March 27, 2002

Mr. H. Sepp, Manager
Regulatory and Licensing Engineering
Westinghouse Electric Company
Post Office Box 355
Pittsburgh, PA 15230-0355

SUBJECT: POTENTIAL NON-CONSERVATIVE MODELING OF DOWNCOMER BOILING IN THE APPROVED WESTINGHOUSE 1981 EVALUATION MODEL USING BASH

Dear Mr. Sepp:

References:

1. Westinghouse Topical Report WCAP-10266-P-A, Revision 2, "The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code," March 1987

2. Letter from H. A. Sepp (Westinghouse Electric Company LLL, NSBU-00-5970) to US NRC (J. Wermiel), "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

3. Letter from S. Dembek, NRC, to H. A. Sepp, Westinghouse Electric Company, "Potential Non-Conservative Modeling in Approved Evaluation Models," November 2, 2000

4. Memorandum from G. S. Shukla, Project Manager, Section 2, PDIV&D, to S. A. Richards, Director, PDIV&D, "Summary of March 27, 2001, Meeting with Westinghouse on Downcomer Boiling Modeling," April 16, 2001

The NRC staff has been evaluating the potential non-conservative modeling of downcomer boiling in the approved Westinghouse (W) 1981 emergency core cooling system (ECCS) evaluation model (EM) using the BASH Code (Reference 1). Based on our review of the method proposed by W to resolve the issue (LOCBART extension method), we have identified additional concerns which need to be addressed by Westinghouse.

In Reference 2, W reported to the NRC that recent large break loss-of-coolant accident (LOCA) analyses that use the 1981 version of the W ECCS EM using BASH have predicted downcomer boiling to occur before the cladding temperature and/or oxidation transients have been conclusively terminated. To address this issue, W developed a computational procedure, called the LOCBART extension method, in order to extend the transient analysis beyond the onset of downcomer boiling. W judged this new method to be a discretionary change to be implemented on a forward-fit basis. W has not submitted the LOCBART extension method to the NRC for review and approval.

To enhance the staff's understanding of the implications of downcomer boiling and the LOCBART extension method, a sequence of meetings and correspondence between W and the staff have taken place. In Reference 3, the NRC requested that W provide an assessment of potential non-conservative modeling (including downcomer boiling) in their approved EM used for licensing analyses of ECCS performance. W provided this assessment during a meeting held with the staff on March 27, 2001 (Reference 4). At this meeting, W concluded that the 1981 BASH-EM does not need to be modified to explicitly model downcomer boiling.

The NRC staff has assessed the information provided in the W correspondence and from the meetings with W on this issue. Because the BASH code fails to conclusively terminate, the staff has questions regarding the continued application of the current approved version of the W 1981 EM using BASH. Additionally, the staff finds that the LOCBART extension method is beyond what was originally approved by the NRC in its acceptance of the 1981 EM using BASH. The staff believes that a formal review of the LOCBART extension method and its application to the 1981 EM using BASH is warranted. The staff questions how the W 1981 BASH-EM and the LOCBART extension method comply with the following requirements of 10 CFR Part 50:

- 10 CFR Part 50, Appendix K, Section I.A.6 requires that heat transfer from the reactor vessel walls and non-fuel internal hardware be taken into account. W must demonstrate how this is accomplished in the 1981 EM using BASH and with the LOCBART extension method after the onset of downcomer boiling.

- 10 CFR Part 50, Appendix K, Section I.D.3 requires that "The refilling of the reactor vessel and the time and rate of reflooding of the core be calculated by an acceptable model that takes into consideration the thermal and hydraulic characteristics of the core and of the reactor system ... The effects on reflooding rate of the compressed gas in the accumulator which is discharged following accumulator water discharge shall also be taken into account." W must demonstrate how this is accomplished in the 1981 EM using BASH and with the LOCBART extension method after the onset of downcomer boiling.

- 10 CFR Part 50, Appendix K, Section I.D.4 requires that "The thermal-hydraulic interaction between steam and all emergency core cooling water shall be taken into account in calculating the core reflooding rate...." W must demonstrate how this is accomplished in the 1981 EM using BASH and with the LOCBART extension method after the onset of downcomer boiling.

- 10 CFR Part 50, Appendix K, Section I.D.5 requires that (a) for reflood rates of one inch per second or higher, reflood heat transfer coefficients shall be based on applicable experimental data for unblocked cores including FLECHT results, and b) during refill and during reflood when reflood rates are less than one inch per second, heat transfer calculations shall be based on the assumption that cooling is only by steam, and shall

take into account any flow blockage calculated to occur as a result of cladding swelling or rupture as such blockage might affect both local steam flow and heat transfer. W must demonstrate how this is accomplished in the 1981 EM using BASH and with the LOCBART extension method after the onset of downcomer boiling.

- 10 CFR Part 50, Appendix K, Section II.2 requires that for each computer program, solution convergence be demonstrated by studies of system modeling or noding and calculational time steps. This requirement is not satisfied because the BASH code fails when downcomer boiling is predicted to occur. W should discuss how and why the BASH code fails, and demonstrate why the 1981 BASH-EM solution converges under these conditions and is acceptable for the entire duration of its expected calculational period (entire duration of the refill and reflood portions of the transient).

- 10 CFR Part 50, Appendix K, Section II.3 requires that sensitivity studies be performed to evaluate the effect on results of "phenomena assumed in the calculation to predominate." W originally assumed that downcomer boiling would not occur, and therefore sensitivity studies of this phenomena were not performed. Based on current knowledge of downcomer boiling and its impacts on peak clad temperature (PCT), the staff requires that sensitivity studies be performed.

- 10 CFR Part 50, Appendix K, Section II.4 requires that to the extent practicable, predictions of the evaluation model, or portions thereof, shall be compared with applicable experimental information. W should provide a comparison of the LOCBART extension method to appropriate experimental data. The comparison should include appropriate scaling considerations.

In addition, the staff has identified the following concerns with the EM which must be addressed by W:

- W has not provided evidence of the validity of the application of the SUDO void fraction correlation with respect to scaling and magnitude of correlation error. W should provide complete justification for use of the SUDO correlation.

- W should address the validity of the assumptions made for the other BASH calculated parameters for the period after onset of downcomer boiling.

- W should submit the technical justification to support review and approval of the LOCBART extension method, including tests and experimental benchmarking.

- W should provide PCT and oxidation impacts for all affected plants that have applied the LOCBART extension method as part of their licensing basis analyses.

The staff requests that discussions be held with W after receipt of this letter to establish an appropriate schedule for submittal of the requested information.

Sincerely,

/RA/

Stephen Dembek, Chief, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 700

cc: Mr. Gordon Bischoff, Project Manager
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P.O. Box 355
Pittsburgh, PA 15230-0355

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