December 11, 1997

Mr. Nicholas J. Liparulo, Manager
Nuclear Safety and Regulatory Analysis
Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
P.O. Box 355
Pittsburgh, PA 15230

SUBJECT: OPEN ITEMS ASSOCIATED WITH THE DRAFT SAFETY EVALUATION REPORT (SER) ON THE AP600 SHUTDOWN RISK SAFETY

Dear Mr. Liparulo:

The Reactor Systems Branch of the U.S. Nuclear Regulatory Commission has provided a draft SER input to the Standardization Project Directorate on the AP600 shutdown risk safety evaluation including the shutdown evaluation report, WCAP-14837. The draft SER input will be SER Section 19.3. The input has open items which have been extracted and designated as FSER open items in the enclosure to this letter.

If you have any questions regarding this matter, you may contact me at (301) 415-1141.

Sincerely,

origi: signed by:

William C. Huffman, Project Manager
Standardization Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Docket No. 52 003

Enclosure: As stated

cc w/encl: See next page

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SER SECTION 19.3 OPEN ITEMS ASSOCIATED WITH THE AP600 SHUTDOWN RISK EVALUATION

440.763F

The shutdown evaluation report, WCAP-14837 , provides insights that can be utilized by the COL applicants to increase the availability of alternate decay heat removal capabilities during shutdown and refueling operations. Westinghouse should provide a COL action item in the AP600 SSAR to ensure that the COL applicant develops plant specific refueling plans that would make use of the insights furnished in WCAP-14837.

440.764F

Air entrained in the RNS piping may hinder the ability to provide adequate shutdown cooling during mid-loop operation. To address this concern, Westinghouse designed the RNS piping to each respective RNS pump suction in a continuously downward sloping path from the RCS connection, thereby creating a self venting path with no high point areas and no loop seals. The RNS piping design feature which precludes loop seals should be included in the ITAAC program for design verification.

440.765F

As part of design features that mitigate air binding of the RNS pump during mid-loop operation, the RNS employs a step-nozzle connection to the RCS hot leg. The step-nozzle connection has several advantages that substantially reduce the RCS hot leg level (critical water level) at which a vortex can occur in the RNS pump suction line because of lower fluid velocity in the hot leg nozzle, and limits the maximum air entrainment into the pump suction, should a vortex occur, to no greater than 5-percent while continuing to provide decay heat cooling. The RNS step nozzle connection should be included in the ITAAC program for design verification.

440.766F

Freeze seals are used for repairing and replacing such components as valves, pipe fittings, pipe stops and pipe connections when it is impossible to isolate the area of repair any other way. Industrial experience indicates that some freeze seals have failed in nuclear power plants and resulted in significant events. To address the issue of freeze seal failure, the AP600 design reduced the potential applications of freeze seals by reducing the number of lines that connect to the RCS. Westinghouse should provide a COL action item in the SSAR which will ensure that the COL applicant develops plant specific guidelines that would reduce the potential loss of RCS boundary and inventory when employing freeze seals.

Enclosure

440.767F

AP600 design includes two RCS safety-related hot leg wide-range thermowell-mounted resistance temperature detectors (RTDs) and incore thermocouples that are used to measure RCS temperature. The incore thermocouples are used to measure core exit temperature, which is the indicative of the RCS temperature, and are available when the reactor vessel head is in place. This capability is not available when the reactor vessel head is detensioned and instruments are disconnected in preparation for refueling activities. In this condition, the ability to measure the RCS temperature is dependent on the RCS wide-range hot leg RTDs. The staff believed that the RTD detector's accuracy would be highly flow dependent and asked (RAI 440.690) that Westinghouse address the ability of RTDs to accurately detect incremental changes in temperature at no flow conditions. Westinghouse indicated that the wide-range RTDs provide a backup indication of coolant temperature when the RNS are operating, and provide the primary indication in the event that the RNS pumps become inoperable. The RTDs are inserted into the bottom of the hot legs in the AP600 design and Westinghouse states that these RTDs do not require flow to provide an accurate temperature measurement of the stagnant water in the hot legs. This configuration will provide indication of the temperature of the water in the hot legs as long as there is water present in the loop piping. Some current plants require flow for an accurate temperature measurement due to the RTD flow bypass manifold arrangement employed to measure RCS temperature. The staff agrees that the AP600 RTDs would accurately measure temperature in the hot leg as long as there is water in the hot leg piping. However, the measured hot leg temperature is not necessarily indicative of the overall RCS temperature if there is a lack of coolant circulation in the RCS loop. Also, the staff considers the ability of the RTDs to relatively quickly measure incremental changes in the RCS temperature an important indication of an approach to RCS boiling and a loss of RNS cooling. The staff could not verify the response time of the wide range RTDs as indicated by Westinghouse. Westinghouse indicated that an analysis was performed to determine the accuracy of the wide range RTDs for the stagnant conditions. The staff has not received results indicating the ability of the RTDs to respond to incremental changes in RCS loop temperature under a stagnant condition. The staff, therefore, considers this an open item.

440.768F

The staff considers the NPSH requirement an important design parameter of the RNS pump's design, and therefore, concludes that this information should be captured in the ITAAC program and the Initial Test Program.

440.769F

Inadvertent actuation or malfunction of the CMTs can cause an increase in RCS inventory. The events may lead to an overfill of the pressurizer and possible loss of reactor coolant. The analysis of the inadvertent actuation of the CMTs is performed with the plant initially in Mode 1, full-power condition and is discussed in SSAR 15.5.1. The reactor trip and the PRHR HX actuation are actuated on the Hi-3 pressurizer level trip setpoint. During the event, the CMTs inject cold and borated fluid into the RCS. The injected fluid expands as it is heated in the RCS by the decay heat. The expansion is counteracted by the heat removal from the PRHR HX. Westinghouse stated that the severity of the fluid expansion increases with higher decay heat levels and claimed that the case at full-power (producing a maximum decay heat) bounds the results initiated from conditions below Mode 1. The fluid expansion is controlled by the injection rate, the core decay heat level and the heat removal rate. At shutdown operations, while decay heat levels are lower, heat removal from the PRHR HX is also lower. The staff notes that in the absence of analyses to quantify the total effect of the injection rate, decay heat levels and the heat removal rate from the PRHR HX on the fluid expansion, it is not clear that the full-power case bounds conditions below Mode 1. Westinghouse is requested to analyze the CMT malfunction events at shutdown modes and show that the results are acceptable.

440.770F

Similar to the concern identified in 440.769F, the analysis of CVS malfunction is performed with the plant initially in Mode 1, full-power conditions and is discussed in SSAR 15.5.2. The severity of the event depends on the fluid expansion, which, in turn, is controlled by the integral flow from the CVS, decay heat levels, and heat removal from the PRHR HX. The staff notes that in the absence of analyses to quantify the total effect of these parameters on fluid expansion, it is not clear that the full-power case discussed in SSAR 15.5.2 bounds events initiated from operations below Mode 1. Westinghouse is requested to analyze the CVS malfunction events at shutdown modes and show that the results are acceptable. This is an Open Item.

440.771F

Westinghouse asserted in Section 4.7.3 of the shutdown evaluation report, WCAP-14837, that margin to the SG overfill would be maintained for SGTR events initiated at lower power levels even with a higher initial SG inventory corresponding to the lower initial power level. The staff notes that margin to SG overfill depend on parameters such as initial SG water inventory, time to actuate the PRHR HX and termination of the CVS flow. In the absence of a quantitative analysis for SG overfill, it is not clear that the margin to SG overfill can be maintained for SGTR events initiated at lower power levels and shutdown modes. Westinghouse is requested to perform SG overfill analyses initiated from lower mode conditions and show that the analytical results are acceptable. This is an Open Item.

440.772F

Technical Specifications allow isolation of one CMT for Mode 5 with the RCS intact. Prior to RNS operation, the initial RCS pressure may maintain at pressures corresponding to full-power pressures. Even though the decay power is less than the value assumed in the Mode-3 LOCA analyses, the availability of safety-related systems (one CMT vs. two CMTs available) is reduced. Westinghouse is requested to perform LOCA analyses for Mode 5 with the RCS intact and at high RCS pressures and show that the results are acceptable. This is an Open Item.

440.773F

Westinghouse stated in its response to RAI 440.713 that the analysis of a loss of the RNS performed in Mode 5 bounds events that may occur during Mode 6 because of the higher decay heat levels. In Mode 6, the water in the refueling cavity provides a large heat sink. Following a loss of the RNS, the water in the refueling cavity can heat up and begin to boil in several hours. Westinghouse stated that, before boiling occurs, the operators are required to close containment. If no operator actions are taken, the water in the refueling cavity can fall to the level of the top of the core in several days. Westinghouse stated that, prior to this time, the operators are required to align IRWST injection and eventually establish containment recirculation to provide long-term cooling. Westinghouse should include a COL action item in the AP600 SSAR for the COL applicant to provide information (procedures or controls) and show that the required operator actions to close containment, align IRWST injection, and establish containment recirculation will be in place for removal of decay heat.

440.774F

In NUREG/CR-5820, "Consequences of the Loss of the Residual Heat Removal System in Pressurized Water Reactors," dated May 1992, the staff and its contractor analyzed the assumed loss of residual heat removal with the vessel upper internals in place to determine the possible core uncovery from a lack of coolant circulation flow. Such conditions could occur during the flooding of the refueling pool cavity while preparing for fuel shuffling operations. Under these conditions, the vessel upper internals may provide sufficient hydraulic resistance to natural circulation flow between the refueling pool and the reactor, and may prevent the refueling water from cooling the core if the residual heat removal cooling is lost. Westinghouse is requested to address this issue for the AP600 design. This is an Open Item.

440.775F

The ultimate responsibility for outage planning and control is within the scope of the plant owners. The staff will review and ensure that the COL applicant has appropriately addressed the outage and planning program to improve low-power and shutdown operations, which, as a minimum would include the following important elements:

- an outage philosophy which includes safety as a primary consideration in outage planning and implementation.
- organizations responsible for scheduling and overseeing outages and provisions for an independent safety review team that would be assigned to perform final review and grant approval.
- control procedures which address both the initial outage plan and all safety-significant changes to schedule.
- provisions to ensure that all activities receive adequate resources.
- provisions to ensure defense in depth during shutdown and ensure that margins are not reduced. In addition, an alternate or backup system must be available if a safety system or a defense-in-depth system is removed from service.
- provisions to ensure that all personnel involved in outage activities are adequately trained; this should include operator simulator training to the extent practicable; other plant personnel, including temporary personnel, should receive training commensurate with the outage tasks they will be performing.

Westinghouse should provide a COL action item in the AP600 SSAR to provide this information.