were discovered in the calculation of geometric terms used with the BASH metal heat model. As discussed below, it was determined that correcting these errors would have a negligible effect on results, so BASHER updates will be deferred to a future code release. When corrected, these changes will represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

The changes described above are small and are considered to have a negligible effect on BASH results. These changes will be deferred to a future code release and are assigned a 0°F PCT impact for 10 CFR50.46 reporting purposes.

INCONSISTENCIES IN VESSEL GEOMETRIC INPUT DATA

Background

Several inconsistencies were identified in the specification of vessel geometric data for plant-specific input models. These changes were evaluated for impacts on current licensing-basis analyses, and will be incorporated into the corresponding input databases on a forward-fit basis. These changes represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1981 Westinghouse Large Break LOCA Evaluation Model with BASH
1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

A combination of sensitivity calculations and engineering evaluation led to the conclusion that the identified changes have a negligible effect on large and small break LOCA analysis results. These changes will therefore be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

Document Control Desk
Attachment I
L-99-0152
RC-04-0072
Page 7 of 17

LOCBART FUEL ROD PLENUM MODELING

Background

A LOCBART calculation performed under non-standard conditions predicted burst to occur in the fuel rod plenum node. This situation does not occur for standard PWR licensing calculations, and is now precluded for all calculations by bypassing the burst calculations for the fuel rod plenum node. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

This situation does not occur for standard PWR licensing calculations and is assigned a 0°F PCT effect for 10 CFR 50.46 reporting purposes.

LOCBART GRID MASS BALANCE

Background

In the LOCBART spacer grid heat transfer model, a mass balance is applied to ensure that the available liquid can support the predicted wetting. Three discrepancies related to the grid mass balance in LOCBART were discovered and corrected, with a tendency for improved grid wetting in some instances. These changes represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

Sample LOCBART calculations demonstrated that these changes have a negligible effect on PCT that will be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

NOTRUMP DRIFT FLUX MODEL INCONSISTENCIES

Background

NOTRUMP was updated to resolve some inconsistencies in the resetting of certain parameters in the drift flux models when single phase conditions are determined to exist. The previous coding had inadvertently omitted certain conditions on drift velocity and void fraction which are now included. Also, in the node boundary mixture level crossing logic, several partial derivatives for liquid and vapor volumetric fluxes with respect to mass flux in the void fraction model were erroneously set to zero. The correct partial derivative calculations were added to the code. In addition, several instances (stacking logic, accumulator empty logic and pump critical flow logic) where flow link specific volumes were incorrectly always based on saturated conditions were corrected. These changes represent a closely related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The subject changes involve logic that is seldom used in standard EM calculations. As such, the estimated effect on PCT calculations is 0°F for 10 CFR 50.46 reporting purposes.

NOTRUMP INVERTED T-NODE SIGN CONVENTION

Background

This change deals with the correction of the sign convention for inverted T-nodes, which was incorrectly applied via input into the EM. It can potentially impact the reactor vessel lower plenum node and the lower reactor coolant pump node in the standard EM. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

This error affected the mixture/vapor interfacial area within a fluid node. Because these conditions only exist momentarily within the pump stack node and never in the reactor vessel lower plenum, it is judged that the impact of this error correction is insignificant. Based on this judgment, coupled with the fact that plant model calculations show this to be the case, the correction of this error will be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

NOTRUMP VAPOR REGION FORMATION LOGIC

Background

The logic governing formation of a vapor region within a fluid node in NOTRUMP was corrected to allow superheated conditions where appropriate, instead of saturated conditions which may not exist at that instant. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

Typically, region formation conditions in standard EM calculations occur at saturation. If a region is formed at superheat conditions, the amount of superheat is usually small and the region quickly reaches saturated conditions. As such, the nature of these changes leads to an estimated PCT impact of 0°F.

Document Control Desk
Attachment I
L-99-0152
RC-04-0072
Page 12 of 17

SBLOCTA BURST LOGIC

Background

The burst logic in SBLOCTA was updated to preclude burst from occurring at more than one axial elevation on a given rod. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

Most SBLOCTA calculations predict burst at no more than one axial elevation per rod and are therefore unaffected by this discrepancy. For the affected cases, SBLOCTA calculations and/or engineering evaluation led to the conclusion that resolving the discrepancy would not produce an increase in the limiting PCT. This change is therefore assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

SBLOCTA ZIRLO™ CLADDING CREEP CONSTANTS

Background

SBLOCTA was updated to correct two of the constants in the high-temperature creep model for ZIRLO™ cladding, which were found to disagree with the basis documentation. These changes represent a closely related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The changes identified above lead to a small change in the creep rate over a limited range of temperatures, which is considered to have a negligible effect on results and will be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

SATIMP/SPADES UPDATES

Background

SATIMP and SPADES are used to generate the plant-specific input models for SATAN-VI and NOTRUMP, respectively. Some minor improvements were made to SATIMP and SPADES, primarily to provide more rigorous calculations of certain SATAN-VI and NOTRUMP inputs. An example of these changes is to replace linear interpolation with parabolic interpolation in the SATIMP calculation of the reactor coolant pump head at steady-state operating conditions. These changes represent Discretionary Changes that will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

1981 Westinghouse Large Break LOCA Evaluation Model with BASH
1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The nature of these changes leads to an estimated PCT effect of 0°F for both large and small break LOCA.

SBLOCTA OXIDE-TO-METAL RATIO

Background

An option has been added to SBLOCTA to allow conversion of the user-specified zirconium-oxide thickness into equivalent cladding reacted. This adjustment is made during problem initialization, and the cladding outside diameter is modified accordingly. This change represents a Discretionary Change that will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

A sample SBLOCTA calculation showed that this change has a minimal effect on PCT. This change will be implemented on a forward-fit basis and will be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

SBLOCTA GAP CONDUCTANCE MODEL

Background

The convective term in the SBLOCTA pellet-to-cladding gap conductance model was updated for consistency with the corresponding model in LOCBART. Included in this change is the implementation of a PAD-version-specific value of the gap reduction factor, which is specified by the user in the SBLOCTA input file. This change represents a Discretionary Change that will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

Sample SBLOCTA calculations showed that this change has a negligible effect on PCT. This change will be implemented on a forward-fit basis and will be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

GENERAL CODE MAINTENANCE (APPENDIX K)

Background

Various changes in code input and output format have been made to enhance usability and help preclude errors in analyses. This includes both input changes (e.g., more relevant input variables defined and more common input values used as defaults) and input diagnostics designed to preclude unreasonable values from being used, as well as various changes to code output which have no effect on calculated results. In addition, various blocks of coding were rewritten to eliminate inactive coding, optimize the active coding, and improve commenting, both for enhanced usability and to facilitate code debugging when necessary. These changes represent Discretionary Changes that will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

1981 Westinghouse Large Break LOCA Evaluation Model with BASH
1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The nature of these changes leads to an estimated PCT impact of 0°F.

Document Control Desk
Attachment II
L-99-0152
RC-04-0072
Page 1 of 5

Attachment 2

LOCA PCT Sheets for Virgil C. Summer Nuclear Station

Westinghouse LOCA Peak Clad Temperature Summary for Large Break

Plant Name: V. C. Summer
 Utility Name: South Carolina Electric & Gas
 Revision Date: 3/3/04

Analysis Information

EM: BASH Analysis Date: 10/1/95 Limiting Break Size: Cd = 0.4
 FQ: 2.4 FdH: 1.62
 Fuel: Vantage + SGTP (%): 10
 Notes: Analysis-Of-Record was done with FQ=2.50 and FdH = 1.70.

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	2099	1	(a)
MARGIN ALLOCATIONS (Delta PCT)			
A. PRIOR PERMANENT ECCS MODEL ASSESSMENTS			
1. SI Error Reanalysis	-90	2	(a,b)
2. Accumulator Line/Pressurizer Surge Line Data, LOCBART Spacer Grid Single-Phase Heat Transfer Error, LOCBART Zirc-Water Oxidation Error, and Reanalysis of Limiting AOR Case	153	2	(a,c)
3. LOCBART Vapor Film Flow Regime Heat Transfer Error	-15	3	
4. LOCBART Cladding Emissivity Errors	-10	4	
5. LOCBART ZIRLO™ Cladding Specific Heat Model	40	5	
6. PAD 4.0 Initial Pellet Temperatures	-40	5	
B. PLANNED PLANT CHANGE EVALUATIONS			
1. None	0		
C. 2003 PERMANENT ECCS MODEL ASSESSMENTS			
1. None	0		
D. TEMPORARY ECCS MODEL ISSUES			
1. None	0		
E. OTHER			
1. None	0		
LICENSING BASIS PCT + MARGIN ALLOCATIONS	PCT =	2137	

References:

1. CGE-95-0009-SGUL, "Revised Large Break LOCA Results for Upgrading Submittal," October 24, 1995.
2. CGE-99-044, "South Carolina Electric and Gas Company, Virgil C. Summer Nuclear Station, 10 CFR 50.46 BART/BASH Evaluation Model, Mid-Year Notification and Reporting for 1999," September 17, 1999.
3. CGE-00-044, "South Carolina Electric and Gas Company, Virgil C. Summer Nuclear Station, 10 CFR 50.46 Appendix K (BART/BASH/NOTRUMP) Evaluation Model, Mid-Year Notification and Reporting for 2000", June 30, 2000.
4. CGE-00-112, "South Carolina Electric and Gas Company, Virgil C. Summer Nuclear Station, 10 CFR 50.46 BART/BASH Evaluation Model Mid-Year Notification and Reporting for 2000," December 2000.

Westinghouse LOCA Peak Clad Temperature Summary for Large Break

Plant Name: V. C. Summer
Utility Name: South Carolina Electric & Gas
Revision Date: 3 /3 /04

5. CGE-03-12, "10CFR 50.46 Annual Notification and Reporting for 2002," March 2003.

Notes:

- (a) Analysis was done for Delta-75 steam generators and core power at 2900 MWt.
- (b) This plant specific reanalysis addressed the correction of Safety Injection Performance Inputs. These results incorporate the SATAN/LOCTA Fluid Conditions Translation Error and the Accumulator Pressure and Water Volume Uncertainties evaluation, so these PCT penalties are no longer applicable. IFBA fuel is limiting compared to non-IFBA fuel.
- (c) This reanalysis was based on the SI Error reanalysis; modelled a reduction in FQ from 2.5 to 2.4, a reduction in FdH from 1.70 to 1.62, and a reduction in P-bar-HA from 1.514 to 1.443; and addressed the following issues: Accumulator Line/Pressurizer Surge Line Data, LOCBART Spacer Grid Single-Phase Heat Transfer Error, and LOCBART Zirc-Water Oxidation Error. IFBA fuel is limiting compared to non-IFBA fuel.

Westinghouse LOCA Peak Clad Temperature Summary for Small Break

Plant Name: V. C. Summer
Utility Name: South Carolina Electric & Gas
Revision Date: 3 /3 /04

Analysis Information

EM: NOTRUMP **Analysis Date:** 2/1/94 **Limiting Break Size:** 2 inch
FQ: 2.4 **FdH:** 1.62
Fuel: Vantage + **SGTP (%):** 10
Notes: Limiting Break Size shifted from 2 inch to 3 inch (b,d) and FQ reduced from 2.45 to 2.40 (f)

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	1823	1	(a)
MARGIN ALLOCATIONS (Delta PCT)			
A. PRIOR PERMANENT ECCS MODEL ASSESSMENTS			
1. LUCIFER Error Corrections	-16	3	
2. Effect of SI in Broken Loop	150	3	
3. Effect of Improved Condensation Model	-150	3	
4. Axial Nodalization, RIP Model Revision and SBLOCTA Error Corrections Analysis	96	4	
5. Boiling Heat Transfer Correlation Error	-6	5	
6. Steam Line Isolation Logic Error	18	5	
7. NOTRUMP Specific Enthalpy Error	20	6	
8. SALIBRARY Double Precision Error	-15	6	
9. SBLOCTA Fuel Rod Initialization Error	10	7	
10. NOTRUMP Mixture Level Tracking / Region Depletion Errors	13	9	
B. PLANNED PLANT CHANGE EVALUATIONS			
1. Increased Accumulator Pressure and Water Volume Uncertainties	34	2	(b)
2. Annular Blankets	10	2	
3. Main Feedwater Temperature Increase Evaluation	0	10	
C. 2003 PERMANENT ECCS MODEL ASSESSMENTS			
1. NOTRUMP Bubble Rise / Drift Flux Model Inconsistency Corrections	35	12	
D. TEMPORARY ECCS MODEL ISSUES			
1. None	0		
E. OTHER			
1. Burst and Blockage/Time In Life	245	9	(c,e)
2. Margin Recovery (SI Performance Inputs Evaluation)	-36	8	(d)
3. GEDM Evaluation	0	11	(f)
4. Analysis Margin	-35	12	
LICENSING BASIS PCT + MARGIN ALLOCATIONS PCT =	2196		

Westinghouse LOCA Peak Clad Temperature Summary for Small Break

Plant Name: V. C. Summer
Utility Name: South Carolina Electric & Gas
Revision Date: 3 /3 /04

References:

1. CGE-93-0054-SGUL, "SECL-93-036, Rev. 1," March 9, 1994.
2. CGE-99-008, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Annual Notification and Reporting for 1998," March 5, 1999.
3. CGE-94-205, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Notification and Reporting Information," February 8, 1994.
4. CGE-94-228, "South Carolina Electric and Gas Company, Virgil C. Summer Station, SBLOCTA Axial Nodalization," October 27, 1994.
5. CGE-95-201, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Notification and Reporting Information," February 3, 1995.
6. CGE-96-202, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Annual Notification and Reporting," February 9, 1996.
7. CGE-96-213, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Small Break LOCA Notification and Reporting," July 8, 1996.
8. CGE-00-006, "South Carolina Electric and Gas Company, Virgil C. Summer Nuclear Station, 10 CFR 50.46 Annual Notification and Reporting for 1999," February 25, 2000.
9. CGE-00-044, "South Carolina Electric and Gas Company, Virgil C. Summer Nuclear Station, 10 CFR 50.46 Appendix K (BART / BASH / NOTRUMP) Evaluation Model, Mid-Year Notification and Reporting for 2000," June 30, 2000.
10. CGE-00-063, "Safety Evaluation for Increased Main Feedwater Temperature (SECL-00-118)," August 25, 2000.
11. CAB-02-64/NF-CG-02-16, "Cycle 14 Reload Safety Evaluation," March 2002.
12. CGE-03-80, "10 CFR 50.46 Mid-Year Notification and Reporting for 2003," January 2004.

Notes:

- (a) AOR performed for core power = 2900 MWt and Delta-75 steam generators.
- (b) The SBLOCA evaluation for increased accumulator pressure and water volume uncertainties causes the limiting break equivalent diameter to shift from 2-inch to 3-inch. The 34°F value does not include the effect on SBLOCA burst/blockage behavior.
- (c) This assessment is a function of base PCT plus margin allocation and as such will increase/decrease with margin allocation changes.
- (d) The Margin Recovery (SI Performance Evaluation) resulted in a 36 °F PCT benefit. Note that the evaluation considered the 2 inch and 3 inch break and resulted in the limiting break equivalent diameter to remain shifted from 2 inch to 3 inch.
- (e) Value includes previous Burst and Blockage / Time in Life penalty SPIKE Correlation Revision penalty (1999 Annual Report), and consideration of a new penalty due to item C.1 (NOTRUMP Mixture Level Tracking / Region Depletion).
- (f) The reduced AOR GEDMs have been violated during the CGE Cycle 14 Reload Process. An evaluation was performed using default GEDMs and taking credit for a lower PHA of 1.42 and FQ of 2.40. Analysis-of-record was done with FQ=2.45 and PHA=1.443. The evaluation concluded a net zero PCT effect to the Small Break LOCA Analysis.