July 8, 1997

MEMORANDUM TO: Theodore R. Quay, Director
Standardization Project Directorate
Division of Reactor Program Management

THRU: Alan Levin, Acting Chief
Special Projects and Advanced Reactor Systems
Reactor Systems Branch
Division of Systems Safety and Analysis

FROM: David T. Diec, Reactor Engineer
Special Projects and Advanced Reactor Systems
Reactor Systems Branch
Division of Systems Safety and Analysis

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION ON AP600 SHUTDOWN EVALUATION REPORT (TAC NO. M98069)

Enclosed is a request for additional information (RAI) based on a review of the WCAP-14837, Revision 1 report by the Reactor Systems Branch and the Plant Systems Branch (SPLB). Also included in the list of RAIs is a set of comments from the Instrumentation and Controls Branch. Any RAI input from Special Projects Section of the SPLB, particularly in the areas of spent fuel pool and floods protection for plant systems, and the Containment Systems and Severe Accident Branch, and Probabilistic Safety Assessment Branch will be transimitted under separate cover.

If you have any questions, please contact David Diec or Summer Sun at 301-415-2834 or 301-415 2868.

Attachment:
As stated

DF03

cc: G. Holahan
S. Newberry
J. Lyons
T. Marsh
C. Berlinger
J. Wermeil

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

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REACTOR SYSTEMS QUESTIONS

1. Section 2.1.2.1 indicates that the AP600 steam generator nozzle dam is installed with the hot leg level much higher than the traditional designs. Provide a detailed drawing and discussion of the nozzle dam design. Discuss the nozzle dam installation process during shutdown and refueling operation to preclude potential inadvertent RCS repressurization. Provide a comparison between the traditional nozzle dam design(s) and AP600 nozzle dam's insertion with respect to the hot leg level.

2. Section 2.1.2.1 also states that sufficient RCS vent path through the pressurizer is established when the coolant level in the hot leg is at 80% of the hot leg level. Table 2.1-1 shows that coolant level at the top of the hot leg is at 31 inches and therefore, a sufficient RCS vent path through the pressurizer at 80% of the hot leg level is 24.8 inches. However, the nominal water level for mid-loop operation is set at 27.74 inches, which is much higher than the 80% hot leg level. Please clarify and provide a programmatic approach to the adequacy of RCS venting, while maintaining a maximized mid-loop level operation. Where will this programmatic approach be implemented or recommended to be followed by the COL applicants?

3. Section 2.1.2.2 indicates that a manual isolation of letdown on low hot leg level capability is provided and actuation of IRWST on (low) empty hot leg level is also provided. Is the IRWST actuation automatic? Are alarm and valves position indications associated with these signals provided in the control room and on the remote shutdown panel?

4. Also in this Section, the IRWST injection is actuated 30-minutes after receipt of the empty hot leg level signal. Table 2.3-2 indicates that it would take 59-minutes to boil empty the hot leg and an additional 43-minutes to expose the core. The 30-minutes time delay for IRWST injection would allow the core to be exposed in 13-minutes if IRWST injection failed. What are operator actions needed to reestablish core cooling at the earliest opportunity and when? How would these operator actions be captured and appropriately incorporated into the emergency operating procedures for shutdown and refueling operation?

5. Table 2.1-1 gives comparison between various hot leg level elevations and time-to-drain, assuming a nominal RCS drain rate of 20gpm. Is this drain rate required when the water level is at the top of the hot leg? Where will this important design/operation information be captured?

6. Also in Table 2.1-1, the draining time (assuming a nominal 20gpm drain rate) appears to be inconsistent and is not linear for the water to drain from the top of the hot leg level to the nominal water level for midloop operation elevation, to the low level alarm set point and to the auto-isolation of letdown. Please explain.

7. Page 2.1-8, RCS Hot Leg Wide-range Temperatures, indicates that safety-related hot leg temperature detectors are provided. The temperature detector's accuracy is highly flow dependent. What are assurances in place for a continuous RCS flow and a credited RCS temperature detection capability? Incore thermocouples are available for midloop operation when the vessel head is on, however, they will not be available when the vessel head is off (i.e., detensioned and instruments disconnected in preparation for refueling activities) to detect changes in RCS temperature and the wide-range hot leg temperature detectors can not reliably measure temperatures at the no RCS flow condition. Discuss how AP600 design would cope with this situation.

8. Section 2.1.2.4 identifies the dedicated drain path, which is used to drain the RCS water during a normal draindown process and is controlled from the main control room. Does this dedicated drain path display information in the control room (i.e., dedicated refueling trees information panel)? How will this improved feature be captured in the ITAAC program?

9. Section 2.1.2.4, second paragraph, it is stated that the letdown flow control valve as well as the letdown line containment isolation valve will receive a signal to automatically close once the appropriate level is attained. Define the appropriate RCS level, and discuss as to how manually controlled letdown would interact with auto-isolation signal to close the letdown control valve and the letdown line containment isolation valve. Are these functions captured and included in the ITAAC program?

10. Section 2.1.3.2, next to the last paragraph, it is stated that when the RCS temperature reduced (during plant cool down process) to 180°F, hydrogen peroxide is added to the RCS to improve activity reduction and also to minimize the chances for collecting a hydrogen bubble in the pressurizer. <u>Pressurizer heaters are continued to operate to maintain system pressure for RCP operations</u>. However, the staff notes that the pressurizer heaters have already been de-energized early in the cooldown process where spray flow is used to further cool the pressurizer while maintaining the required RCP suction pressure at relatively high RCS temperature of 350°F. Clarify the usage of the pressurizer heaters with respect to temperatures and pressures.

11. Section 2.1.3.3 states that at the appropriate time during the cooldown, the operator can initiate the drain-down. Define the optimum time after plant shut down that the operator can initiate the drain-down process. Is this time part of the design and operational defense-in-depth during shutdown and refueling for AP600? Where will this insight be implemented or recommended to be followed by the COL applicants?

12. Section 2.3.1 states that during refueling operations when the IRWST water has been drained into the refueling cavity, other passive means of core decay heat removal are used. Identify what other passive means are used for emergency core decay heat removal and how they will be maintained.

13. Table 2.3-1, from Mode 5 RCS pressure boundary open to Mode 6 reactor internal in- place and refueling cavity not full, indicates that one IRWST path is available. The IRWST injection capability can be challenged during these modes and there will be no other alternative emergency core cooling available if the only available injection capability is rendered inoperable. Discuss why a single IRWST injection path is sufficient for these conditions, where RCS inventory is at the smallest available volume and the ADS operability would do little to help cool the core if there is no emergency core makeup and cooling available.

14. Section 2.3.2.3 indicates that manual actuation of the IRWST is relied upon to mitigate loss of inventory/cooling events. Provide a list of ERGs reference and discuss how IRWST injection capability would be used in these events.

15. Section 2.3.3.2 indicates that the RNS relief valve would open if the operator failed to perform the required action in a loss of RNS cooling during shutdown operations. Provide a list of the RNS system parameters display and alarm in the control room and discuss how they would be maintained throughout the shutdown and refueling operations.

16. Section 2.3.3.3 states that makeup from CMTs is possible in the event of a loss of RNS cooling during midloop operation. Identify CMTs maintenance provisions that allow the tanks to be available during shutdown and refueling operations. Will this insight be proceduralized and made available as vendor shutdown and refueling guidelines for the COL applicants? Identify other potential sources, not including IRWST, that can be used as additional insights for the COL applicants.

17. Section 2.4.2.1 indicates that a large NPSH provides the RNS pump the capability to operate during midloop conditions with saturated fluid in the RCS without throttling the RNS flow. Discuss the NPSH requires for this configuration. Will the required NPSH be included in the ITAAC program?

18. Section 2.4.2.3 discusses the ability to align the RNS to take suction form the IRWST as a diverse method for IRWST injection, regardless whether the RNS pumps are operating. Indentify and discuss flow path, valves positions and injection controls (flow rates) with the pumps not running. Will this insight be proceduralized and made available as vendor shutdown and refueling guidelines for the COL applicants?

19. Table 2.3-2 indicates that RCS boiling would occur 17-minutes after a loss of RNS capability during midloop operation. Discuss the decay heat rate and assumptions used in the analysis, and an optimum time for AP600 to enter midloop conditions. Compare the decay heat rates and time to boil during a forced outage from a steam generator tube leaks with a normal shutdown for refueling. Provide and discuss the AP600 refueling outage plan that would minimize, not only the occupational exposure to refueling personnel, but also the risk of RCS boiling.

20. LTOP protection of the RCS and RNS was implemented in the design. Discuss LTOP's actuation and indication capabilities (i.e., flow indications and information display locations).

21. The RNS provides cooling for IRWST as discussed in Section 2.4.3.4 and that both RNS divisions are also required to maintain the RCS decay heat removal function during the cool down as discussed in Section 2.4.3.2. Discuss the design capacity of the RNS that supports simultaneous RCS and IRWST cooling.

22. The RNS can also provide cooling to the spent fuel pool with the suction connection line located at 4-feet below the SFS pump suction connection. Discuss the potential over- draining of the spent fuel pool due to the inadvertent operation of both the SFS and the RNS for fuel pool cooling.

23. Section 2.8 discusses the spent fuel cooling system. Provide detailed drawings showing the relative elevations of the IRWST, refueling cavity, reactor cavity, fuel transfer canal from the reactor floor. Identify potential loss of refueling water and the impact to the spent fuel assembly during fuel movement. Discuss the ability to quickly move and safely store fuel assembly.

24. The PCS supplies water for fire protection alternatives. Provide analysis discussion of the PCS required water volume and flow rates, which simultaneously satisfy both SFS emergency makeup and fire protection alternative.

25. It is stated in Section 2.8 that an isolation valve in the refueling cavity drain line to the SGS compartment is CLOSED ONLY IMMEDIATELY BEFORE refueling operations. During other plant conditions this valve is locked open to prevent overfilling the refueling cavity during an accident. However, it is also stated that the drain line elevation allows accommodation of the possible estimated 38,200 gallons of IRWST overflow without draining to the SGS during the non-refueling plant conditions. Clarify whether the IRWST overflow can be accomplished with the refueling cavity drain isolation valve locked open during plant non-refueling conditions.

26. Also in Section 2.8, it is stated that a connection line from the SFS to the CVS makeup pump allows the use of the spent fuel pool borated water as a backup source of RCS makeup. Discuss plant conditions which warrant the use of this configuration. Where will this insight be implemented or recommended to be followed by the COL applicants?

27. Section 2.8.2.1 discusses the use of a permanent reactor cavity seal. Provide the seal design reference, detailed drawing showing the seal design and its connection to the reactor vessel cavity.

28. Table 2.8-2 shows five different case studies for spent fuel protection. Discuss case studies #2 and #3 in detail, and provide the safety impact assessment of these studies.

29. The RCS Hot leg level indication system is used to monitor water at midloop condition. The ability to accurately measure the RCS water level at midloop condition is very important not only to maintain safe operation of the refueling activities but to ensure that adequate decay heat removal capability is maintained. Discuss the ability to accurately measure the RCS level during midloop operating condition using the RCS hot leg level monitoring system. Define the system accuracy.

30. Section 4.8 discusses the results of analyses for LOCA events initiated from shutdown modes. In these analyses, initial decay heat in the core was based on the initial conditions of the hot leg temperature of 425°F and the cooldown rate of 50°F/hr. Justify that these initial conditions are the limiting conditions for Mode 3 LOCA calculations.

31. Section 4.8.4 discusses SBLOCAs from a DEDVI line break and an inadvertent ADS opening events. SSAR Section 15.6.5B (Rev. 13), however, indicates that the limiting SBLOCA case is the 10-inch break, resulting in the minimum RCS inventory of 75,000lb. Explain why the 10-inch break was not reanalyzed for Mode 3 condition. The limiting SBLOCA cases resulting from all modes of operation should be included in the SSAR and should be provided for staff review.

32. Section 4.10.2 indicates that PRHR HX capability to meet the safe shutdown temperature is dependent on condensate from the containment shell being returned to the IRWST and this mode of operation can last up to seventy-two hours. It further states that in about twenty-two hours after the loss of a normal feedwater event, if no AC power was available, or if condensate return was not available, the operator would be instructed to actuate the ADS to depressurize and cool down the plant to below 420°F. Where is this guidance implemented in the ERGs and its supporting analyses?

33. SSAR Section 15.1.5 discusses the results of the analysis for a limiting case SLB that initiates from zero power (Mode 2) condition. The analysis takes account for the reactor trip and CMT actuation on the "S" signals. The "S" signals are actuated on the setpoints of low pressurizer pressure, low steam line pressure and low cold leg temperature. Table 3.3.2-1 of the TS requires that the "S" signals be blocked when the pressurizer pressure is below the P-11 setpoint (interlock). Discuss the effects of P-11 interlock considered in the SLB analysis with the pressure below P-11 setpoint for Mode 2 operation.

34. In SSAR Section 5.1.2.2.2, it is stated that the analysis results of excessive increase in feedwater flow are bounded by the analysis results of an uncontrolled rod cluster control assemly bank withdrawal from a subcritical or low-power startup condition. Provide an analysis to support the above statement.

PLANT SYSTEMS BRANCH

1. In Section 2.2 system names are not consistent with the SSAR. For example, Main FW system and Startup FW system in the SSAR are called SGS feedwater subsystem and startup feedwater subsystem in WCAP-14837.

2. Section 2.5 discusses the used of two trains of CCS and service water system, which are needed for spent fuel pool cooling and RNS cooling during refueling operation. Explain the consequences of a failure of both trains of the CCS during the refueling operation.

3. Table 3.1-1, designer recommendations for RTNSS-Important Nonsafety-related Systems that apply to shutdown, identifies that both Normal Residual Heat Removal Systems (RNS) subsystems, Component Cooling Water System (CCS) subsystems, Service Water Systems and, AC power should be available during reduced inventory operations when they are required for decay heat removal. Identify fire areas or zones and describe in details the fire protection provided to protect each of these systems from their redundant system during refueling and shutdown conditions. Provide reference drawings, including cable routings, associated with each of these systems.

   Westinghouse is also requested to address high impedance faults, breaker coordinations and spurious operations to ensure that the redundant decay heat removal systems and associated equipment are protected from a fire.

4. The NRC has concluded that the current PRA for risks associated with fire does not accurately evaluate the facility as described in the SSAR. Provide a revised Shutdown Evaluation Report reflecting the actual plant design described in the SSAR.

INSTRUMENTATION AND CONTROLS BRANCH COMMENTS

1. The 3rd bullet on P.2.9-7 should also include "Trip Turbine" to make it consistent with SSAR Rev.12, P.7.7-16.

2. The 4th bullet on P.2.9-7 refers to isolation of "Critical" containment penetrations rather than isolation of "Selected" containment penetrations as used in SSAR Rev.12, P.7.7-16. The term "Critical" as used in the shutdown risk report seems to be more appropriate.

3. The last sentence on P.2.9-8 refers to subsection 7.7-11 of the SSAR for additional information on the DAS rather than subsection 7.7.1.11.