WOLF CREEK
NUCLEAR OPERATING CORPORATION

Karl A. (Tony) Harris
Manager Regulatory Affairs

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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Reference: Westinghouse Letter SAP-03-23, dated March 7, 2003, Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station Unit 1, 10 CFR 50.46 Annual Notification and Reporting for 2002

Subject: Docket No. 50-482: 10 CFR 50.46 Annual Report of ECCS Model Changes

Gentlemen:

This letter provides the annual report for the Emergency Core Cooling System (ECCS) Evaluation Model changes and errors for the 2002 model year that affect the Peak Cladding Temperature (PCT) for Wolf Creek Generating Station (WCGS). This letter is provided in accordance with the criteria and reporting requirements of 10 CFR 50.46(a)(3)(ii), as clarified in Section 5.1 of WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting." Regulation 10 CFR 50.46(a)(3)(ii) states, in part, "For each change to or error discovered in an acceptable evaluation model or in the application of such a model that affects the temperature calculation, the applicant or licensee shall report the nature of the change or error and its estimated effect on the limiting ECCS analysis to the Commission at least annually as specified in section 50.4. If the change or error is significant, the applicant or licensee shall provide this report within 30 days and include with the report a proposed schedule for providing a reanalysis or taking other action as may be needed to show compliance with section 50.46 requirements."

Wolf Creek Nuclear Operating Corporation (WCNOC) has reviewed the notification of 10 CFR 50.46 reporting information pertaining to the ECCS Evaluation Model changes that were implemented by Westinghouse for 2002 as described in the above Reference. The review concludes that the effect of changes to, or errors in, the Evaluation Models on the limiting transient PCT is not significant for 2002. Therefore, the report of the ECCS Evaluation Model changes is provided on an annual basis.

Attachment I provides an assessment of the specific changes and enhancements to the Westinghouse Evaluation Models for 2002. These model changes and enhancements, except for the change associated with the LOCBART radiation to liquid logic, do not have impacts on the PCT and will generally not be presented on the PCT rackup forms.

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Attachment II provides the calculated Large Break Loss of Coolant Accident (LOCA) and Small Break LOCA PCT margin allocations in effect for the 2002 WCGS evaluation models. The PCT values determined in the Small Break and Large Break LOCA analysis of record, combined with all of the PCT allocations, remain well below the 10 CFR 50.46 regulatory limit of 2200 degrees Fahrenheit. Therefore, WCGS is in compliance with 10 CFR 50.46 requirements and no reanalysis or other action is required.

No commitments are identified in this correspondence.

If you have any questions concerning this matter, please contact me at (620) 364-4038, or Ms. Jennifer Yunk at (620) 364-4272.

Very truly yours,

Karl A (Tony) Harris

KAH/rlg

Attachment I – Assessment of Changes to the Westinghouse Emergency Core Cooling System (ECCS) Evaluation Models for Large and Small Break Loss of Coolant Accidents (LOCA)
Attachment II – Emergency Core Cooling System (ECCS) Evaluation Model Peak Cladding Temperature (PCT) Margin Allocations

cc: J. N. Donohew (NRC), w/a
D. N. Graves (NRC), w/a
E. W. Merschoff (NRC), w/a
Senior Resident Inspector (NRC), w/a

# ASSESSMENT OF CHANGES TO THE WESTINGHOUSE EMERGENCY CORE COOLING SYSTEM (ECCS) EVALUATION MODELS FOR LARGE AND SMALL BREAK LOSS OF COOLANT ACCIDENTS (LOCA)

## BASH-EM TRANSIENT TERMINATION

### Background

A method has been developed to extend BASH-EM transients beyond the point at which downcomer boiling is predicted to occur in BASH by correlating the boiling induced reduction in downcomer driving head to a corresponding reduction in the core inlet flooding rate. This approach, which is referred to as the LOCBART transient extension method, is used to ensure adequate termination of the fuel rod cladding temperature and oxidation transients predicted by LOCBART as required to demonstrate compliance with the pertinent acceptance criteria of 10 CFR 50.46. In accordance with Reference 1, the LOCBART transient extension method is being submitted to the Nuclear Regulatory Commission (NRC) for review and approval. In addition, 10 CFR 50.46 assessments have been completed to ensure adequate transient termination for the BASH-EM analyses within Westinghouse Pittsburgh cognizance. This 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

The estimated effect of this issue was determined on a plant-specific basis. For cases where transient termination can be demonstrated prior to downcomer boiling, no further action is considered necessary. For other cases, transient termination has been demonstrated by applying the LOCBART transient extension method. The effects of downcomer boiling are considered to be implicit in the analysis results. In all cases, it was concluded that the pertinent acceptance criteria of 10 CFR 50.46 are satisfied.

Due to the vintage of the Wolf Creek BASH-EM analysis, significant effort would be required to complete a rigorous evaluation of transient termination. A recent BASH-EM analysis was performed for a 4-loop dry atmospheric containment plant of similar design to Wolf Creek. This analysis demonstrated transient termination with substantial margin to the 10 CFR 50.46 acceptance limits. Based on the analysis results and the general similarity between this plant and Wolf Creek, it is expected that a BASH-EM reanalysis for Wolf Creek would also demonstrate transient termination with substantial margin to the 10 CFR 50.46 acceptance limits. Therefore, it is judged that no further action is required to demonstrate transient termination for the Wolf Creek BASH-EM analysis.

**References**

1. Letter from S. Dembek (USNRC) to H. Sepp (Westinghouse), "Potential Non-Conservative Modeling of Downcomer Boiling in the Approved Westinghouse 1981 Evaluation Model Using BASH," March 27, 2002.

## LOCBART RADIATION TO LIQUID LOGIC

**Background**

A review of the LOCBART cladding-to-fluid heat transfer logic found that radiation to liquid could occur after the core inlet flooding rate dropped below 1 inch per second (in/s), if the channel blockage fraction were simultaneously equal to zero. This logic was modified by deleting the check for a channel blockage fraction greater than zero in Subroutine HTSORT such that radiation to liquid is now ignored whenever the core inlet flooding rate is less than (or equal to) 1 in/s. This 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**

A review of existing analyses within Westinghouse Pittsburgh cognizance determined that the situation described above does not occur for most PWR licensing calculations in which case the subject modification has no effect on existing analysis results. For analyses where this situation did occur, representative plant calculations using the LOCBART code showed that the revised logic generally produced a small-to-moderate increase in peak cladding temperature and that plant-specific assessments were derived from the representative calculations in a conservative manner. For Wolf Creek, the effect of this revised logic was determined to result in a 17 degree Fahrenheit (°F) peak cladding temperature (PCT) penalty.

## LOCBART ZIRLO™ CLADDING SPECIFIC HEAT MODEL

**Background**

The ZIRLO™ cladding specific heat model in LOCBART has been revised to reflect data collected at the Thermophysical Properties Research Laboratory. This change was made to resolve differences between the model and data that could produce an increase in peak cladding temperature for some transients. This 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

Representative plant calculations using the LOCBART code showed that this change results in a moderate PCT penalty for early-reflood-PCT plants, a small-to-moderate PCT penalty for mid-reflood-PCT plants and a negligible PCT effect for late-reflood-PCT plants. Additional BASH-EM sensitivity calculations indicated that the reduction in initial pellet average temperatures due to PAD Version 4.0 provides a PCT benefit that more than offsets any PCT penalty due to the change in specific heat. This PCT benefit was applied in some cases (listed on PCT Rackup Sheet as "PAD 4.0 Initial Pellet Temperatures") as a separate, offsetting credit.

## BASHER CALCULATION OF FLOW LINK INPUTS

### Background

BASHER is used to generate the plant-specific input models for BASH. Some minor errors were discovered in the calculation of elevation and length terms for the flow link that connects the upper head and upper plenum. As discussed below, it was determined that correcting these errors would have a negligible effect on results. Therefore, 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

A sample BASH calculation demonstrated that these changes have a negligible effect on the core inlet flooding rate, which is consistent with the expected result given the minimal importance of the affected flow path during a PWR reflood transient. These changes will be deferred to a future code release and are treated as having a 0 °F PCT effect for 10 CFR 50.46 reporting purposes.

## LOCBART PELLET-TO-CLADDING GAP CONDUCTANCE MODEL

### Background

An error was discovered in a generic LOCBART input value used with the pellet-to-cladding gap conductance model. This error affected calculations performed using fuel rod initial conditions from PAD Version 4.0, and led to an under prediction of the gap heat transfer coefficients. The input guidance was corrected to reflect the appropriate value. This 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**

Representative plant calculations using the LOCBART code demonstrated that this change leads to a small-to-moderate PCT benefit that will conservatively be treated as a 0°F PCT change for 10 CFR 50.46 reporting purposes.

**LOCBART TIME STEP SELECTION LOGIC**

**Background**

LOCBART was updated to resolve some inconsistencies in the time step selection logic, pertaining to the use of the fluid vs. fuel rod time step. This represents 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**

Representative plant calculations using the LOCBART code demonstrated that this change produces a negligible effect on results and will be treated as a 0°F PCT effect for 10 CFR 50.46 reporting purposes.

**LOCBART CLADDING SURFACE HEAT TRANSFER LOGIC**

**Background**

Some recent LOCBART calculations showed anomalous behavior in the cladding surface heat transfer coefficients when the local void fraction was high and the cladding surface temperature had decreased to the temperature at which a return to nucleate boiling is permitted to occur. This behavior was resolved by adding a void fraction criterion to the return-to-nucleate boiling logic in Subroutine HTSORT. This 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**

A sample LOCBART calculation demonstrated that this change produces a negligible effect on results and will be treated as a 0°F PCT effect for 10 CFR 50.46 reporting purposes.

## LOCBART ZIRLO™ CLADDING CREEP CONSTANTS

### Background

LOCBART 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. This represents 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 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 treated as a 0°F PCT effect for 10 CFR 50.46 reporting purposes.

## SBLOCTA TIME STEP SELECTION LOGIC

### Background

SBLOCTA was updated to resolve some inconsistencies in the time step selection logic pertaining to the use of the fluid vs. fuel rod time step. This represents 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 SBLOCTA code demonstrated that this change produces a small PCT benefit for cases modeling Zircaloy-4 cladding that are predicted to burst and a negligible effect on results for other cases. Accordingly, this change will be treated as a 0°F PCT effect for 10 CFR 50.46 reporting purposes.

## SBLOCTA ZIRLO™ CLADDING SPECIFIC HEAT MODEL

### Background

For consistency with the change made to LOCBART (as described previously), the ZIRLO™ cladding specific heat model in SBLOCTA has been revised to reflect data collected at the Thermophysical Properties Research Laboratory. This 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**

Sensitivity calculations using the SBLOCTA code demonstrated that this change produces a negligible effect on results and will be treated as a 0°F PCT effect for 10 CFR 50.46 reporting purposes.

## SIMPLIFIED ISOTHERMAL SOLUTION FOR SBLOCTA SUBROUTINE RATE

**Background**

As discussed in Reference 1, LOCBART was revised in 1999 to correct a logic error that caused the Baker-Just metal-water reaction calculations to be performed three times per time step. During the review of the corresponding code logic, it was determined that the complicated solution technique described in Section 3.3.2 of Reference 2 could be replaced with a simplified isothermal solution with only a minimal effect on results. This change was made in LOCBART per Reference 3 and has also been implemented in SBLOCTA which uses similar logic. This 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**

Representative plant calculations using the SBLOCTA code demonstrated that this change produces a negligible effect on results and will be treated as a 0°F PCT effect for 10 CFR 50.46 reporting purposes.

**References**

1. Westinghouse Letter NSBU-NRC-00-5970, "1999 Annual Notification of Changes to the Westinghouse Small Break LOCA and Large Break LOCA ECCS Evaluation Models, Pursuant to 10 CFR 50.46 (a)(3)(ii)," May 12, 2000.

2. WCAP-8301, "LOCTA-IV Program: Loss-of-Coolant Transient Analysis," June 1974.

3. Westinghouse Letter LTR-NRC-01-6, "U. S. Nuclear Regulatory Commission, 10 CFR 50.46 Annual Notification and Reporting for 2000," March 13, 2001.

## GENERAL CODE MAINTENANCE

### 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 for enhanced usability and to facilitate code debugging when necessary. These 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.

## LARGE BREAK LOCA PEAK CLAD TEMPERATURE (PCT) MARGIN UTILIZATION

| | |
|---|---|
| Evaluation Model: | 1981 EM with BASH |
| Fuel: | 17X17 V5H w/IFM, non-IFBA 275 psig |
| Peaking Factor: | FQ=2.50, $F_{dH}$=1.65 |
| SG Tube Plugging: | 10% |
| Power Level: | 3565 $MW_{th}$ |
| Limiting transient: | $C_D$=0.4, Min. SI, Reduced Tavg |

| | |
|---|---|
| A. ANALYSIS OF RECORD (Rerating 8/92) | |
| Peak Cladding Temperature (PCT): | 1916°F (1) |
| B. PRIOR PERMANENT ECCS MODEL ASSESSMENTS | ΔPCT = 63°F (2) |
| C. PLANNED PLANT CHANGE EVALUATIONS | |
| 1. Loose Parts | ΔPCT = 20°F (3) |
| 2. Containment Purge Evaluation | ΔPCT = 0°F (4) |
| 3. Cycle 10 Fuel Assembly Design Changes | ΔPCT = 95°F (5) |
| 4. Fuel Rod Crud | ΔPCT = 0°F (6) |
| TOTAL PLANNED PLANT CHANGE ASSESSMENTS | ΔPCT = 115°F |
| D. 2002 10 CFR 50.46 MODEL ASSESSMENTS (Permanent Assessment of PCT Margin) | |
| 1. LOCBART Radiation to Liquid Logic Error Correction | ΔPCT = 17°F (11) |
| E. TEMPORARY ECCS MODEL ISSUES | |
| 1. None | ΔPCT = 0°F |
| F. OTHER MARGIN ALLOCATIONS | |
| 1. Transition Core Penalty | ΔPCT = 0°F (7) |
| 2. Cold Leg Streaming Temperature Gradient | ΔPCT = 0°F (8) |
| 3. Rebaseline of Limiting AOR Case (12/96) | ΔPCT = -63°F (9) |
| 4. Adjustment for LOCBART Zirc-Water Oxidation Error | ΔPCT = -5°F (10) |
| **LICENSING BASIS PCT + MARGIN ALLOCATIONS** | **PCT = 2043°F** |
| **CUMULATIVE ABSOLUTE MAGNITUDE OF PCT CHANGES SINCE LAST 30-DAY REPORT (LETTER ET 99-0045 DATED OCTOBER 25, 1999)** | **$\Sigma\|\Delta PCT\|$ = 32°F** |

Notes:

1. Westinghouse Topical Report WCAP-13456, "Wolf Creek Generating Station NSSS Rerating Licensing Report," October 1992.
2. Westinghouse to WCNOC letter SAP-02-6, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, 10 CFR 50.46 Annual Notification and Reporting for 2001," March 4, 2002.
3. Westinghouse to WCNOC letter SAP-90-148, "Wolf Creek Nuclear Operating Corporation, RCS Loose Parts Evaluation," April 18, 1998.
4. Westinghouse to WCNOC letter SAP-94-102, "Containment Mini purge Isolation Valve Stroke Time Increase," January 12, 1994.
5. Westinghouse to WCNOC letter 97SAP-G-0009, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, Safety Assessment for the Wolf Creek Generating Station with ZIRLO™ Fuel Assemblies," February 7, 1997.
6. Westinghouse to WCNOC letter 97SAP-G-0075, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, Wolf Creek Crud Deposition/Axial Offset Anomaly Safety Evaluation," September 29, 1997.
7. Transition core penalty applies on a cycle-specific basis for reloads utilizing both V5H (with IFMs) and STD fuel until a full core of V5H is achieved. Since a full core of V5H has been attained, the 50°F transition core penalty is no longer applicable and has been removed.
8. Westinghouse to WCNOC letter SAP-93-701, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, 10 CFR 50.46 Notification and Reporting Information," January 25, 1993. [A PCT benefit of 2.5°F was assessed; however, a benefit of zero (0)°F will be tracked for reporting purposes.]
9. Westinghouse to WCNOC letter SAP-99-148, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, 10 CFR 50.46 BART/BASH Evaluation Model Mid-Year Notification and Reporting for 1999," September 22, 1999.
10. This assessment is a function of analysis PCT plus certain margin allocations and as such may increase/decrease with margin allocation changes.
11. Westinghouse to WCNOC letter SAP-02-32, "10 CFR 50.46 BART/BASH Evaluation Model Mid-Year Notification and Reporting for 2002," June 20, 2002.

## SMALL BREAK LOCA PEAK CLAD TEMPERATURE (PCT) MARGIN UTILIZATION

| | |
|---|---|
| Evaluation Model: | 1985 EM with NOTRUMP |
| Fuel: | 17X17 V5H w/IFM, non-IFBA 275 psig |
| Peaking Factor: | FQ=2.50, $F_{dH}$=1.65 |
| SG Tube Plugging: | 10% |
| Power Level: | 3565 $MW_{th}$ |
| Limiting transient: | 3-inch Break |

| | |
|---|---|
| A. ANALYSIS OF RECORD (Rerating 8/92) | |
| Peak Cladding Temperature (PCT) | 1510°F (1) |
| B. PRIOR PERMANENT ECCS MODEL ASSESSMENTS | ΔPCT = 44°F (2) |
| C. PLANNED PLANT CHANGE EVALUATIONS | |
| 1. Loose Parts | ΔPCT = 45°F (3) |
| 2. Cycle 10 Fuel Assembly Design Changes | ΔPCT = 1°F (6) |
| 3. Reduced Feedwater Inlet Temperature | ΔPCT = 10°F (4) |
| 4. Fuel Rod Crud | ΔPCT = 4°F (5) |
| 5. Auxiliary Feedwater Temperature Increase | ΔPCT = 16°F (8) |
| TOTAL PLANNED PLANT CHANGE ASSESSMENTS | ΔPCT = 76°F |
| D. 2002 10 CFR 50.46 MODEL ASSESSMENTS (Permanent Assessment of PCT Margin) | |
| 1. None | ΔPCT = 0°F |
| E. TEMPORARY ECCS MODEL ISSUES | |
| 1. None | ΔPCT = 0°F |
| F. OTHER MARGIN ALLOCATIONS | |
| 1. Cold Leg Streaming Temperature Gradient | ΔPCT = 7°F (7) |
| **LICENSING BASIS PCT + MARGIN ALLOCATIONS** | **PCT = 1637°F** |
| **CUMULATIVE ABSOLUTE MAGNITUDE OF PCT CHANGES SINCE LAST 30-DAY REPORT (LETTER ET 99-0024 DATED JUNE 11, 1999)** | **$\Sigma\|\Delta PCT\|$ = 35°F** |

Notes:

1. Westinghouse Topical Report WCAP-13456, "Wolf Creek Generating Station NSSS Rerating Licensing Report," October 1992.
2. Westinghouse to WCNOC letter SAP-02-6, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, 10 CFR 50.46 Annual Notification and Reporting for 2001," March 4, 2002.
3. Westinghouse to WCNOC letter SAP-90-148, "Wolf Creek Nuclear Operating Corporation, RCS Loose Parts Evaluation," April 18, 1990.
4. Westinghouse to WCNOC letter SAP-96-119, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, Small Break LOCA Evaluation for Reduced Feedwater Temperature," May 30, 1996.
5. Westinghouse to WCNOC letter 97SAP-G-0075, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, Wolf Creek Crud Deposition/Axial Offset Anomaly Safety Evaluation," September 29, 1997. (This penalty will be carried until such time it is determined to no longer apply.)
6. Westinghouse to WCNOC letter 97SAP-G-0009, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, Safety Assessment for the Wolf Creek Generating Station with ZIRLO™ Fuel Assemblies," February 7, 1997.
7. Westinghouse to WCNOC letter SAP-93-701, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, 10 CFR 50.46 Notification and Reporting Information," January 25, 1993.
8. Westinghouse to WCNOC letter SAP-98-138, "Wolf Creek Nuclear Operating Corporation, Wolf Creek Generating Station, Assessment of an Increase in Auxiliary Feedwater Temperature," July 23, 1998.