December 17, 1997

Mr. Nicholas J. Liparulo, Manager
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Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
P.O. Box 355
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SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (RAI) ASSOCIATED WITH TECHNICAL ISSUES IDENTIFIED DURING AP600 QUALITY ASSURANCE (QA) INSPECTION

Dear Mr. Liparulo:

The Nuclear Regulatory Commission conducted an inspection of the AP600 quality assurance program implementation associated with computer code qualification, testing, and design basis accident analyses, during the week of November 17 through 21, 1997, at the Westinghouse Energy Center in Monroeville, Pennsylvania. During this inspection, technical issues were identified by the staff which need to be promptly addressed by Westinghouse to support the staff's safety evaluation schedule for the AP600 design. These issues are described in the enclosed request for additional information (RAI) and are being forwarded to permit Westinghouse to initiate a response before an inspection report is issued. The quality assurance implication of the staff's observations and other inspection results will be documented separately in the inspection report.

If you have any questions regarding this matter, you may contact me at (301) 415-1118.

Sincerely,

original signed by:
Theodore R. Quay, Director
Standardization Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Docket No. 52-003

Enclosure: As stated

cc w/encl: See next page

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Westinghouse Electric Corporation

Docket No. 52-003
AP600

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REQUEST FOR ADDITIONAL INFORMATION ON AP600 TECHNICAL ISSUES
OBSERVED DURING NOVEMBER 1997 QUALITY ASSURANCE INSPECTION

440.753F Increase in the RCS Inventory Events (SSAR 15.5)

In an NRC inspection of Westinghouse AP600 design control activities from November 17 through 21, 1997, the staff found that operator actions were necessary (opening of the reactor vessel head vents) to prevent overfill of the pressurizer under some of the conditions in the analyses of increased RCS inventory events. The limiting case presented in the SSAR states that it "bounds cases that model explicit operator action 30 minutes after reactor trip." It is the staff's understanding that the cases that model explicit operator action actually require operator action or the pressurizer overfill would be worse than reported in the SSAR. It appears that Westinghouse has reported the worst overfill transient that does not require operator action but not the worst transient if no operator action were assumed. Consequently, the staff concludes that operator action is necessary to mitigate the worst increase in RCS inventory events. Westinghouse should provide the following additional information relative to the cases that model explicit operator action within 30 minutes:

(a) Discuss assumptions important to the calculations related to pressurizer overfill resulting from increased RCS inventory events where operator action is necessary. What is the maximum time delay that can occur without taking operator action before the transient would exceed the limits currently reported in the SSAR.

(b) Provide information to demonstrate that unambiguous alarms or indications for the events are available, and the procedural instructions are clear to operators to take appropriate actions within the time frame assumed in the analyses.

(c) Westinghouse stated that the cases that model explicit operator action take credit for the use of the reactor vessel head vents to reduce the RCS inventory. Address compliance of this case with the technical specification requirements of 10 CFR 50.36. Specifically, item (c)(2)(ii)(C), criterion 3 for the TS requirements, states that "A structure, system, or component that is part of the primary success path and which functions or actuates to mitigate a design basis accident or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier."

(d) Update the SSAR to include the limiting analyses that credited the operator actions to prevent pressurizer overfill from occurring.

(e) Discuss the need to add an ITAAC to verify the capacity of the reactor vessel head vent system used by operators to prevent pressurizer overfill from occurring.

440.754F Boron Dilution Analyses (SSAR 15.4.6)

In an NRC inspection of Westinghouse AP600 design control activities from November 17 through 21, 1997, the staff found that the applicant relied on the test data documented in EGG-LOFT-5867 (Project No. P 394) to establish the required RCS circulation flow rate of 1000 gpm cited in Technical Specification 3.4.9 and to support its complete boron mixing model assumed in the boron dilution analyses. The AP600 design features are different from the test conditions discussed in EGG-LOFT-5867. For example, the injection location is at DVI for AP600 while the test facility simulated a cold-leg injection. For AP600, the maximum boron dilution flow rate assumed in the analyses is 200 gpm and the required TS RCS circulation rate is 1000 gpm to assure complete mixing of the unborated water. For the tests, the test facility simulated conditions with unborated flow rate of 300 gpm and RCS circulation rates greater than of 3000 gpm. In light of differences in the injection location and injected flow rates, Westinghouse is requested to address the applicability of the boron mixing testing data to the AP600 design and validate the complete boron mixing model assumed in the boron dilution analysis.

440.755F Calculation Note SSAR-GSC-356

In an NRC inspection of Westinghouse AP600 design control activities from November 17 through 21, 1997, the staff reviewed calculation note SSAR-GSC-356 related to WCOBRA/TRAC long term cooling calculations. In an effort to determine single phase flow resistance, a solution of DP vs flow was presented. The objective was to determine the asymptotic part of the solution. The author of the calculation note observed that a harmonic oscillation was built-in the solution, thus, proposed to take the average value.

Please assess: (1) if the average value is equal to the asymptotic solution had the oscillation not been present (2) if there is a difference in the asymptotic solution, what is the impact on the flow resistance and (3) if this oscillation is also present in the vessel flow , DP, and vessel collapsed liquid level solutions?

440.756F Calculation Note SSAR-GSC-377

In an NRC inspection of Westinghouse AP600 design control activities from November 17 through 21, 1997, the staff reviewed calculation note SSAR-GSC-377 related to WCOBRA/TRAC long term cooling calculations and has the following questions:

(a) A large mass discharge from ADS 1-3 was noted in two scenarios analyzed in this calculation note. However, it was noted that the calculating was initialized with the pressurizer empty and, in this time window, the IRWST should also be empty. If these initial conditions for the window are correct, how could there be such a substantial ADS 1-3 mass flow? Because the ADS 1-3 flow is used to calculate the for mass balance, what impact does this have on the validity of the case analyzed (if the ADS 1-3 flow is not real)?

(b) In the same calculation it was noted that there was substantial negative flow through the DVI lines back into the sump. Please explain if this is physically possible. What does this mean for the validity of the case analyzed?

440.757F <u>Calculation Note SEC-APS-4746-CO</u>

In an NRC inspection of Westinghouse AP600 design control activities from November 17 through 21, 1997, the staff reviewed calculation note SEC-APS-4746-CO related to WCOBRA/TRAC long term cooling calculations. The calc note stated in the concluding section that "...variations in initial conditions are expected to have a relatively unimportant effect on the analyses results." Please explain the basis for this conclusion.

480.1112F

In an NRC inspection of Westinghouse AP600 design control activities from November 17 through 21, 1997, there were a number of technical issues related to the AP600 passive containment cooling system and WGOTHIC computer program, which will require further evaluation by Westinghouse.

During the review of document 1100-SOC-001 (revision 0 through 4), for the calculations of "Containment Volumes and Heat Sinks," it was determined that thermal insulation surrounding pipes and components was not included in the analyses used to establish the free volume within compartments (or predefined nodes for the containment pressure calculations with WGOTHIC) or in the analyses used to establish flow paths areas between compartments.

The staff believes the omission of insulation needs to be addressed by Westinghouse. Specifically, the staff is concerned that accounting for insulation may impact the already limited margin to design pressure in the current licensing analyses presented in SSAR 6.2.1.3 and 6.2.1.4 (the MSLB limiting case with a peak pressure of 44.8 psig and the LOCA with a peak pressure of 44.0 psig as compared to the 45 psig design pressure). In addition, there are other design analyses areas that may be impacted by the insulation issue. For example, the subcompartment loads analyses provided in SSAR 6.2.1.2, and the evaluation of flooding levels within compartments and which compartments may be subjected to flooding.

With respect to SSAR 6.2.1.3 and 6.2.1.4 Westinghouse is requested to respond to the following concerns:

(a) Evaluate the significance of the insulation on the free volume used to determine the peak containment pressure. Provide adequate justification, as appropriate, that the free volume is conservative.

(b) Evaluate the significance of the insulation on the flow path characterizations used to determine the peak containment pressure, including flow areas and form losses, for both paths connecting below operating deck compartments as well as flow paths connecting below operating deck regions to above operating deck regions. Assess the effects for each of the four LOCA phases as well as the MSLB.

With respect to SSAR 6.2.1.2:

(c) Evaluate the significance of the insulation on the flow path characterizations used to determine the differential pressures across subcompartment walls, including flow areas and form losses, for both paths connecting below operating deck compartments as well as flow paths connecting below operating deck regions to above operating deck regions.

With respect to the flooding issues, Westinghouse needs to address the following concern:

(d) Evaluate the significance of the insulation on compartment flooding, address both timing and levels, as well as which compartments would be affected.

480.1113F

In an NRC inspection of Westinghouse AP600 design control activities from November 17 through 21, 1997, document CN-CDBT-92-233 Rev. 3 (5/22/97), "AP600 WGOTHIC Input Deck Development," was reviewed. Errors were identified in the model and documented by Westinghouse after the computer analyses were completed. Westinghouse determined these errors to have negligible impact on the analyses and, therefore, reanalyses were not performed. However, no discussion was provided on how this conclusion was reached. Considering the lack of margin in containment peak pressure calculations, the potential that there are other "negligible" errors is a concern. Similar statements were found in other documents, for example CN-CDBT-92-233 Rev. 2 (although in this specific case the AP600 nodalization was modified after the error was found, the inspection review was not detailed enough to determine if the error was promulgated into the revised model).

Westinghouse needs to respond to the following questions:

(a) For the specific errors, involving incorrect areas and incorrect loss coefficients, provide justification that the impact of these errors are conservative, or that the cumulative impact of known errors would not result in a change in the pressure calculation greater than 0.2 psig. The loss factors selected were considered to be applicable to "natural circulation" but, for the flow paths in question, the loss factors should not have been applied. Assess the effects for each of the four LOCA phases as well as the MSLB.

(b) Provide justification for allowing known errors to remain in the licensing analyses that support design certification. Include the supporting knowledge base employed by Westinghouse that is used to assess errors to determine that, in consideration of the 0.2 psig (½ of 1 percent) margin in the calculated allowance to the design pressure, known errors have a negligible impact (for example, only conservative errors remain, or that the cumulative impact of known errors would not result in a change in the pressure calculation greater than 0.2 psig). Consider both accumulation of errors as well as the impact of errors in consideration of the different phenomena and characterizations for each of the four LOCA phases and the MSLB.

480.1114F

Document numbers SSAR-GSC-125 / CN-CRA-93-219-R0
WGOTHIC_S Version 1.2 Design Specification Including Subcooling

The beginning of the document describes what is called a complete and a correct mathematical and physical model of the film energy transport. The equations are not mathematically and physically complete and correct. A complete and correct description would start out with mass, momentum and energy balances on the film and then show what terms can be neglected to obtain the final mathematical model. Several terms are obviously missing from the equations. Condensation and evaporation terms are not in the equations. There are also terms missing that depend on the time rate of change of the film thickness that result from the application of Leibniz's rule to the integral balance equations for a moving boundary problem. These missing terms may be negligible if the film thickness is changing slowly, but the assumptions that go into the complete equations should be clearly stated in the documentation. Westinghouse needs to start with a complete set of equations that treat the film correctly and use this complete set to derive the equations ultimately solved (including justification for neglecting the terms that are left out of the final model) or clearly state and justify the assumptions that are implicit in the set of equations that are ultimately solved.

In addition, related to Equation 8, an artificial thermal capacitance equal to half the thermal capacitance of the film is added to the thermal capacitance of the wall node adjacent to the film for numerical stability reasons. Adding this artificial term introduces an error in energy conservation. Westinghouse should either remove this term from their equations or justify that the error introduced is negligible.