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

June 8, 1994

Docket No. 52-003

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

Dear Mr. Liparulo:

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION ON THE AP600

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. The additional information is needed in the area of regulatory treatment of non-safety-related systems and probabilistic risk assessment (Q440.173-Q440.246).* These requests for additional information (RAIs) are related to Westinghouse's Topical Report WCAP-13856, "AP600 Implementation of the Regulatory Treatment of Nonsafety-Related Systems Process," and other related material in the June 1992 Probabilistic Risk Assessment (PRA). If the responses to these RAIs change, add, or eliminate any success criteria assumed in the PRA, then you should modify the PRA accordingly, and identify any changes in the success criteria as soon as possible. Enclosed are the staff's questions. Please respond to this request on a schedule that will support development of the November 1994 draft final safety evaluation report on the AP600 design.

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 this request for additional information does 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's Public Document Room.

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*The numbers in parentheses designate the tracking numbers assigned to the questions.

This request for additional information affects 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 can contact me at (301) 504-1120.

Sincerely,

(Original signed by)

Thomas J. Kenyon, Project Manager
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Associate Director for Advanced Reactors
and License Renewal
Office of Nuclear Reactor Regulation

Enclosure:
As stated

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See next page

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Mr. Nicholas J. Liparulo
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Docket No. 52-003
AP600

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REQUEST FOR ADDITIONAL INFORMATION
ON THE WESTINGHOUSE AP600 DESIGN

440.173 In the September 24, 1993 focused PRA, the set of success paths credited implies a set of systems and associated missions. In order for the staff to evaluate the RTNSS issue, specify a set of quantitative reliability/availability (R/A) missions (upper bound unavailabilities) for these systems, having the property that overall safety objectives are met provided that the systems are kept within these unavailability limits. For purposes of the staff evaluation, it is theoretically possible to use as targets Westinghouse's best estimate values, but this would lead to formulation of oversight measures based on needlessly high R/A missions (low unavailabilities). Provide a set of quantitative R/A missions for the purposes of this evaluation. Specifically, for each event tree branch point for which success is claimed in a safety-grade success path, furnish an upper-bound unavailability. In addition, identify initiating event (IE) frequency bounds, so that measures to ensure low IE frequency can be considered. If any active non-safety-related system is credited to meet the overall safety objectives as a result of using the upper-bound unavailabilities of the passive safety systems, provide the R/A missions of the active systems.

In order to clarify the relationship between the best-estimate value and the R/A mission, provide branch point probabilities for each of the success paths credited in the focused PRA (e.g., system failure probabilities at each stage of each success path), together with the overall failure probability associated with each success path. In some cases, these numbers are not necessarily system failure probabilities, but may be events corresponding to stuck-open relief valves or other phenomenological branch points.

440.174 In the September 24, 1993 focused PRA, the evaluation of small RCS leak events appears to take credit for the chemical and volume control system (CVS), but concludes that no regulatory oversight beyond a reliability assurance program is necessary. The staff believes that this conclusion is premature. If an R/A mission is credited for a system, then active regulatory oversight should be considered for that system.

a. Provide quantitative R/A missions (unavailability given a challenge) of the CVS in the RCS leakage IE.

b. In report ET-NRC-93-3900 (October 20, 1993), the frequency of this IE of 6.5E-05 per year was calculated as the product of the frequency of leakage in the range of 1 to 100 gpm (1.2E-2 per year) and the failure probability of the CVS (5.4E-03). Tabl[illegible] shows that this IE contributes to 0.5% of the total core d[illegible] frequency of 3.4E-7 per year, i.e., 1.7E-9 per year. Therefore, if no credit is taken for the CVS, the contribution would be at

Enclosure

least 3.14E-7 per year. The actual frequency is even higher because, in the event tree, credit is taken for the repair of the CVS. Therefore, the staff believes that the effect is significant with respect to core damage frequency. Describe why Westinghouse does not believe that it is significant.

440.175 For those elements (systems, structures, and components) credited for performing beyond their design basis in the evaluation of the large release frequency, what level of physical performance is being credited, and in what scenarios are these levels of performance necessary? Provide a comprehensive table of these items. (This should include elements of the containment boundary subjected to a higher-than-design-basis temperature or pressure, credit for beyond-design-basis hydrogen removal, etc.) Indicate where, in material already submitted, the basis for this performance is to be found, or furnish the basis if it has not been previously submitted.

440.176 Section 8.1.1 of WCAP-13856 identifies general methods used for the evaluation of the functional interaction aspect of systems interactions between the active and passive systems in the AP600 design. These methods include (a) assuming the operation of a non-safety-related system if its actuation worsens the analytical result of the Chapter 15 analysis, (b) considering those integral tests involving both safety-related and non-safety-related systems in the AP600 test program that will validate the thermal-hydraulic codes used in Chapter 15, and (c) modelling the system interdependencies in the system fault trees and event trees in the PRA. This section also includes a list of safety-related functions of the active non-safety-related systems in the AP600 design to preclude the potential for non-safety-related systems to adversely interact with the safety system. However, it does not provide detailed information to demonstrate how these methods can capture all of the subtle interactions.

Provide a discussion of the detailed methods used to identify possible adverse systems interactions (ASI) that could be hidden in the AP600 design, and proposed resolutions of these ASIs, including design modifications and operating procedures. In addition, provide the following information:

a. For some combinations of depressurization hardware, the success criteria analysis for medium- and small-break LOCA reported in the PRA (Appendix J) indicates that significantly higher peak clad temperatures (PCTs) are predicted for the operation of two accumulators as compared to one accumulator operation. It states that with two accumulators, the pressurization following accumulator injection causes an increase in the pressurizer water level. This results in a lower release of steam through the automatic depressurization system (ADS) valves, which leads to a delayed in-containment refueling water storage tank (IRWST) injection and a higher PCT because of the lower two phase reactor vessel water level. Confirm that no clad failure would take place. What are the boundary conditions, initial conditions, and timing of events that can be varied in the analysis of these events, such that a worst and bounding case can be determined? Can partial or brief operation of the normal residual heat removal system (RNS) in the injection mode have a similar effect?

b. For certain medium-break LOCA cases and the transient event trees, the status of the CVS is not queried. This implies that the ADS success criteria are identical whether or not the CVS worked. Can continuous or intermittent operation of the CVS result in the RCS pressure "hanging up" above the gravity injection pressure while not providing sufficient CVS flow to maintain core cooling?

c. Can CVS operation cause a situation where insufficient flow is provided to the RCS by CVS during a steam generator tube rupture (SGTR) event, but gravity injection cannot function because the ADS success state assumed cannot compensate for pressure effects of the CVS?

d. Given a small-break LOCA, the expected response of the plant is reactor coolant pump (RCP) trip, core makeup tank (CMT) actuation, passive residual heat removal system (PRHRS) actuation, ADS actuation, and manual actuation of RNS injection. In such a scenario, the low pressurizer level signal or a safety injection signal will also start the CVS pumps and keep them running and injecting to the PRHRS return line to the SG channel head. How does the CVS injection affect the operation of the PRHRS and the plant's ability to mitigate the small-break LOCA and other transients that result in the CVS injection?

e. In an SGTR, what is the effect of SG pressure on the RCS pressure? Can SG pressure cause the RCS pressure to remain high, impeding gravity injection flow? How does the answer to this question depend on the number of tubes ruptured? How does the status of SG isolation affect RCS pressure for one- or multiple-tube rupture scenarios?

440.177 Many of the sequences in the PRA, OK or core damage, do not appear to be explicitly supported by code runs, or if they are supported, the documentation does not make it clear. Establish a correspondence between the code runs, the tests, and the mission success criteria in the event tree sequences. Provide the following information:

a. Provide, for each IE modelled in the PRA, a table showing the initial conditions and status of every system modelled in each run, including how many trains of each system that functioned during the run, the peak clad temperature calculated, and the length of time the analysis was carried through.

b. In a separate table for each IE, list all the OK sequences and the code runs and tests that confirm the scenario defined by the sequence, including the timing of events and success criteria.

If some sequences were not analyzed because they were believed to be bounded by others, indicate which sequences are treated in this way, and why the case analyzed is considered more bounding. If particular elements of the testing program correspond closely to a particular code run confirming success path performance, generate a roadmap establishing the correspondence between the testing program and the applicable code runs.

The response to this question can also be used to address many of the questions Q440.178 through Q440.189.

440.178 The ADS is credited for in many sequences of the event trees in the PRA. The staff is concerned with whether or not it is capable of performing the intended function in the scenarios. Provide the following information (see also Q440.177):

a. Table C5-2 of the June 26, 1992 PRA lists the success criteria of the ADS under different boundary conditions. For each entry of the table, indicate the thermal hydraulic analysis or tests performed that verify the success criteria used. Refer to sections, tables, and figures of Chapter 15 of the SSAR or Appendix J of the PRA. If no thermal hydraulic analysis or test corresponds to the entry of the table, indicate the analysis or test that provides bounding justification of the success criteria used. Discuss why the analysis or test justifies the success criteria.

b. For each thermal hydraulic analysis or test, specify the IE, initial condition, and the status of systems such as the CVS, the PRHRS, and the CMT. Provide a discussion on the behavior of the systems and how it affects the scenario. Demonstrate that the operation of the CVS pump will not adversely affect gravity injection and the ADS success criteria.

440.179 Discuss how the various code runs were performed to assure that no localized pressure effects would prevent the ADS from accomplishing its mission of supporting gravity injection. Specifically, discuss the issue of the use of average RCS pressure versus RCS pressure at the gravity injection inlet area (see also Q440.177).

440.180 The following questions are related to the medium-break LOCA case depicted in Figure F-14 of the PRA (see also Q440.177).

a. For the case where the CMTs are available (sequence 2), it appears that no code runs have been performed to validate the ADS success criteria. What justifies the assumed success criteria?

b. For the case where the CMTs have failed (sequence 9), one of the success criteria for the ADS is 3/4 from Stages 2 and 3. However, it appears that the only code run associated with this success criterion assumed success of 4/6 from Stages 1, 2 and 3. How does the analysis support the assumed success criteria?

440.181 It appears that, given the failure of the CMTs, it is assumed that operator action to initiate the ADS occurs at 10 minutes. Has an analysis been performed to establish the realistic amount of time available for the operator to initiate the ADS for the spectrum of initiators and sequences where manual action is credited? Provide an analysis to establish these time frames. Are these actions credited in the September 24, 1993 focused PRA (see also Q440.177)?

440.182 Table C5-2 of the PRA defines the ADS success criteria for various accident conditions. Figure F-17 depicts the small-break LOCA event tree. Provide the following information (see also Q440.177):

a. In sequence 2 of the small-break LOCA event tree, both the CMT and the PRHRS are available, and the following two success criteria are credited: (1) 3/4 from Stages 2 and 3 of ADS, and (2) 1/2 from Stage 4. The first criterion is not directly evaluated, but is supported by a code run that assumes that the PRHRS is unavailable. However, there does not appear to be any supporting calculation for the second criterion. Provide justification for that criterion.

b. In sequence 10 (and sequence 5 of turbine trip event tree, Figure F-1), the CMT is available and the PRHRS is not available. It appears that no analysis is available to support the ADS success criterion of 1/6 from Stages 1, 2, & 3 and 1/2 for Stage 4. Provide justification for the criterion.

c. In sequence 18, the CMT fails and the PRHRS succeeds. The following two success criteria are credited: (1) 4/4 from Stages 2 & 3 and (2) 1/2 for Stage 4. The first of the two criteria is not directly evaluated, but is supported by a code run that assumes that the PRHRS is unavailable. The closest run similar to the second criteria assumes PRHR failure but success of 1/2 for Stage 1. The implication of the selected success criterion is that the pressure reduction capability of the PRHR during a small-break LOCA is at least as high as that provided by opening 1/2 Stage 1 lines. What analysis supports this conclusion?

440.183 Provide the following information with respect to the ATWS event tree in Figure F-21 of the PRA (see also Q440.177):

a. In sequences 6 and 23 with both the CMT and the PRHRS available, no code run was done for a "prolonged" ATWS to support the ADS success criteria. The assumed success criteria for this case are the same as for the non-ATWS transients where the CMT is available and the PRHRS is failed. The implication of this is that the impact of the ATWS is canceled out by the operation of the PRHRS. What analysis supports this conclusion?

b. In sequences 12 and 29, where the CMT is failed and both accumulators and the PRHRS are available, no code run was done to support the ADS success criteria in the "prolonged" ATWS. The assumed success criteria are the same as that for the non-ATWS transients where the CMT failed, the accumulators are available, and the PRHRS failed. The implication of this is that the impact of the ATWS is canceled out by the operation of the PRHRS. What analysis supports this conclusion?

440.184 No code run was performed to establish the success criteria of the ADS during a SGTR. The reason given for this is that the code runs that were performed, although not fully representative of all of the sequences modelled, indicate that the ADS is never actuated and the plant reaches a stable state. However, most of the success sequences are shown as requiring the ADS. Provide the appropriate analysis to support this success criteria. In particular, it was noted that no analysis of any kind appears to have been performed for cases where the CVS continues to run to determine the effect of CVS operation on depressurization. Address this issue (see also Q440.177).

440.185 In many of the event trees in the PRA, CMT success is taken to be "flow from one CMT," and whenever one CMT succeeds, there is no decision point for the accumulators. This implies that success is claimed for all of the following cases: (a) 1 CMT, 0 ACC, (b) 1 CMT, 1 ACC, (c) 1 CMT, 2 ACC, (d) 2 CMT, 0 ACC, (e) 2 CMT, 1 ACC, (f) 2 CMT, 2 ACC.

Each event tree success path may correspond to different hardware success/failure combinations, with physical outcomes that differ significantly from each other while still satisfying the peak cladding temperature criterion. In the AP600 design, it may not be the case that more injection is always better, and it is therefore necessary to identify which of the above cases are the most unfavorable, which may depend on failure configurations of ADS valves. For each success path on the event trees for which more than one hardware configuration may correspond to "success," which of these hardware configurations is most limiting in terms of PCT? What code runs establish this conclusion? For the most limiting case of each success path, what is the temperature history of the core (see also Q440.177)?

440.186 Provide the following information for the SGTR event tree in Figure F-20 of the PRA (see also Q440.177):

a. In the SGTR tree, there are a number of success paths (9-2, 10-2, 11-2) involving CMT success when the CVS fails to trip. However, apparently no code runs were performed for the case in which the CVS fails to trip. What is the basis for these success paths?

b. In the SGTR tree, there are a number of success paths (6-2, 11-2) involving CMT success when steam generator (SG) isolation fails. However, it appears that no code runs were performed for the case in which SG isolation fails. The most-closely-corresponding run involves failure of a secondary PORV to reclose, followed by auto-isolation. What is the basis for these success paths?

c. For SGTR scenarios (2,10) in which the PRHRS is operating, modelling suggests that the CMT will discharge and actuate the ADS, thereby depressurizing the RCS. However, LOFTTR2 runs indicate that CMT discharge will not occur, and thus the ADS will not be actuated. Explain this discrepancy.

440.187 In the steamline break trees (SLD, SLO, SOV) of the PRA, it is assumed that one CMT is sufficient to mitigate the event. It is also assumed that the CMT discharge is small enough that the ADS will not be actuated. The only code run associated with this case is a LOFTRAN/THINC run with 2/2 CMT and 2/2 ACC available. What is the basis for concluding that with 1 CMT available, the ADS will not be actuated? Why is the CMT needed at all? If no makeup is provided, will shrinkage result in core damage? For purposes of this concern, both "isolation" and "no isolation" cases should be considered (see also Q440.177).

440.188 In sequences 2 and 10 of the SGTR event tree, sheet 2 of Figure F-20 of the PRA, if stage 4 of the ADS is actuated with no Stage 1-3 actuated, what is the effect on the PRHR from the loadings? Can the PRHRS with only one heat exchanger (HX) cool the RCS down to where Stage 4 can work with no Stage 1-3 opening? Can the PRHRS with only one HX cool down to equalize RCS pressure to secondary side pressure? Is there a gap release for any configuration implicitly credited as PRA success? (For example, PRHRS + 1/2 Stage 4 ADS, the most adverse CMT + Accumulator operation, etc.). If so, the event tree structure describes as "OK" some of the events in which the SG is not isolated. What are the releases in that case (see also Q440.177)?

440.189 What analysis has been done to support the claim that full depressurization for transients and small-break LOCAs can be achieved by only 1 out of 2 lines of the 4th stage of the ADS if PRHR is available? Is the use of the PRHRS in this way explicitly covered by the testing program? Is the PRHRS single-failure-proof for this mission? How much thermal-hydraulic margin does the PRHRS have for this mission? Is the PRHRS a safety-grade item for this mission, or is it functioning beyond its design basis for this mission (see also Q440.177)?

440.190 In several portions of the Design Change Description Report (February 15, 1994), it is stated that PRA modelling is not affected by the design changes. For example, the following statements are made in the report:

P2-8: The change in the CVS control logic improves the expected operation of the plant during non-LOCA events by minimizing the potential of automatic actuation of ADS. This change does not affect how the CVS is modeled in the PRA.

P2-11: The modification of the ADS Stage 1 setpoint increases the margin to automatic ADS actuation. This change does not affect the success criteria used in the PRA.

P2-13: Actuation of ADS Stages 2 and 3 on times instead of CMT level will not affect the ADS reliability.

P2-16: The change in the CMT by adding an inlet diffuser will have no impact on the PRA since it does not affect how the systems are modeled and has no effect on success criteria.

Does this mean that the safety benefit is so small as to be unquantifiable, or that modelling uncertainties in the PRA overwhelm the expected benefits?

440.191 In many of the event trees, some of the sequences ended in an initiating event such as a small-break LOCA, (e.g., path 42 on Figure F-3 of the PRA). In the September 24, 1993 focused PRA, no credit is taken for non-safety systems. This may increase the frequency of these sequences. As a result, the IE frequency of the event trees that the sequences are transferred to will be increased. Is such increase in IE frequency factored in the RTNSS evaluation? Show the increase in IE frequency. Demonstrate that there is no increase, if that is the case.

440.192 Confirm and demonstrate that RCP trip is not needed given loss of component cooling water (CCW)? Do they trip with unit probability in a useful time frame? Are there degradations of the CCW that count as this IE that don't deterministically trip the RCPs?

440.193 In the safety path using the PRHRS (PRT), does the loss of instrument air, T_{CA}, interfere with throttling the PRHRS?

440.194 Regarding the loss of offsite power (LOOP) event tree (event T_E, Figure F-9 of the PRA) for RTNSS, how were the recovery factors handled? Recall that in an extended station blackout, the system automatically actuates the ADS at 24 hours.

440.195 How do you estimate the probability that a SGTR occurs as a result of a main steam line break (MSLB) or stuck open secondary relief valve? What are the measures against this scenario?

440.196 In Figure F-11 of the PRA for an MSLB upstream of MSIV, there are no safety grade success paths following the PRHRS failure (PRT) if the MSL isolation fails (CIA). Why not?

440.197 How much condensate is expected in the containment following an MSLB and feedwater line break, respectively? Can this lead to boron dilution if the scenario goes into ADS actuation?

440.198 Is PRHR "control" (e.g., path 2 on T_{SOV} tree of the PRA) credited for purposes of the RTNSS evaluation?

440.199 Why isn't recirculation queried on the SIS tree of the PRA?

440.200 It appears that given a LOCA of any size, even a very small-break LOCA, part of the expected plant response is to use full ADS actuation. Is this correct? If yes, the frequency of full ADS actuation is higher than the frequency of LOCAs that is approximately 2E-03 per year. Is this accurate?

440.201 It appears that in the very small-break LOCA event tree, sheet 2 of Figure F-18 of the PRA, sequences 1 to 8 give an example of non-coherence (i.e., the top event frequency may either increase or decrease with increasing failure probability, depending on the values assumed by other variables) in the logic. In this example, successful partial depressurization can lead to core damage, while its failure leads to "OK." Is this an artifact of the mission time assumption? Does event PP (stuck-open pressurizer valve) ever help or does it always hurt? (see the event tree for secondary to primary mismatch; PP turns the scenario into an S1). If depressurization is needed, is the conditional probability of CD lower given event PP, or higher? Do sequences ending in T_{SQV} on the T_E tree have a lower conditional probability of CD, or higher, as a result of stuck open valve?

440.202 In the PRHRS break tree, Figure F-19 of the PRA, does the RTNSS evaluation take credit for isolating the break? Does it reflect the possibility that one HX was isolated previously and the other one has the break in it now? Are there any missions in the PRA for which both heat exchangers are needed?

440.203 How much makeup water (CVS, CMT) is needed during extended operation of the PRHRS for decay heat removal?

440.204 Define the mission time of the event tree analyses and discuss its effect on how the "OK" sequences are terminated. For example, in the case of sequence 37 of event tree F-9 for a loss of offsite power, the PRHRS is in operation and can continue for 72 hours without the condensate returned to the IRWST. Here a mission time of 72 hours appears achievable. However, the mission time used in calculating the valve failure probability is probably 24 hours. In those cases in which gravity injection is used, how long can gravity injection last? When is the containment sump recirculation needed? Is it before 24 hours?

440.205 In sequence 24 of the LOOP event tree, PF-203, Figure F-9 of the PRA, the offsite power is not recovered in 24 hours and the PRHRS is initially operating. What is the effect of ADS actuation at 24 hours after LOOP? What is the operator expected to do in this regard? Can RNS be used to remove decay heat? Will a transportable generator be available after 24 hours?

440.206 Some PRA success paths allow the cladding temperature to go high enough to cause cladding damage. How is recovery from those situations accomplished?

440.207 In the event trees of the PRA, some sequences lead to a transfer to event trees of other IEs. These sequences have some pre-defined conditions that may be different than that assumed for the event trees they transfer to. For example, sequence 21 of the loss of instrument air event tree is a transfer to a medium-break LOCA. How do you account for the fact that the instrument air is lost?

440.208 An issue for conventional PWRs during a large-break LOCA is potential precipitation of boron in the core region. The issue is addressed by switching to hot leg injection. How does the AP600 design address this issue? Describe the behavior of boron in the core during long-term recirculation with the RCS steaming to the containment and water returning through the sump recirculation screens. Does boron accumulate in the core?

440.209 Why isn't a seismic event at shutdown analyzed? What is the likelihood of a seismic event causing a LOCA in the RNS? Such a LOCA, if unisolated, can bypass the containment and result in flooding the auxiliary building with IRWST inventory.

440.210 It appears that the only IEs analyzed are LOOP, loss of RHR, and LOCA for hot shutdown and cold shutdown with the RCS not drained. Why are other IEs, such as loss of CCW or service water, not analyzed?

440.211 Provide a description of how the event trees for shutdown conditions were quantified. How was the IE frequency estimated? What is the timing of the scenarios? What are the top events in the event trees? What is the emergency or abnormal procedure that provides guidance to the operators?

440.212 What assumptions are made regarding maintenance unavailability of equipment during shutdown?

440.213 Why are steam generators or reflux cooling not credited for in the event trees for mid-loop operations?

440.214 Note 16 in the P&ID PXS M6001 and note 22 of PXS M6002 indicate that freeze seal would be used for direct vessel injection lines, accumulator injection lines, and gravity injection lines. Why is this necessary? What is the plant condition under which a freeze seal is used? How do you account for this in the PRA?

440.215 In those sequences in which the CMTs failed, the ADS has to be initiated manually. What is the time available for this operator action. What is the information available to the operator that will help him to decide on the needed action?

440.216 The Stage 4 valves of the ADS are interlocked so that they can not open unless the RCS pressure has been substantially reduced.

a. Provide the value of the interlock set pressure. Verify that RCS pressure is below the interlock pressure in all sequences in which the success criteria of 1 out of 2 Stage 4 valves is used.

b. The February 15, 1994 AP600 Design Change Description Report indicates that squib valves may be used in Stage 4 of the ADS. What is the frequency of inadvertent actuation of Stage 4 squib valves that may result in an unisolable LOCA?

440.217 What fraction of ADS MOV failures can be repaired at power?

440.218 In a transient with loss of steam generator heat removal, the PRHRS is used to remove decay heat. In such transients, what are the projected RCS pressure, temperature and level? What does the operator need to do to ensure its operation? What instrumentations are available to the operator? During a transient, some RCS inventory may be lost through the pressurizer safety valves. In an overcooling transient, the RCS level could shrink due to thermal contraction. The staff is concerned that there may not be sufficient inventory to support PRHR operation. What is the minimum RCS inventory that can support PRHR operation? What is the elevation of the top of the PRHRS HX? How does it compare with the level in the CMT and the top of the vessel? Can the RCS inventory become lower than the minimum needed in some of the transients? What is the pressurizer level at which the PRHRS HX would start draining?

440.219 Based on the PRA, in the event trees for steam line break or stuck open secondary relief valve, the PRHRS alone is not sufficient, and RCS makeup is needed. Is there any analysis that demonstrates that the inventory is or is not sufficient to support PRHRS operation?

440.220 How is the PRHRS HX tube integrity verified? Do you need to perform eddy current tests similar to that for steam generators? How and during what plant conditions are these tests done? How do such tests affect the availability of the IRWST?

440.221 What is the rate at which radiolytic gas is produced during a transient? Can the gas enter the PRHRS HXs and prevent natural circulation from taking place?

440.222 Provide the following information regarding sequence 6 of the S2 event tree of the PRA:

a. The PRHRS provides depressurization and there is some pressurizer relief, but not enough for full depressurization to succeed without PRHR. What is the flow pattern in the PRHRS under these conditions?

b. In sequence 6 of the S2 event tree, is one HX enough to support credit for (PRHRS + Stage 4) operation of full depressurization, or, if one HX is isolated, does this success option become marginal?

440.223 In sequence 1 of the SGTR event tree of the PRA, the CVS trips and the PRHRS succeeds. What equalizes the pressure between the primary side and secondary side of the ruptured SG? What happens in the long run? It seems that the use of the PRHRS has the disadvantage of creating steam inside the containment making cleanup a difficult task. Why is cooling the IRWST not taken credit for?

440.224 Describe the scenarios of sequences 23 and 29 of the ATWS event tree of the PRA. In particular, assuming that startup feedwater failed, what will actuate the PRHRS? If the pressurizer safety valves are lifted, what is the flow pattern in the PRHRS? Is one PRHRS HX sufficient? What will actuate the CMT? Will the CMT level become low enough to actuate the ADS? If not, what will actuate the ADS? How is the success criterion for the ADS determined?

440.225 In the LOOP event tree of the PRA, with PRHRS operation successful, the sequences are terminated successfully. PRHR operation will cause a low pressurizer pressure signal that will actuate the CMT. How does the CMT operation affect PRHR? Will the ADS be actuated due to low CMT level? Is it possible to reach the ADS actuation setpoint without losing RCS inventory? What does the operator need to do regarding the operation of the CMT and the ADS?

440.226 During a medium- and small-break LOCA, the rate of depressurization through the break may be such that it releases non-condensable gases in the PRHRS loop that may degrade the establishment of natural circulation flow in the PRHRS. However, operation of the PRHRS is credited as a means of depressurization and contributes to some of the success criteria for ADS. Is there any documentation/evaluation of removal of noncondensables in the PRHR system? Can slow depressurization during non-LOCA sequences lead to release of sufficient noncondensables to affect PRHR?

440.227 What is the effect of the system on the plant behavior during a small-break LOCA as documented in Section 15.6.5.4B.3 of the SSAR? What is the behavior of the system in terms of the flow, temperature, and level?

440.228 There are many sequences in the event trees of the PRA that transfer to the medium-break LOCA event trees with a stuck open pressurizer safety valve. How does the CMT work with stuck open pressurizer safety valves (PSV)? Does the phenomenology of inadvertent opening of a PSV differ from a cold leg medium-break LOCA analyzed in the PRA success criteria analyses?

440.229 It is not clear whether or not secondary steam relief through the SG PORVs or safety valves was modelled in the PRA. The documentation discusses steam dump but not the SG PORVs and safety valves. Some event tree branches use "VAL2" or "VAL3." It is not known where they were documented. Clarify the above and provide the assumptions regarding steam relief.

440.230 What is the capacity of the deaerated storage tank. How long can the inventory last in an accident?

440.231 Describe how de-boration during plant startup is done, in terms of the lineup of equipment in supplying unborated water and discharging borated water. What is the flow rate and boron concentration in the flow paths? How is this process controlled? How long does it take? What is the effect of a LOOP on this mode of operation? For the boron dilution scenario due to restart of RC pumps following a LOOP discussed in Section F.4.7.3 of the PRA, determine the amount of unborated water that can be injected, and the reactivity effect it has on the reactor, taking into consideration the possibility of mixing of the unborated water with reactor coolant.

440.232 Section A.3 of the PRA defines a small-break LOCA as a break from 3/4 to 4 inches, while Section 15.6.5.4B.3.1 of SSAR defines a small-break LOCA as a break size of one square foot or less. Provide the following information:

a. Clarify the inconsistency in the definition of LOCA sizes.

b. What is the size of the LOCA that a CVS pump is capable of mitigating? How long can this pump perform its mitigating functions? Given such a LOCA, what is the expected plant and operator response to bring the plant to a safe condition?

c. For how long will the CVS be able to inject borated water during an RCS leak or a very small-break LOCA? How much inventory is available? What measures assure that this inventory will be available?

440.233 In the PRA, Table 7-1 shows that the medium-break LOCA frequency is a factor of 5 or 6 higher than that of a large-break LOCA, and Table A-3 shows that the success criteria for medium-break LOCAs are more stringent than those of large-break LOCAs. What is the reason that the core damage frequency of medium-break LOCAs in Table 8-1 is only comparable to that of large-break LOCAs?

440.234 Assuming the regenerative and letdown HXs are like the SGs or PRHR HXs, the frequency of a LOCA due to their tube rupture should be comparable to that of a SGTR. Clarify whether or not the LOCA frequency calculations include ruptures in the regenerative HX, letdown HX, demineralizers, and filters in the CVS.

440.235 How often do the components of the CVS inside the containment, e.g., demineralizers and filters, need to be maintained? What is the plant condition when the maintenance is done?

440.236 During RNS operation, is the letdown orifice bypass valve always open with the CVS makeup pump running continuously? If yes, what is the flow rate? Are there any automatic signals that will affect this operation? For example, does the flow path get a containment isolation signal to close?

440.237 In the PRA, where is the dependency on the CCW system modeled? For example, the RNS is used to provide injection in many event trees. In these cases, is the dependency on the CCW modeled? Why does loss of the system in the September 24, 1993 focused PRA lead to a 99% increase in the core damage frequency?

440.238 Table 9.2.2-2 of the SSAR shows the loads on the CCW system in different modes of plant operations. Basically, two CCW pumps are needed in all modes, except normal operation. Provide the following information:

a. During an accident, the plant is shutdown. Shouldn't two pumps instead of one be needed in the PRA analysis? What are the loads listed in the table that are not needed during a transient or accident? What is the guidance to the operators in shedding the loads?

b. For accidents during shutdown conditions, do you use 1 out of 2 success criteria for the CCW system? Again, what are the loads that need to be removed? What is the guidance to the operator?

440.239 During a drained maintenance, what kind of wide range level instrumentation is available? Does it need a standpipe system that is used for current PWRs? Without it, how is the RCS level determined during drain down?

440.240 In the shutdown PRA, the time available to restore offsite power is taken to be 1.5 or 2 hours based on the time to core uncovery. This implies that the RNS pumps can operate with saturated RCS coolant. Is this correct?

440.241 For hot and cold shutdown conditions, what is the condition of the reactor at 2 hours after a loss of the RNS? What is the system pressure during this 2 hours? It appears that the only relief valve available is the one in the RNS. A bubble will form in the vessel while coolant is spilled out of the RNS relief valve. Can the RNS withstand the expected pressure? What is the flow path and flow rate to the RNS relief valve? How does this flow affect the operation of PRHRS? When is the operator expected to actuate the PRHRS? Will the PRHR HXs be drained at some time? What about the SG tubes? In this scenario, will the bubble in the vessel prevent CMT injection and ADS actuation? If some of the systems have to be manually actuated, what is the information that tells the operator to do so? How much time does the operator have to perform the actions?

440.242 Section 5.4.7.1.2.3 of SSAR states that the RNS system is initiated within 2 hours of actuation of the PRHR to remove heat from IRWST. This appears to not be modelled in the PRA. Why?

440.243 Section 9.2.7.2.4 of SSAR states that the low capacity chilled water subsystem provides cooling to both the makeup pump room and the RNS pump room. What is the reason that the dependency of the RNS is not modelled while that of the makeup pump is?

440.244 Provide information on the transportable generators. What kind of requirements are applicable on their R/A? Are they taken credit for in the PRA?

440.245 Provide the following information regarding the onsite dc system:

a. Section 8.3.2.1.1.1 of SSAR states that class 1E divisions A and D have one battery bank each while divisions C and B have two. On the other hand, Figure C17-1 of the PRA shows that the 4 divisions have very similar structures. Explain the inconsistency.

b. Tables 8.3.2-1 to 8.3.2-4 of the SSAR list the loads on the class 1E buses. Are there similar tables for the non-class 1E dc buses?

440.246 In the event tree for a loss of instrument air with startup feedwater available, the sequence is successfully terminated. With loss of air, the PRHRS should be in service due to failed open AOVs that will lower the system pressure to that below the safety valve setpoint, and the CMT should be actuated for the same reason. The main steam lines will be isolated and the PORVs failed closed. The primary system pressure will not reach the setpoint for the SG safety valves when the PRHR is in operation. Provide the following information:

a. How is the secondary steam relieved?

b. Figure C8-1 of the PRA for startup feed water system shows that the flow control valve V255A fails closed. In the loss of air event tree, how do you open these valves?

c. It appears that the 3 compressors of the system are the only compressors for the plant. They also supply the service air loads and breathing air to the inside of the containment. Is this correct? What is the requirement on system capacity due to this correct? What is the requirement on system capacity due to these loads? Can these loads affect the success criteria used in the PRA? Can these loads affect the performance of the system during an accident? If these loads are isolated from the instrument air system, will the performance of operators during an accident be affected by loss of air supply?