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

May 11, 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 the reactor coolant system (Q440.123-Q440.144).* Enclosed are the staff's questions. Please respond to this request by June 30, 1994 to support the staff's review of 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.

*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

440.123 Section 5.4.1.2.1 of the SSAR states that the canned-motor reactor coolant (RC) pumps have been used in commercial nuclear plant service. Provide historical information regarding the use of these pumps in the commercial nuclear power plants and their reliability and performance records.

440.124 Table 5.4-1 of the SSAR provides the canned-motor RC pump design parameters, including the design flow rate, developed head, and motor/pump rotor moment of inertia.

a. Provide a pump head-capacity characteristic curve.

b. Does the value of the moment of inertia include the moment of inertia of the flywheel and all other rotating parts?

c. With regard to the canned-motor pump performance, Section 5.4.1.3.1 of the SSAR states that minimum NPSH requirements are not required to ensure safe pump operation because the required net positive suction head (NPSH) is provided with ample margin to minimize the potential for cavitation. It further states that the required NPSH for the impeller represents a 3 percent head drop-off condition, and the recommended plant available NPSH represents 100 percent margin, or twice the required value. Elaborate on the special requirements and/or restrictions on the design and operation of the AP600 canned-motor pumps to achieve these goals.

440.125 Section 5.4.3.1 of the SSAR classifies the small lines in the RC system with a 3/8-inch or less flow restricting orifice as AP600 equipment Class B because, if one of these lines breaks, the chemical and volume control charging pumps are capable of providing makeup flow while maintaining pressure water level. 10 CFR 50.55a(c)(2)(i) allows the components that are connected to the RCS and are part of the RC pressure boundary (RCPB) to be excepted from meeting the Class A requirements for the RCPB if, in the event of postulated failure of the component during normal reactor operation, the reactor can be shut down and cooldown in an orderly manner, assuming makeup is provided by the RC makeup system.

a. The CVCS in the AP600 design is a non-safety related system. What is the justification for taking credit for the CVCS makeup capability so that the small lines in the RCS can be excluded from meeting the Class A requirement for the RCPB?

b. What regulatory measures are proposed to ensure availability and reliability of the CVCS when called upon?

Enclosure

440.126 10 CFR 50.34(f)(2)(xiii) requires that the pressurizer heaters be provided with a sufficient power supply and associated motive and control power interfaces to establish and maintain natural circulation in hot standby conditions with only on-site power available. Section 5.4.5.3.1 of the SSAR states that the AP600 design conforms to this requirement because the pressurizer heater buses can be powered from the on-site diesel generators via manual alignment with sufficient capability to establish and maintain natural circulation in hot standby condition. It further states that, in the event of a station blackout, the core decay heat is removed from the RCS using the passive RHR heat exchanger to the IRWST without requiring the use of pressurizer heaters to maintain pressure control.

Because the AP600 diesel generators are of non-safety grade design, use of this power supply does not fully conform to the requirement of 10 CFR 50.34(f)(2)(xiii). However, the safety-grade PRHRS with a sufficient capability to establish and maintain natural circulation could provide an alternative to meet the intent of the regulation to ensure availability of a safety grade decay heat removal method. Provide analyses and/or test data to demonstrate and confirm the capability and reliability of the PRHRS under various transient and degraded plant conditions (e.g., loss of all decay heat removal capability by the steam generators), including an evaluation of the capability of the PRHRS to maintain hot standby conditions without pressurizer heater control of the primary coolant pressure.

440.127 Section 5.4.7.1.2 of the SSAR states that the reliability of the non-safety grade normal residual heat removal system (RNS) is achieved by using highly reliable and redundant equipment and a simplified system design, and the system piping and components are Safety Class C, seismic Category I for pressure retention purposes only.

a. Clarify or define the term "highly reliable equipment."

b. Regulatory Guide 1.29, C.1.d, requires that systems or portions of systems that are required for reactor shutdown, residual heat removal, or cooling the spent fuel storage pool are designated as seismic Category I and shall be designed to withstand the effects of safe shutdown earthquake and <u>remain functional</u>. What are the bases for designing the RNS piping and components as Safety Class C, seismic Category I <u>for pressure retention purposes only</u>?

440.128 Section 5.4.7.1.2.1 of the SSAR states that the RNS is designed to successfully reduce the RCS temperature from 350 °F to 120 °F within 96 hours after shutdown, and maintain the RCS temperature at or below 120 °F for the entire plant shutdown with both subsystems of RNS pumps and heat exchangers available, and that a failure of an active component during normal cooldown will not preclude the ability to cooldown, but will only lengthen the time required to reach 120 °F.

a. Has a single failure analysis (such as a failure modes and effects analysis) been performed to determine the limiting single failure?

b. How long will it take to cooldown to 120 °F if one of the two subsystems is not available?

440.129 Section 5.4.7.1.2.3 of the SSAR states that the RNS is designed to provide cooling for the in-containment refueling water storage tank (IRWST) during operation of the passive RHR heat exchanger or during normal plant operations when required to limit the IRWST water temperature to less than 212 °F during extended operation of the PRHRS.

a. Because the RNS is required to support the operation of the safety grade PRHRS and IRWST, what are the bases for not requiring it to remain operational after a shutdown earthquake?

b. Figure 5.4-6 of the SSAR shows that the motor-operated valve in the IRWST discharge to the RNS suction line is normally open, which should be normally closed as shown in Figure 5.4-7. Correct the inconsistency.

440.130 The RNS is designed to provide defense-in-depth functions for cooling the RCS during shutdown operation.

a. Provide an analysis to demonstrate that the RNS RHR has the capability to ensure that the specified design limits are not exceeded for the plant infrequent and moderate frequency events during shutdown cooling mode.

b. For an RNS pipe break outside containment that disables one train of the RNS while in a shutdown cooling mode operation, provide the following information: (1) the maximum discharge rate, (2) the capability of the intact RNS train, (3) the elapsed time before unacceptable consequence without operator recovery actions, (4) the alarms that are available to alert the operator of the event, (5) the recovery procedures, and (6) operator recovery action time.

440.131 Appendix 1A of the SSAR indicates that Regulatory Guide (RG) 1.1 is not applicable to the AP600 RNS, because it is not a safety system and does not control or mitigate the consequences of an accident in the licensing basis accident analyses. RG 1.1 requires that emergency core cooling and containment heat removal systems be designed to provide adequate NPSH to the system pumps assuming maximum expected temperatures of pumped fluids. Since the RNS is a safety-significant system based on the analysis of regulatory treatment of non-safety systems, what are the bases for not designing the system to meet this requirement?

440.132 With regard to the staff position stated in SECY-90-016 on the interfacing system LOCA (ISLOCA) concern, the December 22, 1992 response to Q440.30 stated that the RNS pump seal in the AP600 design is the only component or system connected to the RCS that is not designed to have an ultimate rupture strength (URS) equal to or greater than the normal RCS operating pressure. An evaluation regarding AP600 compliance with the ISLOCA is described in Sections 1.9.5 of the SSAR, along with AP600 design features addressing the ISLOCA described in Section 5.4.7.2.2.

a. Are the RNS and the CVCS the only systems and components that are located outside the containment and directly or indirectly connected to the RCS?

b. Provide a list of all systems, subsystems, and components (e.g., CVCS letdown line, sampling systems, etc.), that are located outside the containment and are directly or indirectly connected to the RCS, and all pressurization pathways that can be established by a fully opening valve, an inadvertent opening of a valve or valves, or a failure of containment isolation.

c. Is the conclusion that the RNS pump seal is the only component not meeting the URS criterion based on a systematic evaluation of all interfacing systems and components and pressurization pathways described in Item (b)?

d. Provide a description of the process used by Westinghouse for evaluating compliance with the staff's position on ISLOCA, including the identification of those interfacing systems and pressurization pathways described in Item (b), determination of the design pressures and temperatures as well as URSs of these interfacing systems and components, and the bases or justifications for not meeting the URS criteria, and the design response, such as features or improvement for mitigating or limiting the scope of ISLOCA events.

e. For each system or pressurization pathway evaluated, provide the specific values of the design pressures, temperatures, and URS of these components, including flanges, connectors, valve, valve bonnets, stem seals, pump seal, packing, heat exchanger tubes, etc., to show their URSs are no less than the RCS full pressure.

440.133 As a part of design features to mitigate air binding of the RNS pump during mid-loop operation, Section 5.4.7.2.1 of the SSAR states that the RNS employs a step-nozzle connection to the RCS hot leg, that will (a) substantially lower the RCS hot leg level at which a vortex can occur in the RNS pump suction line due to the lower fluid velocity in the hot leg nozzle, and (b) limit the maximum air entrainment into the pump suction, if a vortex should occur, to no greater than 5 percent. This value has been demonstrated experimentally. Provide a discussion of the actual design configuration of the AP600 stepped nozzle connection, the experiment(s) and associated data, as well as any analysis that demonstrate the adequacy of this design to minimize vortex formation and air entrainment into the RNS pump suction.

440.134 The following questions are related to the RNS isolation valves:

a. Section 5 4.7.2.2 of the SSAR indicates that the RNS contains an instrumentation channel indicating the pressure in each pump suction line, and a high pressure alarm in the control room. Does the RNS also have position indication in the control room for the isolation valves on both the suction and discharge sides of the RNS as discussed in BTP RSB 5-1?

b. What evaluations have been made to address common cause failures (e.g., failure of the outboard containment isolation valve on the RNS common suction line, or failure of a pressure transmitter applied to the inner or outer isolation valves in the suction lines) that could disable both trains of RNS? What are the effects of these common cause failures?

c. If a failure of the pressure transmitter to the RNS suction valve interlocks occur, what operator actions and procedures are necessary and where must they be performed under those conditions to initiate the RNS when the RCS pressure is below 450 psig?

d. Because the closure of the manual maintenance valves upstream of the RNS pumps could isolate the RNS, describe the procedures and controls that eliminate the possibility of manual initiation of valve closure during shutdown operation.

440.135 Section 5.4.7.4.3 of the SSAR states that, if need arises, the RNS has the capability of transferring water from the IRWST to the refueling cavity during refueling, which is performed by the spent fuel pit cooling system. Is this function performed by the RNS through the direct vessel injection line?

440.136 Section 5.4.7.4.4 of the SSAR states that for accident recovery operations, upon actuation of automatic depressurization, the RNS can be employed to provide low pressure RCS makeup, and that operation of the RNS will not prevent the passive core cooling system (PXS) from performing its safety functions. What tests or analyses have been made to demonstrate proper PXS performance upon RNS operation?

440.137 Item A.1.d of Appendix A to Regulatory Guide (RG) 1.68 states that preoperational testing for several active systems, including residual heat removal system, should be performed to verify operability, redundancy, and electrical independence. Appendix 1A of the SSAR indicates that the AP600 position <u>conforms</u> to this RG, but further states that these systems have been eliminated by the design of the AP600 passive safety systems. Clarify this statement.

440.138 Section 5.4.7.5 of the SSAR states that the design of the RNS has been compared with the acceptance criteria set forth in Section 5.4.7 and BTP RSB 5-1 of the SRP, as appropriate. Discuss how the AP600 design complies with the Section 5.4.7 and BTP RSB 5-1 of the SRP. For those acceptance criteria or the staff positions that the AP600 design does not comply with, provide bases and justifications for these deviations. Address the following concerns:

a. BTP RSB 5-1 states that the RHR system isolation valves in the suction lines should have independent diverse interlocks to prevent the valves from being opened, unless the RCS pressure is below the RHR system design pressure. The two parallel sets of two in-series isolation valves in the RNS suction lines in the AP600 are designed with interlocks to prevent them from being opened by the operator when the RCS pressure is above 450 psig. Section 7.6.1.1.1 of the SSAR states that the logic for the outer valves is identical to that provided for the inner isolation valves, except that equipment diversity is provided by virtue of the fact that the pressure transmitter used for valve interlocks on the inner valves is diverse from the pressure transmitter used for the outer valve interlocks. Discuss the nature of the diversity of the pressure transmitters between the inner and outer isolation valves, and how this meets the diversity requirement of BTP RSB 5-1.

b. BTP RSB 5-1 states that the fluid discharged through the pressure relief valves must be collected and contained such that a stuck open relief valve will not result in flooding of any safety-related equipment. Has this been considered in the design of the AP600?

c. Item E of BTP RSB 5-1 states that the isolation valve operability and interlock circuits should be designed so as to permit on-line testing when operating in the RHR mode. Section 5.4.7.6 of the SSAR states that the testing requirements of the RNS pumps and the remaining MOVs are only those required to provide reliability consistent with the values assumed in the AP600 PRA. Does the RNS design meet the guidance of Item E of BTP RSB 5-1?

d. Will boron mixing tests and natural circulation cooldown tests be performed in the first plant with AP600 design per BTP RSB 5-1?

440.139 To prevent an inadvertent closure of the RNS suction isolation valves while the RNS is in use (Generic Issue 99), Section 7.6.1.1.1 of the SSAR states that their motor breakers are opened or removed during extended RNS operations following cooldown. Are opening or removal of the motor breakers done automatically or manually? Will this manual operator action be included in the operating procedure?

440.140 Section 5.4.7.5 of the SSAR states that the compliance of the RNS design with General Design Criteria 2, 4, 5, 19 and 34 is found in Section 3.1. However, the statement of compliance with these GDCs is not clearly described in Section 3.1. For example, the statement of compliance indicates that the safety-related structures, systems, and components (SSCs) are designed to meet GDC 2 and that the SSCs important to safety will be designed to withstand the effects of natural phenomena without the loss of the capability to perform their safety functions. It further states that those SSCs vital to the shutdown capability of the reactor are designed to withstand the maximum probable natural phenomena at the intended site. Because the RNS is categorized to be a non-safety-related system that provides defense-in-depth functions, it is not clear whether it complies with GDC 2. Provide a specific description of GDC compliance for the RNS, and provide the bases for any noncompliance.

440.141 Section 5.4.12.1 of the SSAR states that the reactor vessel head vent system (RVHVS) is designed to remove noncondensable gases or steam from the RCS via remote manual operations from the control room (CR) through a pair of solenoid-operated isolation valves, and that a parallel path of manual valves is provided to perform similar functions during normal filling and venting operations.

a. Identify any operational differences between the solenoid-operated valves and the manual valves.

b. Do these valves have individual positive valve position indication and alarm in the CR?

c. Section 5.4.12.2 of the SSAR states that the RVHVS valves are included in the operability program. Does this mean that the vent system has provision to test for operability?

d. The solenoid-operated valves are powered by the diverse vital power supplies. Discuss the diverse power source and its compliance with the guidance of Section 5.4.12 of the SRP that they be powered from emergency buses.

440.142 Describe the procedures for venting the RCS system, including the criteria for opening and closing the RVHVS and ADS first stage valves, respectively, the necessary instrumentation, and the bases for these criteria and procedures.

440.143 Section 5.4.12 of the SRP states that the size of the vent line should be kept smaller than the size corresponding to the definition of a LOCA to avoid unnecessary challenges to the ECCS. Does the one-inch vent pipe in the AP600 design meet this criterion?

440.144 Describe the procedures used for venting and removing gases from the steam generator U-tubes to assure coolability of the core.