52-003

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

August 22, 1995

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

SUBJECT: FOLLOWON QUESTIONS CONCERNING AP600 PRELIMINARY VALIDATIONS REPORTS FOR NOTRUMP

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 in order to complete its review. Specifically, the enclosed questions and comments have resulted from the a comprehensive review by the staff and its contractor, INEL, of the NOTRUMP Core Makeup Tank preliminary validation report (MT01-GSR-001 dated April 1995) and the NOTRUMP Automatic Depressurization System preliminary validation report (RCS-GSR-003 dated April 1995).

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
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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REQUEST FOR ADDITIONAL INFORMATION

AP600 NOTRUMP AUTOMATIC DEPRESSURIZATION SYSTEM
PRELIMINARY VALIDATION REPORT

RCS-GSR-003 DATED APRIL 1995

440.
432 On page 3-1, it is stated that the entire ADS package is modeled as a single flow link and that the effective loss coefficient of the ADS system is also not needed since the flow is choked for all tests. This appears to be an over simplification since the three ADS valves in Fig. 3-1 do not appear to be arranged symmetrically. As such, choking is not expected to occur simultaneously in these lines. Please identify where choking occurs in the tests and show that the omission of form losses in the momentum equation do not influence the system depressurization rate. That is, please explain why asymmetric effects can be ignored in the modeling of the ADS lines. Please also show how the inertia and line loss terms were computed for the single flow link simulating the three ADS valves depicted in Fig. 3-1. Also, discuss the modeling of momentum flux effects in the momentum formulation in the ADS lines using NOTRUMP since there are many contractions and expansions in these lines.

433 Page 3-1 states that NOTRUMP cannot model the air in the discharge lines, so the piping system was initially filled with steam. Air trapped in the lines could impact the dynamics of the system pressure response and could be a potential source of the errors in the ability of the NOTRUMP code to reproduce the flow quality transient behavior within the first 6 seconds of each test. Please explain the effect of not modeling air in the lines and the effect on the ADS system pressure, flow, and quality responses. Please also explain the effects of the initially steam filled pipes on system behavior.

434 On page 3-2, the 100-series tests are not modeled because the tests were with single phase steam. Please demonstrate the ability of the NOTRUMP code to accommodate single phase steam critical flow since the ADS system is expected to transition to high quality steam flow discharge.

435 The flow quality data show an increase in quality within the first six seconds for all of the tests while NOTRUMP displays a decreasing trend. While the flow quality at the sparger discharge will establish the depressurization rate for the system, the miscalculated flow quality, particularly in the beginning of each test, suggests that NOTRUMP is lacking dynamic effects. As such, explain how the two-region fluid model void distribution in the liquid regions is computed, and how this lower region void fraction affects the quality exiting a volume. Also, does the assumption that steam regions form above liquid regions affect the fluid void distribution in the ADS lines? That is, explain the conditions where separation occurs versus highly dispersed liquid-steam mixture conditions with void gradients and how NOTRUMP treats these conditions in the ADS lines. Are void gradients computed in the liquid regions? How is the release of steam from the liquid region computed; is it based on

the average void fraction in the region or is a surface void fraction computed for release calculations? In vertical sections, during depressurization transients or vertical regions with high heat addition, large void gradients can develop where the surface void fractions can be two to three times greater than the average. Please explain how NOTRUMP treats the void distribution and release of steam from the two-phase regions under these conditions?

436 Please explain how the NOTRUMP code uses Equation 4-1 in computations of the fluid quality.

437 NOTRUMP overpredicts the depressurization rate in the pressurizer for several tests while the fluid qualities in the ADS lines for these tests were underpredicted. Since lower quality should lead to a reduced depressurization rate, please explain this inconsistency. See for example Figs. 4-13, and 4-33, 4-53. Also, these tests are only displayed for 30 seconds and only capture the very initial short period of the depressurization. Please explain why the comparisons were not carried out beyond 30 seconds or until atmospheric pressures are approached. Some of the tests show a marked deviation between the data and the NOTRUMP prediction suggesting the long term depressurization may be grossly overpredicted as in Figs. 4-53, while the flows show a growing discrepancy with the data as in Figs. 4-32 and 4-12 at 30 seconds. Since the ultimate judge of the ADS is its ability to depressurize the system to very low pressure, displaying the test comparisons for only the first 30 seconds where the system remains at elevated pressures does not demonstrate the NOTRUMP code ability to predict ADS depressurization over the full range of system pressures. Please provide the NOTRUMP comparisons to the data until the system has completely depressurized.

438 Please explain the inconsistency in the discussion of the effect of the tank pressure on quality on page 4-3, the middle of the second paragraph. The explanation suggests that both low and high tank pressures will lead to lower qualities.

439 Accurate characterization of the ADS mass and energy loss rates is vital to the prediction of the RCS depressurization rate, subsequent ECC injection, and the vessel inventory. Modeling of elevation differences and line losses are therefore of most importance to modeling the effectiveness of the ADS. With this in mind, has the NOTRUMP code been assessed against single-phase and two-phase pressure drop data in piping systems with expansions and contractions present? If so, please provide the information. The Janssen [1] data provides an example of separate effects test data to validate the momentum flux and line loss modeling in a code such as NOTRUMP.

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(1) Janssen, E., "Two-Phase Pressure Loss Across Abrupt Contractions and Expansions, Steam Water at 600 to 1400 psia," Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7 through 12, 1966.

REQUEST FOR ADDITIONAL INFORMATION

AP600 NOTRUMP CORE MAKEUP TANK PRELIMINARY VALIDATION REPORT FOR 500-SERIES NATURAL CIRCULATION TESTS MT01-GSR-011, APRIL 1995

440.

440 Thermal stratification in the CMTs is a major modeling concern in the AP600 simulations. On page 4-2, comparisons of the NOTRUMP code to test data, demonstrate that the code tendency is to overpredict the temperatures in the CMT and as a consequence overpredicts the drain flow rates. As such, was a nodalization study performed to justify the use of four nodes in the CMT? Fig. 2-5 shows a much larger lower node was used at the bottom of the CMT, please explain why this nodalization was used. The poor comparisons with temperature suggest more nodes are required. More nodes may not eliminate the numerical diffusion, but the errors in the NOTRUMP temperature prediction should be reduced with additional nodal detail in the CMT. Please provide the results and discussion of the nodalization study used to justify this spacial model. Also, provide plots of the fluid driving heads calculated by NOTRUMP for each side of the loop shown in the system model in Fig. 3-1. These plots should help to understand the inlet and outlet flow behavior in NOTRUMP for the tests.

441 Were wall temperatures measured in the facility in the CMT and piping? If so, how does the NOTRUMP code compare to these data. Please provide the comparisons and discuss the results.

442 Were wall heat structures modeled in the piping and reservoir? If not, please justify the omission? If so, please describe the model and mesh structure in the all walls where wall heat was simulated.

443 Please confirm and justify the reservoir nodalization? Fig. 3-1 indicates that a single node was modeled. Please justify the nodalization and explain the effects of thermal stratification and mixing, or lack thereof, in the S/W reservoir on the NOTRUMP results.

444 Was a time step study performed for these tests? What time steps were used to simulate these tests? Please discuss and show that the time steps used do not contribute to the error in the NOTRUMP predictions. Are the time steps consistent with those used in the plant model?

445 As discussed in Section 5.0, the time averaged flows over the entire test may show good comparisons, however the first half or early portions of the event may show the time averaged flows are over-predicted by NOTRUMP. The early flow rates are over-predicted partially due to the coarse nodalization which increases the driving head and increases the flow. The results and conclusions may be different if the plots are divided into two portions, a time averaged flow condition for the first half (i.e. when the temperatures in the CMT are over-predicted) and the second half of each event. Please discuss the behavior of the NOTRUMP code with this time average splitting. While the overall transient response of the time averaged inlet flow may be in agreement, the first half of the event may not and incorrectly affect the RCS loop temperatures and system behavior later in the event.

446 As mentioned in Section 5.0, please summarize the referenced report and briefly explain why the inlet flow uncertainty is higher than the outlet flow uncertainty measurement for the tests. Please explain this uncertainty in light of the NOTRUMP inlet flow rate predictions.