August 14, 1992

MEMORANDUM FOR: Robert C. Pierson, Director
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal, NRR

FROM: Conrad E. McCracken, Chief
Plant Systems Branch
Division of Systems Technology, NRR

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (RAI) ON PRELIMINARY REVIEW OF AP600 STANDARD SAFETY ANALYSIS REPORT

Enclosed are the RAIs from the Plant Systems Branch. This request is based on our preliminary review of AP600 SSAR in the areas of environmental qualification, water systems, flood protection, habitability systems, fission product removal and control systems, radwaste management systems, and containment systems. If additional information is required contac. Mr. Chang-Yang Li on 504-2830.

Original signed by

Conrad E. McCracken, Chief
Plant Systems Branch
Division of Systems Technology, NRR

Enclosure:
As stated

cc w/enclosure:
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Enclosure

REQUEST FOR ADDITIONAL INFORMATION
FROM THE PLANT SYSTEMS BRANCH
REGARDING AP600 SSAR

270.1 In AP600 SSAR Section 3.11.1.2 "Definition Of Environmental Conditions" where postulated high-energy line failures are considered, a high-energy line is defined as a line with nominal diameter greater than one inch. This definition is not consistent with the Standard Review Plan (SRP). Appendix A of SRP 3.6.1 Branch Technical Position ASB 3-1 defines High-Energy Fluid Systems as fluid systems that, during normal plant conditions are either in operation or maintained pressurized under conditions where either the maximum temperature exceed 200 °F or operating pressure exceeds 275 psig. In accordance with 10CFR 50.49 electrical equipment to be qualified includes equipment that is relied upon to remain functional during and following design basis events. It is the staff position that design basis events includes high-energy systems as defined in Branch Technical Position ASB 3-1. Therefore the definition of a high-energy line in the AP600 SSAR should be change and made to be consistent with the SRP.

270.2 In Section 3.11.2.1 it is stated that the methodology for environmental qualification of electrical equipment is based on guidelines provided in IEEE standard 323-1983. To date the NRC staff has not endorse 323-1983 therefore references to this standard in its entirety or in part is not acceptable. As indicated in a foot note to 10CFR 50.49 and stated in NUREG-0588 and Regulatory Guide 1.89 the guidance in IEEE standard 323-1974 is acceptable to the NRC staff for qualifying equipment within the scope of 10CFR 50.49.

270.3 In Section 3.11.2.1 qualification by analysis is considered to be an acceptable method for environmentally qualifying electrical equipment important to safety for AP600. However, in accordance with 10CFR 50.49(f) and NUREG-0588, paragraphs 2.1(2) and 2.1(4) and in accordance with previous NRC staff practice, qualification by analysis only is not acceptable. Therefore, environmental qualification of electrical equipment important to safety for AP600 should be in accordance with the requirements of 10CFR 50.49(f).

410.1 SSAR Section 3.4.1.2.2.1 states that reverse flow from the containment sump to the two PXS compartments and the CVCS compartment is prevented by redundant "backflow preventers" in each of the three compartment drain lines. Provide design information on these components, including leakage characteristics. Discuss the likelihood of failure of these components and the subsequent flooding effect.

410.2 Identify potential sources of external flooding from components which are within the AP-600 design scope.(SSAR Section 3.4.1)

410.3 Throughout SSAR Section 3.4.1, distinctions appear to be made between flood protection for safe-shutdown equipment versus safety-related equipment. Explain how flood protection requirements differ between safe shutdown and safety-related equipment.

410.4 How will safety-related equipment be protected from failures of structures, systems, and components which are not within the AP-600 design scope? (SSAR Section 3.4.1)

410.5 Discuss the ability of safety-related equipment to perform its safety function while fully flooded, partially flooded, or wet (e.g. from spray)? Pay particular attention to the five containment isolation valves subject to flooding. (SSAR Section 3.4.1)

410.6 SSAR Section 3.4.1.2.2.1 states that the PXS-A, PXS-B, and CVCS compartments are physically separated and isolated from each other by structural walls such that flooding in any of these compartments or in the RCS compartment cannot cause flooding in any of the other compartments. This appears to contradict another statement in this section which says that, because the floor drains for these compartments are routed to the containment sump, flooding in one compartment could cause flooding in another compartment. The staff recognizes that "backflow preventers" are located in each line to prevent reverse flow into other compartments but insufficient detail has been provided on the design and operations of these components (see Question 410.1).

410.7 SSAR Section 3.4.1.2.2.1 states that each of the compartment drain lines is monitored by a flow sensor providing the plant operators with an indication of the source of water flow. Provide more detailed information about these sensors. Are these sensors redundant and safety grade? Are these the only means of identifying the source of flow?

410.8 SSAR Section 3.4.1.2.2.1 states that the safe shutdown components located in PXS-A and PXS-B are redundant and "essentially" identical. Clarify what differences there are between the components in these two compartments.

410.9 Provide drawings of the drain system for the various compartments in the reactor building. (SSAR Section 3.4.1)

410.10 Two lines are routed from the IRWST to each of the PXS compartments. The six inch line is routed to PXS-A and the 10-inch line is routed to PXS-B. What is the purpose of these lines? Why are these lines sized differently? What is the effect if the PXS compartment overflows? (SSAR Section 3.4.1)

410.11 Discuss the effects of wetting from spray on equipment in the non-radiologically-controlled areas of the Auxiliary Building. (SSAR Section 3.4.1)

410.12 Identify Component Cooling Water on the building layout drawings. (SSAR Section 3.4.1)

410.13 Section 9.2.1.3.3 of the SSAR states that during normal plant operation the service water system (SWS) provides cooling water which has been cooled to a maximum operating temperature of 91 degree-F from the circulating water system when the wet bulb temperature is at 81 degree-F. Since the AP-600 is a standard design and the plant may be built in anywhere of the world, the design of the SWS should be generic enough that it can be applicable to environmental conditions of all the possible sites. It is possible that a site may have a maximum temperature higher than 91 degree-F. Discuss the possible degradation of the system function and remedial measures that will be needed.

410.14 Section 9.2 of the SSAR states that the SWS consists of two 100-percent-capacity service water pumps. These pumps take suction from the circulating water pump basin, which receives water cooled by the plant cooling tower. The cooling tower is site specific and is designed as a hyperbolic natural draft structure. Since the natural draft feature is created by the density difference between the warm air inside the tower and the colder atmospheric air flow through the cooling tower, the change of seasons may affect natural draft heat sink capability. Discuss the adequacy of the water temperature of the circulating water pumps basin if the ambient temperature is above 91 degree-F. Discuss the effects on the function of the SWS.

410.15 Section 9.2.2.1.1 of the SSAR states that the component cooling water system (CCWS) serves no safety-related function and has no nuclear safety design basis except for containment isolation. The AP-600 has non-safety-grade active systems to provide defense-in-depth capabilities for reactor coolant makeup and decay heat removal. These non-safety systems will serve as the first line of defense to reduce challenges to the passive systems in the event of transient or plant upsets. Since the licensing design-basis analysis will rely solely on the passive safety systems, the non-safety-related systems have no nuclear safety design basis. The staff may not require the non-safety CCWS to meet all the safety-grade criteria, but the applicant should show a high level of confidence that the system will be available when needed in its defense-in-depth roles. Provide information to demonstrate the availability of the CCWS and discuss the failure effects of the CCWS.

450.1 Section 6.4, Habitability Systems, to Chapter 6 of AP600 SSAR states that in absence of ac power, the main control room (MCR) emergency habitability system (VES) is capable of providing emergency ventilation and pressurization for the MCR, (2) prolonged occupancy is provided for a maximum MCR design basis operating shift draw size of five persons, and (3) the radiation exposure of MCR personnel throughout the duration of any of the postulated limiting faults does not exceed the limits set by GDC 19.

The VES does not deal with the safety-related radioactive release filtration function except providing the emergency ventilation and pressurization to maintain 1/8-inch water gauge (WG) positive differential pressure with respect to the surroundings during any postulated loss of coolant (LOCA) accident concurrent with loss of offsite power while nuclear island non-radioactive ventilation system (VBS) is isolated when radiation levels in the MCR supply air duct of the VBS exceed the High-2 setpoint. Provide your methodology and calculations for staff review to assess acceptability of 20 scfm of ventilation which is claimed to be sufficient to maintain 1/8-inch water gauge differential pressure and maintain the carbon dioxide concentration below one percent by volume, assuming a maximum occupancy of five people. Also, provide your rationale for limiting occupancy to five people; and your rationale for concluding that the environment inside MCR envelope is habitable. Also, provide justification to assure that safety-related and important to safety equipment will not be degraded so that safe shutdown can be achieved and maintained during postulated accident conditions. Explain in detail with proper rationale for not providing safety-related filtration system or make provision to provide a safety-related engineered safety feature (ESF) filtration system in accordance with Regulatory Guide 1.52, Design, Testing, and Maintenance criteria for Post Accident Engineered-Safety-feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light Water-Cooled Nuclear Power Plants.

450.2 AP600 SSAR Section 6.4 states that the VES is capable of providing emergency ventilation and pressurization of the MCR. Also, it is stated that the VES is sufficient to maintain a 1/8-inch water gauge positive pressure differential with respect to the adjacent areas preventing infiltration of containment air into the main control room envelope while VES is in operation. Also, Table 15.6.5-2 identifies C.3 cfm unfiltered air inleakage from ingress and egress.

Staff considers 0.3 cfm unfiltered inleakage for entire control room envelope unrealistic as judged from the to-date experience of the existing operating plants. Reassess the unfiltered infiltration inside the control room envelope and provide credible infiltration inleakage which can be supported by approved methodology and which can be tested periodically and verified. Also, Provide (1) a list of areas considered part of main control room envelope, (2) entire MCR envelope volume, (3) the expected revised unfiltered infiltration rate in the entire MCR envelope and (4) value credited for the entire MCR envelope infiltration rate in accident dose calculations. Also, explain in detail how the MCR envelope is isolated during accident conditions in order that it does not exceed the to be revised value of the unfiltered infiltration rate used in accident dose calculations. Identify the permanent measures to be implemented including sealing the MCR envelope and periodic verification and testing provisions. If sealants are used, provide their acceptability and qualification to maintain needed isolation through the proposed design plant life.

450.3 Identify interfaces in AP600 SSAR document for the future licensee/applicant to (1) ensure that the CRH design meets GDC 4, 5, and 19 and that operators are protected in accordance with TMI Action Item III.D.3.4; (2) verify that the as-built design, and the operating, maintenance, and emergency procedures and training and the performance characteristics of the Control Room Habitability system are consistent with the licensing basis documentation; and (3) verify that the technical specifications and surveillance procedures are consistent with the licensing basis documentation and provide adequate verification of system performance and integrity. (SSAR Section 6.4)

450.4 You have identified several site chemicals in AP600 SSAR Table 6.4-2 and stated that analysis of their sources are in accordance with Regulatory Guide 1.78. However, you have not addressed chlorine concern. Further, you have stated in AP600 SSAR Table 1.9-1 that Regulatory Guide (RG) 1.95, Protection of Nuclear Power Plant Control Room Operators Against an Accident Chlorine Release, is not applicable to AP600. Provide your rationale for not addressing the chlorine gas exposure in the AP600 certification document. If chlorine release is considered site-specific, it should be so identified and future licensee/applicant should be required to conform with RG 1.95. (SSAR Section 6.4)

450.5 Discuss the elevation and location of plant vents, including positions relative to the control room ventilation inlet. (SSAR Section 6.4)

450.6 Provide flow diagrams showing normal, abnormal, smoke removal and purge, and emergency (radiation and toxic release) modes of operation flow data (i.e., cfm, temperature, and pressure) for VES and VBS habitability systems. (SSAR Section 6.4)

450.7 WCAP-13053 identifies that the AP600 MCR and containment do not have post-accident ESF atmospheric cleanup systems and AP600 SSAR Section 6.5 also states that ESF filter systems are not applicable to the AP600 (design). However, AP600 SSAR Section 6.4 credits VBS when ac power is available to provide normal and abnormal HVAC services to MCR and other associated areas and AP600 SSAR Section 9.6.1 states that supplemental air filtration subsystem is designed to meet RG 1.140.

Provide your justifications for not conforming with the guidance of RG 1.52 for the ESF atmospheric cleanup system (supplemental air filtration subsystem of VBS) for control room while crediting it during abnormal as well as normal operation when ac power is available. Also, clarify your statement in AP600 SSAR Section 6.5-1 which claims that ESF filter systems are not applicable. This is inconsistent with the credit for filtration by VBS during abnormal as well as normal HVAC services to control room and other associated areas. (SSAR Section 6.4)

450.8 Section 6.5 of the SSAR indicates that AP600 does not have ESF filter systems, containment spray system, and secondary containment for the fission product control. The only fission product control system is the primary containment.

GDC 41 specifies the requirements of containment atmosphere cleanup systems. SPR Sections 6.2.3, 6.5.1, 6.5.2, and 6.5.3 provide guidelines on the fission product leakage control through secondary containment functional design, ESF atmosphere cleanup systems, containment spray as a fission product cleanup system, and fission product control systems and structures. The function of the fission product control systems and structures is to limit the potential release of radioactive materials that would result from accidents.

The applicant states in Section 15.6.5.3.9 that the calculated dose consequences at the site boundary and control room meet the regulatory requirements. The staff is reviewing the methodology of the calculation separately and has not reached a conclusion. However, the staff finds that there is a reduction of the fission product control systems in the design of AP600 compared to the design of current operating plants. It results in a lack of redundancy and reduction in safety margin. The staff has not found in the SSAR any testing program to demonstrate the adequacy of the overall fission product control systems of AP600. Based on the above concern, the staff is not convinced the adequacy of the fission product control systems even if the calculated dose consequences are found to be acceptable. Provide any additional information or testing results to address the above staff concern.

450.9 As stated in SRP 6.5.2 Rev. 1, Item II.1, the pH of the aqueous solution collected in the containment sump after completion of injection of containment spray and ECCS water, and all additives for reactivity control, fission product removal, or other purpose, should be maintained at a level sufficiently high to provide assurance that significant long-term iodine re-evolution does not occur. Long-term iodine retention with no significant re-evolution may be assumed only when the equilibrium sump pH, after mixing and dilution with the primary cooling and ECCS injection, is above 8.5. SSAR Section 6.5.2 and 6.5.3 do not indicate that the long-term pH of the sump water will be maintained at a minimum of 7.0. It is understood that "by the onset of the spray recirculation mode" is not applicable to the AP600 design, however, long-term iodine re-evolution is a concern. Also, WCAP-13053 indicates that there will be additives for the adjustment of the sump solution pH. Demonstrate how long-term iodine retention is achieved and maintained precluding any significant re-evolution of iodine. (SSAR Section 6.5.2)

460.1 In accordance with SRP Sections 11.2 "Liquid Waste Management Systems" (Section III.2.C) and 11.3 "Gaseous Waste Management Systems" (Section III.2.b), the staff uses reactor coolant fission product source terms corresponding to 1 percent failed fuel as the basis for determining the design adequacy of the liquid and gaseous radwaste systems for processing the liquid and gaseous radwastes at design basis fission product levels. In view of the above practice, either revise AP600 SSAR Section 11.1.1.1 and Tables 11.1-1, 11.1-2 and 11.3-4 to be consistent with 1 percent failed fuel or justify 0.25 percent failed fuel design basis used in the subject SSAR section and tables. (SSAR Sections 11.1 and 11.3)

460.2 Correct the following SSAR inconsistency relating to secondary coolant concentration (SSAR Sections 11.1 and 11.2):

Tables 11.1-4 and 11.1-7: Total steam generator (SG) blowdown flow rate - 4.2×10^4 lb/hr

Table 11.2-6: Total SG blowdown flowrate - 8.4×10^4 lb/hr

460.3 Provide schematics for the processing of the various liquid radwaste streams and explain how you have arrived at the decontamination factors (DFs) given in AP600 SSAR Table 11.2-6 for the different radionuclide categories in the various streams. (SSAR Section 11.2)

460.4 Regarding gaseous radwaste management systems (SSAR Section 11.3), provide the following:

a. Description of release points for airborne effluents (plant vent and turbine building vent). Your description should include information on height of the release point above grade, its height above and relative location to adjacent structures, expected temperature of the gaseous effluents, flow rate and size and shape of the flow orifice (note that these parameters are required in conjunction with plant-specific parameters to determine plant-specific atmospheric dispersion factors).

b. Demonstration of AP600 design compliance with Branch Technical Position (BTP) ETSB 11.5 "Postulated Radioactive Releases due to a Waste Gas System Leak or Failure."

c. Discussion of AP600 design compliance with GDC 3 as it relates to providing protection to gaseous waste handling and treatment systems from the effects of an explosive mixture of hydrogen and oxygen. Your description should include the provisions incorporated in AP600 design to control releases due to hydrogen explosions in the gaseous waste management system. Additionally, it should include the type, number and locations of gas analyzers provided in the design of the gaseous waste management system (for response guidance, see SRP Section 11.3, Acceptance Criterion II.B.6).

d. Discussion of AP600 design compliance with GDC 60 as it relates to control of releases of radioactive materials to the environment. Your discussion should refer to Regulatory Guide (RG) 1.140 to be consistent with SRP Section 11.3, Acceptance Criterion II.6.a (note that reference to the subject guide in SSAR Section 9.4 alone is not sufficient. As a minimum, you should cross reference Section 9.4 and state clearly whether you comply with the guide or not).

e. Discussion of AP600 design compliance with GDC 61 as it relates to radioactivity control in gaseous waste management systems and ventilation systems associated with fuel storage and handling areas.

460.5 Regarding solid radwastes (SSAR Section 11.4) provide the following:

a. Estimates of solid waste volumes expected to be shipped annually for wet solid wastes and dry solid wastes separately.

b. Discussion of AP600 design compliance with BTP ETSB 11-3, Position III.1 regarding the storage capacity for accumulated filter sludges.

c. Discussion of AP600 design compliance with BTP ETSB 11-3, Position III.2 regarding storage volume for solidified wastes (both wet and dry solid wastes) available in the plant.

460.6 The staff finds that the proposed seismic design of the structures that house liquid, gaseous and solid radwaste management systems as well as the proposed design of the applicable components of the 11.4) gaseous waste management systems do not meet RG 1.143 seismic design guidelines in the sense that the operating basis earthquake (OBE) has been eliminated in the AP600 design (see AP600 SSAR Appendix 1A). Revise either the design criteria for the above to meet the applicable guidelines of RG 1.143 or provide justification for all the deviations. Also, clarify how AP600 design meets Position C.1.1.3 for liquid radwaste management system. (SSAR Sections 11.2, 11.3, 11.4)

460.7 SRP Section 11.5, "Process and Effluent Monitoring Instrumentation and Sampling Systems," Table 2 includes service water system effluent monitor. The staff notes that AP600 design includes an upstream provision in the form of component cooling water system monitor. The staff does not consider an upstream provision as an adequate basis for eliminating a downstream provision. Therefore, either include a service water system monitor or justify its elimination. (SSAR Sections 11.5)

480.1 Section 1.2.1.4.1 of AP600 SSAR states that the number and complexity of operator actions required to control the safety systems are minimized. One of the principal design requirements of the EPRI Passive Requirements Document is that the core must be cooled and containment integrity maintained for 72 hours without reliance on ac power and operator action. This requirement is stated in Section 2.3.2.9 of Chapter 1 and Section 1.2.1.1. of Chapter 5 of the EPRI Passive Requirements Document. The extent of this commitment regarding operator action in the AP600 appears to be less than that in the EPRI Requirements Document.

The applicant is required to clarify its position. Will AP600 meet the above cited EPRI requirements without modification? If AP600 takes a different position, identify the differences and state all the operator actions during the 72-hour period.

480.2 Provide a discussion on the mechanistic heat and mass transfer correlation for the passive containment system (PCS) in more detail (SSAR Section 6.2.2).

a. Identify and discuss the major improvement made in the PCS. Identify the difference between the correlation used in the PCS and that used in the current Westinghouse containment code such as the COCO code. Compare the two different correlations quantitatively in terms of condensation, evaporation, convection and radiation. We understand that the condensation and convection are included in the COCO code. Are there modifications in these two terms from COCO code to PCS correlation? Do these modifications of these two terms contribute significantly to the overall results? Or do the other two terms (evaporation and radiation) make the major contribution to the heat transfer improvement in the PCS.

b. What are the bases for Westinghouse to believe that the correlation used in the PCS is valid. Verify the correlation used in the PCS and justify its validity. Describe the hand calculation and discuss the specific tests that were used by Westinghouse for the verification.

480.3 Compare the failure probability of the PCS in an AP600 to the failure probability of the containment heat removal systems in a typical Westinghouse plant. What is the failure probability of the air operated valves in the PCS? Compare the consequence of the failure of the PCS to the consequence of the failure of the containment heat removal systems in a typical Westinghouse plant. In Section 1.2.1.4.1 of the SSAR it is stated that with only air cooling, the containment pressure does not exceed its ultimate pressure during a core melt scenario. Does this correspond to the worst consequence of a total failure of PCS? What is the value of the containment ultimate pressure? What are the bases for choosing this value? (SSAR Section 6.2.2)