June 20, 2003

Mr. James F. Mallay
Director, Regulatory Affairs
Framatome ANP
3315 Old Forest Road
Lynchburg, VA 24501

SUBJECT: POTENTIAL NON-CONSERVATIVE MODELING OF DOWNCOMER BOILING IN THE APPROVED FRAMATOME ANP EMERGENCY CORE COOLING SYSTEM (ECCS) EVALUATION MODEL FOR APPLICATION TO WESTINGHOUSE AND COMBUSTION ENGINEERING DESIGNED PRESSURIZED WATER REACTORS (PWRs) (TAC NO. MB9505)

REFERENCES:

1. Letter from S. Dembek, NRC, to J. F. Mallay, Framatome ANP, Inc., "Potential Non-Conservative Modeling of Downcomer Boiling in the Approved Framatome ANP Emergency Core Cooling System Evaluation Model for Application to Certain Westinghouse and Combustion Engineering Designed Pressurized Water Reactors," June 3, 2002.

2. Letter from J. F. Mallay, Framatome ANP, Inc., to Document Control Desk, USNRC, "Downcomer Boiling in Framatome ANP PWR ECCS Evaluation Models," Revision 1, April 4, 2003.

3. BAW-10168P-A, Revision 3, "BWNT Loss-of-Coolant Accident Evaluation Model for Recirculating Steam Generator Plants," December 1996

4. BAW-10164P-A, Revision 3, "RELAP5/MOD2-B&W - An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis," July 1996.

5. BAW-10171P-A, Revision 3, "REFLOD3B - Model for Multinode Core Reflooding Analysis," December 1995.

6. BAW-10166P-A, Revision 4, "BEACH - Best Estimate Analysis Core Heat Transfer, A Computer Program for Reflood Heat Transfer During LOCA," February 1996.

7. Memorandum from A. C. Thadani, USNRC, to S. J. Collins, USNRC, "Research Information Letter 0202, Revision of 10 CFR 50.46 and Appendix K," dated June 20, 2002.

Dear Mr. Mallay:

The NRC staff has been evaluating non-conservative modeling of downcomer boiling (DCB) in approved 10 CFR Part 50, Appendix K, ECCS evaluation models (EMs), and previously requested information related to DCB from Framatome ANP (Reference 1). Framatome ANP

(FANP) responded to the NRC staff's request for additional information (RAI) in a letter dated April 4, 2003 (Reference 2). The NRC staff's review of FANP's RAI response identified several concerns, which the NRC staff discussed with FANP in a telephone conference on May 27, 2003. The purpose of this letter is to document the NRC staff's position on this issue and request FANP to resolve this issue and provide additional information to the NRC.

The NRC staff met with FANP on April 16, 2002, to discuss issues related to a fuel transition license amendment request submittal. The approved FANP Appendix K EM (References 3-6) and the issue of DCB were discussed at this meeting. FANP informed the NRC staff that the REFLOD3B calculation terminates when the downcomer and lower plenum reach saturated conditions, and that the approved FANP Appendix K EM cannot calculate the effects of DCB. Additionally, FANP reported that the calculation terminates due to code numerical issues at a time prior to calculated core quench. As such, the amount of clad oxidation cannot be determined utilizing this approved model.

Based on this information, in a letter dated June 3, 2002, the NRC staff requested that FANP provide additional information regarding potential non-conservative modeling of the downcomer region and DCB in the accepted FANP Appendix K EM used for licensing analysis of certain Westinghouse and Combustion Engineering type PWRs. Sensitivity studies have shown DCB to be of greater concern for plants with low backpressure containments and low safety injection flow. Specifically, the NRC staff questioned how the currently approved FANP Appendix K EM complies with the following requirements of 10 CFR Part 50:

- 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 REFLOD3B code fails at the time when DCB is predicted to occur and prior to core quench. FANP should discuss how and why this code fails, and demonstrate why the 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." Based on current knowledge of DCB and its impacts on peak cladding temperature (PCT) and oxidation, sensitivity studies of this phenomenon must be performed.

FANP provided a response to the NRC staff's RAI in a letter dated April 4, 2003. The NRC staff has reviewed this RAI response and finds that the questions have not been adequately addressed. FANP's response did not address the NRC staff's RAI question regarding the solution convergence requirement of 10 CFR Part 50, Appendix K, Section II.2. The response did not include any discussion regarding code failure or the performance of the approved Appendix K EM under the conditions and at the time when DCB would be predicted to occur. With respect to 10 CFR Part 50, Appendix K, Section II.3, Framatome's response states that it is not familiar with any NRC-approved Appendix K EMs that model the downcomer region in sufficient detail to allow DCB sensitivity studies to be performed. As such, FANP has not performed DCB sensitivity studies using their approved Appendix K EM.

FANP concludes that the existing conservatism in the Appendix K EM is adequate to bound the PCT impacts of DCB and that no adjustments to the EM to account for DCB are necessary. FANP's conclusion is based in part on results of sensitivity studies performed using other thermal-hydraulic methodologies to estimate the impacts of DCB on PCT. Specifically, FANP applied its realistic large break loss-of-coolant-accident best-estimate model (SRELAP5) to perform these analyses. FANP did not provide an estimate of the impact of DCB on oxidation results for the limiting hot rod or for the core wide contribution.

The NRC staff does not agree with FANP's position that changes to the currently approved Appendix K EM are not required. The NRC staff views the non-conservative modeling of the downcomer region and DCB in the subject EM as a significant error in the model because the PCT impacts have been shown to be greater than 50°F. FANP's estimate of the impacts of DCB on PCT are noted as proprietary in the Reference 2 letter, but can exceed the 50°F threshold. Sensitivity studies performed by the NRC staff and their consultants show that PCT can increase 200 - 400°F under certain circumstances (Reference 7).

Section 50.46(a)(3)(ii) requires that licensees submit to the NRC staff an estimate of the impacts of a significant error and also provide a schedule for providing a reanalysis or taking other action as needed to show compliance with 10 CFR 50.46 requirements for a particular plant. The NRC staff accepts FANP's best-estimate sensitivity studies as an estimate of the impacts of DCB on PCT for the plants discussed in Reference 2; however, it is not clear that this estimate applies to all PWRs utilizing the subject Appendix K EM. Compliance with 10 CFR 50.46 and Appendix K must be demonstrated using the model approved for application and which forms the licensing basis for a particular plant. Because licensees continue to apply this Appendix K EM in licensing applications, the NRC staff feels that corrective action is necessary.

If FANP does not take corrective action, then conditions must be placed on the continued application of the subject Appendix K EM for certain PWRs that are susceptible to DCB. Sensitivity studies have shown DCB to be of greater concern for PWRs with low backpressure containments and/or low safety injection flow. For these PWRs, future analyses performed to demonstrate that the requirements of 10 CFR 50.46 are satisfied shall be performed using an NRC approved best-estimate methodology. For those PWRs less impacted by DCB, plant-specific justification for continued application of the current Appendix K EM must be provided to the NRC staff. Additionally, the NRC staff will continue to request plant-specific information regarding downcomer modeling and DCB during plant-specific license amendment request reviews. The NRC staff requests that FANP provide a listing of those PWRs currently applying the subject Appendix K EM with the downcomer modeling deficiencies.

Alternatively, FANP can provide information which demonstrates that the currently approved Appendix K EM accurately models the DCB phenomenon and demonstrates solution convergence. FANP could also take corrective action and modify the approved Appendix K EM or develop an alternative methodology or approach to extend the calculation beyond the time at which DCB occurs. The corrected methodology or alternate approach should show fuel rod quench and quantify the extent of oxidation for the hot rod and total core wide contribution. Any changes or modifications to the approved Appendix K EM would require NRC review and approval.

If you have any questions on the above, please contact Drew Holland at 301-415-1436.

Sincerely,

/RA/

Herbert N. Berkow, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 728

If you have any questions on the above, please contact Drew Holland at 301-415-1436.

Sincerely,

/RA/

Herbert N. Berkow, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

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