Central File

52-003

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

August 4, 1995

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

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (RAI) RELATED TO THE AP600 PROBABILISTIC RISK ASSESSMENT (PRA)

Dear Mr. Liparulo:

Enclosed are the Nuclear Regulatory Commission's (NRC) staff comments on several areas evaluated in the AP600 PRA. Enclosure 1 contains RAIs on the seismic margins assessment of the AP600 design. Enclosure 2 contains RAIs related to the structural evaluation in support of the conditional containment failure probability assessment (Chapter 42 of the AP600 PRA). You are requested to provide a response to these questions and comments within thirty days of receipt of this letter.

Enclosure 3 contains a report from Idaho National Engineering Laboratory (INEL) discussing modelling of human actions in the Level 2 PRA. The staff is providing Westinghouse this report in advance of forthcoming RAIs so your staff may familiarize themselves with the INEL evaluation.

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 the INEL report and 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 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.

DF03

If you have any questions regarding this matter, you may contact me at (301) 415-8465.

Sincerely,

Original signed by

Michael X. Franovich, Project Manager
Standardization Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Docket No. 52-003

Enclosures:
As stated

cc w/enclosures:
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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REQUEST FOR ADDITIONAL INFORMATION ON WESTINGHOUSE'S SEISMIC MARGINS ANALYSIS FOR THE AP600 DESIGN

1. The risk-based seismic margins analysis (SMA) must be updated to reflect revisions made in the internal event analysis. Such revisions include changes in event and fault tree models, success criteria, hardware failure and human error probabilities. The updated analysis should state explicitly all important assumptions made in constructing the seismic event trees, starting with the internal event trees.

2. The guidance provided by NRC for SMA requires that in addition to seismic only contributions, combinations of seismic and random failures/human errors need to be identified and reported. Only random failures having a failure probability of 1E-3 or greater need be considered. The explanation provided in Sections H.3.5 and 2.2 is not clear. Please explain how potential combinations of seismic and random failures were systematically identified.

3. Because of the extra demands on the operators following a seismic event, human error probabilities (HEPs) used in seismic events should be reviewed to determine their applicability to the conditions expected to exist after the seismic event of the postulated magnitude. Please identify which of the internal event's "operator failure to start ADS" is used in the SMA and provide a brief discussion of its applicability.

4. A mission time of 24 hours is assumed in the SMA (as for the internal events analysis). This assumption must be justified on the basis of the plant state at 24 hours. If the plant is not at a stable state, the beyond 24 hours risk must be assessed or shown to be negligible (e.g., in terms of available options, time windows for human actions, etc.). An example is the scenario of a seismic event that causes loss of offsite power and loss of all non-safety related "active" systems (low HCLPF values) combined with failure to isolate the containment (random plus seismic).

5. The seismic fault tree for the passive RHR (Figure 2.2-2) shows a system failure when the DC power needed to open the AOVs is lost. Do not these AOVs fail open upon loss of 125 V DC power? Please explain.

6. Section H.3.2.8 states: "a consequential small LOCA could occur because the pressurizer safety valves open and do not close, small pipe breaks occur, or for any other reason." Are these small pipe breaks due to the seismic event? If the answer is yes please provide the HCLPF values for such small pipes.

7. No seismic event tree is included in the analysis for main steam line breaks inside containment (MSBI). The explanation for this (provided in H.3.3.5) is not clear. Please provide a seismic event tree for MSBI or explain why this event tree is not needed to gain additional insights than those already available through other seismic event trees.

8. Westinghouse should correct several errors in reporting combinations of seismic and random failures (mixed cut sets). For example, in sequence 27 of MSBO event tree, 1.28g + OA(2.2E-3) is reported. The correct result should be stated as: 1.28g + 1.28g * OA(2.2E-3) = 1.28g.

9. The only failure mechanism considered for loss of containment cooling, as a result of blockage of the baffle, is the structural failure of the baffle itself. However, it is possible for the baffle to be blocked as a result of release of water following the seismic induced failure of the Passive Containment Cooling Water Storage Tank (PCCWST) and failure to drain the water below the baffle plate due to, for example, blockage of the drains by debris from the failed PCCWST. Westinghouse should report the HCLPF for the PCCWST and evaluate and discuss the feasibility of this containment cooling failure mode.

10. For several components, the reported HCLPF and median values seems to be inconsistent. For example, the HCLPF value for the RCS components V001A/B/C/D is estimated to be 2.85g. This is higher than the listed median value of 2.38g (Table H-1). Please explain.

11. Westinghouse should evaluate the results of the seismic analysis. This should include sensitivity analyses to evaluate the effects of changes in certain assumptions. For example, the effect on the plant HCLPF of a reduction in the assumed HCLPF values of certain systems, structures and components (e.g., due to uncertainties). Such sensitivity analyses provide important insights about the design. The documentation of this evaluation should include: (1) a discussion of the plant HCLPF; (2) a discussion of the dominant seismic and mixed (seismic/non-seismic) sequences; (3) conclusions and discussion of the conclusions; and (4) a list of important assumptions and insights.

12. Passive systems depend on very low driving heads to generate the required flow. The specific orientation of equipment and piping may have a significant impact on the ability of these systems to generate sufficient head. Seismic events in excess of the SSE have the potential to result in inelastic behavior and associated permanent distortion of systems or the structures they are anchored to. In forced flow systems, such minor distortions (such that the operability of the equipment would not be compromised) would not result in system failure, since pumped flow would be able to overcome minor changes in flow resistance. Therefore, previous SMAs (for operating and advanced evolutionary reactor designs) do not consider such failure modes. However, it is not clear that this assumption can be fully supported for passive systems.

    Changes in the orientation of equipment or piping (e.g., the downstream end of a pipe being raised above the upstream end) could result in loss of sufficient driving head through increased resistance or the formation of gas bubbles ("loop seals") within the piping runs. There is a need to understand the importance of piping orientation to the success of these systems. Similarly, seismically-induced failure of check valves to open has not been considered. While the existing guidance on SMA justifies this assumption for check valves in active systems, that guidance did not consider whether such an assumption would be valid under the operating conditions present for passive systems.

    A systematic investigation is needed to determine whether there are "passive system related" failure modes with HCLPF values lower than those already considered in the SMA. If such failure modes are found, they should be addressed in the SMA or show (e.g., using results from the passive system performance reliability analysis) that they will not affect the conclusions and insights expected from the SMA.

REQUEST FOR ADDITIONAL INFORMATION ON WESTINGHOUSE'S
CHAPTER 42 OF THE AP600
PROBABILISTIC RISK ASSESSMENT (PRA)
Revision 4

1. In Chapter 42 of the PRA, the mean failure pressure is mentioned for each failure mode. As stated in DSER, the staff recommended the best estimate pressure be median for the conditional containment failure probability (CCFP) calculation. (If lognormal distribution is used, the mean is median times $\exp(\beta^2/2)$ where β is logarithmic standard deviation.) For the best estimate pressure, the staff is not in a position to accept the 32% increase using both von Mises criterion and mean yield strength of SA Class 2 material. See Open Items 3.8.2.4-19 and 19.2.6.2-3.

2. In Section 42.2, is lognormal distribution applicable for the 16-ft and 25-ft equipment hatches? Due to their convexity, these are under compression when subjected to containment internal pressure as mentioned, further justification is necessary for these equipment hatches.

3. In Section 42.4.1, how is the coefficient of variance (COV) of 0.1 derived from Ref. 42-1? This is the most important factor for the CCFP.

4. In Section 42.4.2, in DSER, the best estimate pressures for yielding at crown, yielding at knuckle region and incipient buckling are 146 psig, 152 psig, and 174 psig, respectively at 100°F. How is the post-yielding buckling in knuckle region of 192 psig derived?

   Because the best estimate yielding at the crown is the lowest pressure, it should be used for the CCFP.

5. In Section 42.3, where is the test data supporting 50% increase for critical pressure? See Open Items 3.8.2.4-26 and 19.2.6.3-6.

6. In Section 42.5, provide the sample CCFP calculation for cylinder at 100 psig. You have constructed the containment failure probability distribution for a particular failure mode by first developing the failure distribution assuming only random error and then developing another distribution assuming only subjective error. The staff believes this method may not be conservative in comparison with the combination of random and subjective errors ($\beta_c^2 = \beta_{material}^2 + \beta_{modelling}^2$) in the left tail region.

7. In Section 42.6, what is the definition of mean internal pressure? Does it mean median pressure? See Open Items 3.8.2.4-27 and 19.2.6.3-7.

8. In Table 42-1, does "Structural" under COV heading mean "Material"?

   How is 144 psig derived for ellipsoidal head buckling failure mode? It is not given in the SSAR.

Enclosure 2