Docket File
52-003

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 14, 1997

Mr. Nicholas J. Liparulo, Manager
Nuclear Safety and Regulatory Activities
Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
P.O. Box 355
Pittsburgh, PA 15230

SUBJECT: REQUESTS FOR ADDITIONAL INFORMATION (RAIs) ON SECTION 12, "CLIME NODING STUDY," OF WCAP-14407, "WGOTHIC APPLICATION REPORT"

Dear Mr. Liparulo:

The Nuclear Regulatory Commission's (NRC) Containment Systems and Severe Accident Branch (SCSB) staff reviewed Section 12, "Clime Noding Study," of WCAP-14407, "WGOTHIC Application Report," which was submitted by Westinghouse Electric Corporation (the applicant) on March 14, 1997, and determined that it needs additional information in order to complete its review of the AP600 passive containment cooling system and WGOTHIC computer code. Enclosed are questions identified as RAI# 480.1022 to 480.1041. It is expected that WCAP-14407 will be updated to reflect the questions and comments enclosed in this letter.

You have requested that portions of the information submitted in the June 1992 application for design certification be exempt from mandatory public disclosure. While the staff has not completed its review of your request in accordance with the requirements of 10 CFR 2.790, that portion of the submitted information is being withheld from public disclosure pending the staff's final determination. The staff concludes that these questions and comments do not contain those portions of the information for which exemption is sought. However, the staff will withhold this letter from public disclosure for 30 calendar days from the date of this letter to allow Westinghouse the opportunity to verify the staff's conclusions. If, after that time, you do not request that all or portions of the information in the enclosures be withheld from public disclosure in accordance with 10 CFR 2.790, this letter will be placed in the Nuclear Regulatory Commission Public Document Room.

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If you have any questions regarding this matter, you may contact me at (301) 415-8548.

Sincerely,

original signed by:

Diane T. Jackson, Project Manager
Standardization Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Docket No. 52-003

Enclosure: As stated

cc w/enclosure:
See next page

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Mr. Nicholas J. Liparulo
Westinghouse Electric Corporation

Docket No. 52-003
AP600

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Enclosure to be distributed to the following addressees after the result of the proprietary evaluation is received from Westinghouse:

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AP600 - REQUEST FOR ADDITIONAL INFORMATION ON WCAP-14407,
SECTION 12, "Clime Noding Study"

On Page 12-1 of WCAP-14407, the applicant states: "A detailed description of the GOTHIC Code and the modifications implemented in the amended code as WGOTHIC is presented in Section 3.2 of this report." That section currently describes WGOTHIC Version 4.0. However, in the letter of transmittal (Ref: NSD-NRC-97-5010, dated March 14, 1997), the applicant states that the sensitivity calculations performed in Chapter 12 were done using WGOTHIC Version 4.1, which corrects an error in the clime model calculation, as well as a significant number of additional changes to the AP600 model description.

480.1022 The applicant needs to expand the one sentence discussion of the technical differences between WGOTHIC Versions 4.0 and 4.1 presented in the cover letter and incorporate this discussion in the body of WCAP-14407, specifically the over-prediction of heat removal from a clime which experiences dryout. Describe the changes to the "ccvel" subroutine and its impact on the annulus inertia lengths.

480.1023 The applicant needs to provide an evaluation of the differences between WGOTHIC Versions 1.2 and 4.1 on the previous calculations presented in the "WGOTHIC Code Description and Validation" report, WCAP-14382. This evaluation should present a technical justification why these existing calculations remain valid, and consider the "ccvel" subroutine and the changes to the annulus inertia lengths. Those calculations deemed most likely to be impacted by the change from Version 1.2 to Version 4.1 should be rerun (at a minimum, Tests 214.1A, 214.1B, 216.1B, 219.1A, 219.1B, 219.1C, and 222.4B) and provide comparison plots of pressure, passive containment cooling system (PCS) air and film temperature, heat flux, and heat removal rate.

The following questions refer to the Clime Noding Sensitivity Study discussed in Section 12.2.1 and the results presented in Section 12.3.1.

480.1024 a) Why was an arbitrary selection process used to define the downcomer-to-riser volume ratio?

b) Why is the sensitivity model much shorter than the AP600?

c) The applicant needs to compare (in tabular form) the Reynolds, Prandtl, and Grashof numbers for the coolant flow through the downcomer and annulus in the Section 12.1 sensitivity study model to the Section 12.2 AP600 containment model.

480.1025 a) The applicant needs to justify the use of the selected film flow rate for two of the three sensitivity studies. This value is 20 times greater than the value selected which results in dryout in the simulated riser section.

Enclosure

b) The applicant needs to compare the Gamma,(Γ - lbm/ft-sec), and the Reynolds number for the film flows used in the Section 12.1 sensitivity study model to the Section 12.2 AP600 containment model.

480.1026 In Figure 12-3, the applicant needs to identify the climes and resistances which represent the thick steel plate. Also, identify the climes and resistances which represent the acrylic plate.

480.1027 a) What does the thick steel plate represent in the AP600? If it is the AP600 containment shell, why is it much thinner and why not include the inorganic zinc paint? If it is the baffle, why was the baffle modeled much thicker than the actual baffle dimension for the AP600?

b) What does the acrylic plate represent in the AP600? If it is the baffle, does the acrylic plate provide a satisfactory representation of the heat transfer to the downcomer?

c) What is the impact of the acrylic baffle on the sensitivity results?

d) Compare the Biot number for the thick steel plate and the acrylic cover to either the AP600 containment shell or baffle plate, which ever is correct.

480.1028 The applicant needs to justify the selection of a sub-atmospheric pressure boundary condition. Also, identify the node noted on Page 12-6 as the fixed pressure boundary: Figure 12-3 shows an exit and an entrance node, Nodes 1P and 2P, which are unconnected.

480.1029 On Page 12-5 of WCAP-14407, the applicant states that the riser and downcomer stacks were divided into nodes of equal size. What values were given for the volumes, flow areas, frictional lengths and boundary conditions for the exit and entrance nodes (Nodes 1P and 2P of Figure 12-3)?

480.1030 Why does the drain require the addition of a dummy clime? Could not a simple volume (Volume 18) be added to facilitate draining of the annulus runoff, instead of a dummy clime which has dummy heat transfer connections to the containment and from the downcomer? As the AP600 Evaluation Model uses an "evaporation limited flow," why was it necessary to add this dummy clime to the AP600 Evaluation Model?

480.1031 The applicant needs to justify the use of a constant temperature heat source for the Clime Sensitivity Model. In the WGOTHIC evaluation model, the temperature of a dry clime would be much

hotter than a wet clime. This model forces the surface temperature to remain the same, artificially minimizing the impact of temperature dependent differences on evaporation and radiation heat transfer rates.

480.1032 The applicant needs to confirm the accuracy of the information presented in Figures 12-18 and 12-19. Have these two figures been erroneously exchanged during the document preparation process?

480.1033 The applicant needs to provide plots showing the annulus and downcomer pressure, density, and flow velocity profiles for the three clime models at 2000 seconds.

480.1034 On Page 12-8, the applicant states that figures provided show that the WGOTHIC results were close to steady-state at the end of the 2000-second transient period. Since 2000 seconds are required for the annulus air flow calculations to approach steady-state, an initialization procedure must be used by Westinghouse to set the WGOTHIC downcomer and annulus air flow velocities to their steady-state values in lieu of preceding the start of the blowdown calculations with a 2000 second "null-transient." The applicant needs to describe this procedure and provide a technical justification for its use.

The following questions refer to the AP600 Containment Clime Noding Sensitivity Study discussed in Section 12.2.2 and the results presented in Section 12.3.2.

480.1035 The applicant needs to incorporate the changes to the WGOTHIC Evaluation Model, as described on Pages 12-6 and 12-7, into the Evaluation Model description provided in Section 4 of WCAP-14407.

480.1036 The applicant needs to provide an evaluation of the differences between WGOTHIC Versions 4.0 and 4.1 on the previous calculations presented in the current "WGOTHIC Application to AP600" report, WCAP-14407. This evaluation should present a technical justification why these existing calculations remain valid. Those calculations deemed most likely to be impacted by the change from version 4.0 to 4.1 (including the modeling changes related to below operating deck region loss factors, heat structures, renodalization, and modified mass and energy releases) should be rerun and comparison plots of pressure, PCS air and film temperature, heat flux, and heat removal rate should be presented.

480.1037 a) The applicant needs to provide a more detailed discussion of the AP600 models used for the case with an increase in the number of climes in a stack (the axial sensitivity study) and the case with an increase in the number of stacks (the azimuthal sensitivity study).

b) As in all WGOTHIC analyses previously submitted for staff review, do these cases also include a "one-to-one" correspondence of a GOTHIC PCS annulus fluid node to clime pair (the wet and dry regions) to containment dome (above operating deck region) fluid node? If not, and considering the withdrawal of Section 13 from WCAP-14407 on noding studies in support of the evaluation model, how does Westinghouse conclude that the dome (above operating deck region) nodalization is appropriate, provides a converged solution, and does not contains numerical instabilities?

c) Particularly for the azimuthal study provided, with fixed fluid boundary nodes it does not appear to the staff that there would be any differences (temperatures, heat fluxes, etc.) between the set of wet or set of dry climes associated with the same set of boundary nodes. Please provide an explanation.

480.1038 Figures 12-28 through 12-36 all terminate at about 43,200 seconds (12 hours). Please extend these figures to span 24 hours. Do any of the wet stack climes experience dryout in this time period? If so, please indicate the time of dryout on the figures. Is this the dryout behavior expected for the AP600 loss-of-coolant-accident (LOCA)?

480.1039 Are the changes (both to WGOTHIC 4.1 and to the AP600 model) expected to impact the main steam line break (MSLB) cases?

480.1040 The applicant needs to provide comparative plots of heat flux and film temperatures versus clime location for a representative wet stack and the heat flux and shell surface temperature versus clime location for a representative dry stack for the "base case clime" and "increased number of climes case" AP600 models prior to blowdown, at 30 seconds, at 1500 seconds, and at 24 hours.

480.1041 The applicant needs to provide the annulus and downcomer pressure, air temperature, density, and flow velocity profiles for the "base case clime" and "increased number of climes case" AP600 models prior to blowdown, at 30 seconds, at 1500 seconds and at 24 hours. How does Westinghouse confirm that these profiles represent stable and converged flow solutions?