52-003

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

March 11, 1996

Mr. Nicholas J. Liparulo
Nuclear Safety and Regulatory Activities
Westinghouse Electric Corporation
P.O. Box 355
Pittsburgh, Pennsylvania 15230

SUBJECT: DISCUSSION ITEMS FOR AN AP600 MEETING ON THE OREGON STATE UNIVERSITY (OSU) TEST ANALYSIS REPORT (TAR)

Dear Mr. Liparulo:

As a result of its review of the June 1992, application for design certification of the AP600, the staff has determined that it needs additional information. The enclosed questions and comments have been developed by the staff's contractor (INEL) based on an ongoing review of the OSU TAR and are specifically related to Test SB09.

We propose that these question serve as an agenda item for a currently unscheduled meeting concerning AP600 testing issues. The meeting will be scheduled when the contractor has completed the review of the OSU TAR. During the meeting, the staff will determine which discussion items need to be formally addressed by Westinghouse.

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 followon questions 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 NRC Public Document Room.

These followon questions affect nine or fewer respondents, and therefore is not subject to review by the Office of Management and Budget under P.L. 96 511.

If you have any questions regarding this matter, you may contact me at (301) 415-1141.

Sincerely,

original signed by:

William C. Huffman, Project Manager
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Office of Nuclear Reactor Regulation

Docket No. 52-003

Enclosure: As stated

cc w/enclosure:
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AP600

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QUESTIONS, COMMENTS, AND DISCUSSION ITEMS

CONCERNING THE WESTINGHOUSE AP600 OSU TAR TEST SB09

Section 5.4: Test SB09

1. a. In Figure 5.4.1-1, the rate of depressurization changes sharply at about 380 seconds, well before the beginning of the ADS phase of the transient. Please explain the reason for the increased rate of depressurization between 380 seconds and ADS-1 actuation. Note: The text, on p. 4.4.1-2, appears to attribute this behavior to emptying of the steam generator tubes. If this is the case, please explain the rationale behind this assertion, since it appears that emptying of the SG tubes would allow steam to enter the tubes, which would then superheat due to heat transfer from the secondary side (primary pressure is lower than secondary pressure at this time). It is not clear why this sequence of events would lead to a higher depressurization rate.

   b. In addition, the end of the blowdown phase is said to occur when the primary and secondary pressures reach equilibrium, however, Figure 5.4.2-4 shows that from about 160 seconds to 380 seconds, the primary pressure oscillates at a value slightly above the secondary and then drops rapidly below the secondary pressure (as noted in number 1, above), without ever really reaching an equilibrium. Please discuss.

2. Why is there an approximately 200-second difference between the times for initiation of IRWST injection for the two DVI lines? Is this related to the different times at which the CMTs empty?

3. A plot of system pressure during the IRWST phase is absent in Figure 5.4.1-1. This would be especially of interest between 10,000 and 13,000 seconds, when system-wide oscillations in pressure were noted.

4. The integrated CMT flow in Figure 5.4.2-9 differs from the two CMTs. Is this due to lack of recirculation in CMT-1 for a substantial period due to the balance line break? This plot is somewhat confusing. One would expect the integrated mass flow to equal the original mass in the CMT, assuming the CMT empties completely. This is not the case, because the flow coming back into the CMT during recirculation is not subtracted from the integrated outflow. So instead of an integrated mass flow of about 650 lb. [(2000 cu. ft/192)*62.4], values in this test range from about 700 to 840 lb.

5. It appears as if the way in which the average void fraction is estimated assumes an average void distribution along the entire length of the heated rods. This could be non-conservative, if boiling begins above the bottom of the rods; i.e., the actual average void fraction along those

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portions of the rod where boiling exists would be higher. This could affect assumptions about the effectiveness of heat transfer along the rods, especially in the highest void-fraction region near the top.

6. In Figures 5.4.2-48 to -51, as the upper plenum and head are recovering, there is one final sharp down-spike in level at about 2000 seconds. This does not appear to be reflected in the core level/mass plots in Figures 5.4.2-44 and -45. What causes the dip in the upper plenum and upper head?

7. Figure 5.4.2-33, curve "C" shows integrated PRHR heat removal. The curve peaks at around 600-800 seconds, after which it begins to decrease. If this is truly an integrated curve, a decrease would seem to indicate heat transfer <u>from</u> the IRWST <u>to</u> the primary system, which does not seem to be logical. Please explain what this curve shows and the reason for its shape.

8. There appears to be a slight zero offset in time on Figure 5.4.2-67; the break flow begins to rise before time "zero." Please explain.

9. Why does the curve in Figure 5.4.2-67 have a "multiple hump" shape? What is driving the increases and decreases in steam flow?

10. Why is the indicated liquid break flow in Figure 5.4.2-68 negative between about 100 and 200 seconds? Is flow really going back through the break, or is this an anomaly of the configuration of the BAMS?

11. The description of the break flow behavior in the first paragraph of "Energy Transport via the Break and Automatic Depressurization System" on p. 5.4.2-3 hardly captures the behavior of the curves. The liquid break flow, for example, peaks well above the stated 4 lbm/sec., oscillates, goes sharply negative, recovers, goes negative again, then drops to near zero. The text should more clearly describe and explain the behavior of the curves.

13. There appears to be a slight inflection and increase in the slope of the break flow curves in Figures 5.4.2-62 and -63, around 250 seconds. Why does this occur?

14. Figure 5.4.2-70 shows "total mass." However, the system components contributing to this "total" are not described. It is not clear, therefore, how the "total mass" can rise immediately after the start of the transient, when it would not seem that mass is being added to the system; if anything, with inventory going out the break, "total mass" would appear to decrease. In addition, if the "total" includes components that can inject mass to the system, then it is not clear why the "total mass" should increase at all. Please clarify what this plot represents, and discuss its behavior as a function of time.

15. Please describe in detail the system response immediately upon opening the sump injection valves. Specific items of interest include the sharp spike in sump flow and the reversal of DVI-1 injection flow.

16. Figure 5.4.3-36 shows two spikes in steam flow shortly after the end of the second set of large-amplitude oscillations. What is responsible for these spikes? Similar features are noted in several other figures, e.g., 5.4.3-34, -35, and -37.

17. On p. 5.4.3-2, the upper plenum collapsed liquid level is described as staying "between the hot leg and DVI elevations throughout the transient." The level did not drop to this point until after the inception of sump injection.

18. At the end of Section 5.4.3.1 (p. 5.4.3-3), the ADS-4 liquid flow is said to increase after about 13,100 seconds. This is not clear from the figure referenced (Figure 5.4.3-44), where average values are difficult to discern due to oscillations and/or noise. If the ADS-4 flow does increase for a brief time, it appears to decrease beginning around 14,000 seconds. Please elaborate on this behavior and explain how the description of events is represented by the plots.

19. Please clarify what is meant by the last sentence in Section 5.4.3.1. What does "no effect on downcomer level" mean in this context?

20. In the second paragraph of Section 5.4.3.2 (p. 5.4.3-3), it is stated that there was reverse flow through the break was indicated after 6000 seconds. The way in which the BAMS is configured for this break appears to make actual reverse flow through the break difficult to achieve. Is there an alternate explanation for <u>indicated</u> negative break flow, which does not actually result in backflow through the break? Would such an alternate explanation affect the conclusions reached in this section?

Editorial Comments Related to SB09

1. The text on p. 5.4.1-1 indicates that Figure 5.4.1-2 shows the total DVI line flow and each of the components of that flow. However, the figure shows only the components (CMT, ACC, IRWST, sump), and not the total flow. A plot with the total flow would be quite useful.

2. There is a minor inconsistency in the text, which puts the end of the blowdown phase at 160 seconds, and Figure 5.4.1-1, where it is shown as 120 seconds.

3. The reference to Figures 5.4.2-6 and -7 in the first paragraph of Section 5.4.2.1 should be Figures 5.4.2-5 and -6. The staff also notes that these figures are sometimes difficult to interpret because of the subtle variations in shades of gray. Color plots are much easier to decipher.

4. The reference to CMT-2 in the third line from the bottom of p. 5.4.2-1 should be CMT-1.

5. On p. 5.4.2-2, it would be helpful (first paragraph) to indicate the time at which the core outlet temperature became subcooled after reaching saturation at 24 seconds. This time appears to be about 55 seconds. It then remained subcooled from 55 to about 180 seconds before returning to saturation.

6. In the next-to-last paragraph on p. 5.4.3-2, it is stated that the equilibrium mass of water in the reactor vessel is about 375 lbm. It would be useful to state when this value was reached (it appears to be about 2000 seconds after the start of sump injection).

7. In Drawing LKL 920200, the reference to Cold Leg 1 at the bottom of the PBL originating at the top of CMT-1 appears to be wrong. This should be Cold Leg 3.