June 12, 1996

FOR: The Commissioners

FROM: James M. Taylor /s/
Executive Director for Operations

SUBJECT: POLICY AND KEY TECHNICAL ISSUES PERTAINING TO THE WESTINGHOUSE AP600 STANDARDIZED PASSIVE REACTOR DESIGN

- PURPOSE:
- BACKGROUND:
- DISCUSSION:
- COORDINATION:
- CONCLUSIONS:
- RECOMMENDATIONS:

PURPOSE:

To present the Commission with recommended positions on policy issues pertaining to the Westinghouse AP600 standardized passive reactor design certification, and to request that the Commission approve the underlined staff positions presented in this paper. In addition, for the Commission's information, this paper presents proposed resolutions and, where appropriate, staff positions on key technical issues.

BACKGROUND:

In June 1992, Westinghouse submitted its application for design certification of the Westinghouse AP600 passive reactor design. In November 1994, the staff issued its draft safety evaluation report (DSER) for the AP600 and, in May 1996, the staff issued a supplement to the DSER discussing its safety review of the code and testing programs for the AP600. The staff is in the process of resolving open issues identified in the DSER and its supplement and issues identified during the review of recent Westinghouse submittals.

In accordance with Commission directives, the staff identified policy and key technical issues on passive designs in SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (LWR) Designs," dated April 2, 1993; SECY-94-084, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs," dated March 28, 1994; and SECY-95-132, "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems (RTNSS) in Passive Plant Designs (SECY-94-084)," dated May 22, 1995. In its staff requirements memoranda (SRM) dated July 21, 1993; June 30, 1994; and June 28, 1995, the Commission has provided guidance on these proposed resolutions.

In SECY-95-172, "Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design," dated June 30, 1995, the staff identified key technical issues that are specific to the AP600 design. The staff did not identify any policy issues for which Commission guidance was requested. In its letter dated June 15, 1995, the Advisory Committee on Reactor Safeguards (ACRS) provided comments on some of the technical issues, to which the staff responded in its letter dated August 8, 1995.

DISCUSSION:

As a result of its continuing review of the AP600 design, the staff has identified three policy issues that are specific to the AP600 design concerning prevention and mitigation of severe accidents, post-72 hour actions, and external reactor vessel cooling, and is seeking Commission guidance on the proposed resolutions of the policy issues in accordance with Commission directives. In the attachment, the staff describes these issues, the proposed resolutions, and the basis for the staff's positions on these issues. Where appropriate, a discussion of the ACRS's comments is also provided. The staff has underlined the positions for which it is requesting the Commission's approval.

In the attachment, the staff also identifies issues resulting from the staff's review of the AP600 design. At this stage of the review, the staff considers these to be technical issues and is still discussing their resolution with Westinghouse. However, where appropriate, the staff also discusses resolution approaches and its current positions on these matters. Because of the stage of the review, the staff is not requesting Commission guidance on these technical issues at this time.

A technical issue concerning Westinghouse's proposed resolution of its approach to leak-before-break (LBB) that was discussed in SECY-95-172 has been resolved to the satisfaction of the staff. The staff reexamined its position on the margin for loads and finds that using a factor of 1.0 on loads and combining the loads by the absolute sum method as proposed by Westinghouse provides a conservative approach for the AP600 leak-before-break analysis. Therefore, the staff is applying the equivalent level of conservatism on the piping loads as that which has been applied to operating plants, and no longer considers this a technical issue that needs to be elevated for Commission review. However, the appropriateness of the use of LBB for feedwater lines is currently under staff review, and, if found unacceptable, will be discussed in a future policy paper.

The staff developed the recommendations in this paper after

(1) reviewing current operating reactor designs, evolutionary designs, and passive light water reactor (LWR) designs;

(2) considering operating experience;

(3) considering insights from the available results of the probabilistic risk assessment (PRA) of the AP600;

(4) considering the Commission's guidance on issues resolved for the evolutionary LWRs;

(5) considering the staff's evaluation of the Electric Power Research Institute's (EPRI) Utility Requirements Document (URD) for passive LWR designs;

(6) considering applicable ACRS comments on these issues; and

(7) considering information related to these issues provided by Westinghouse (Westinghouse has been informed of the positions taken in this paper, but has not reviewed the evaluations presented in this paper).

The staff concludes that the positions discussed in the attachment are fundamental to the Agency's decisions on the acceptability of the AP600 design. As discussed in SECY-91-262, "Resolution of Selected Technical and Severe Accident Issues for Evolutionary Light-Water Reactor (LWR) Designs," the staff proposes to implement final positions on these matters as approved by the Commission through the individual design certification for the AP600.

COORDINATION:

The Office of the General Counsel (OGC) has reviewed this paper and has no legal objection. OGC notes that Commission approval would be tentative, subject to further review in the design certification rulemaking for the AP600, and that communications with Westinghouse regarding these Commission positions should state this fact.

The ACRS was briefed on some of the technical issues during meetings on May 31 and June 9, 1995. Comments provided by the Committee in its June 15, 1995, letter are addressed in the attachment. However, the Committee has not been briefed on the underlined positions taken by the staff on the policy matters.

CONCLUSIONS:

The staff requests that the Commission approve the recommended underlined positions for the AP600 design. Such approval will enable the staff to proceed with the final design approval and the design certification review of Westinghouse's AP600 design.

RECOMMENDATIONS:

The staff recommends that the Commission

(1) approve the positions underlined in the attachment.

(2) note that the staff is still considering other potential policy issues and will seek the Commission's approval of its positions in the future.

(3) note that, should a new policy issue be identified, it will be promptly identified to the Commission.

original /s/ by

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Attachment: Policy and Key Technical Issues on the AP600 Design

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ATTACHMENT

Policy and Key Technical Issues on the AP600 Design

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POLICY AND KEY TECHNICAL ISSUES ON THE AP600 DESIGN

I. Design Basis Accident Radiological Consequences

In SECY-95-172, "Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design," Item X - **Long-Term Severe Accident Radiological Consequences**, the staff stated that it planned to use the updated accident source term insights of NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants," to perform design basis accident (DBA) radiological consequence assessments for the AP600 design. The staff also stated that it planned to use the framework presented in the proposed changes to 10 CFR Parts 50 and 100 (SECY-94-194, "Proposed Revisions to 10 CFR Part 100 and 10 CFR Part 50, and New Appendix S to 10 CFR Part 50"). The proposed rule sets a dose criterion of 25 rem total effective dose equivalent (TEDE) that must not be exceeded (1) for any 2-hour period at any location on the exclusion area boundary and (2) for the entire accident period at any location on the outer boundary of the low population zone. A Commission paper (SECY-96-118, "Amendments to 10 CFR Parts 50, 52, and 100, and Issuance of a New Appendix S to Part 50"), which recommends adoption of the framework as described, has been forwarded to the Commission. If rulemaking results in changes to the proposed framework in a time frame consistent with the schedule for the AP600 review, the staff will incorporate those changes into the AP600 review.

DBAs are also considered in the assessment of control room habitability issues. GDC 19, "Control Room," of Appendix A to 10 CFR Part 50 requires, in part, that

> ... adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident.

Consistent with the proposed staff position to use a TEDE criterion for the offsite radiological consequence assessments for DBAs, the staff also plans to use 5 rem TEDE as the acceptance criterion for evaluation of the AP600 control room habitability (GDC 19) design. In addition to the Commission papers cited above, the source term issue was also discussed in SECY-90-016, "Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements," dated January 12, 1990, and SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," dated April 2, 1993.

In an April 1, 1996, letter, Westinghouse described the source term model that it proposes to use in its DBA assessments. The Westinghouse proposal agrees with the staff's approach in most ways, but there are two departures. First, Westinghouse proposes that core release fractions for the low-volatile elements be reduced from those identified in NUREG-1465 (a reduction factor of 5 for strontium, barium and the cerium group and a reduction factor of 2 for the lanthanide group). The low-volatile fission product release fractions in NUREG-1465 were based on (1) the results of the expert panel elicitation for NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants"; (2) additional research results obtained since the issuance of NUREG-1150; (3) the results of the in-pile severe fuel damage experiments at the Power Burst Facility; and (4) further examination of the Three Mile Island accident. In NUREG-1465, the staff selected the 75th percentile value for the low-volatile fission product release fractions on the basis that it bounds most of the range of research data values. Although the staff plans to use the low-volatile fission product release fractions outlined in NUREG-1465 for its evaluation of the AP600 design, the differences proposed by Westinghouse do not result in substantive differences in calculated DBA offsite and control room dose consequences.

Second, in the April 1, 1996 letter, Westinghouse contends that the release of fission products from the fuel to the containment in the gap release phase would be in two stages: (1) the release of gap activity from 5 percent of the fuel rods would begin at the 30-second mark from the initiation of a DBA, and (2) the release of gap activity from the remaining 95 percent of the fuel rods would begin at the 50-minute mark. In an earlier submittal, Westinghouse proposed that the release of gap activity from all of the fuel rods would begin 53 minutes from the initiation of a DBA. If the dose is evaluated for any 2-hour period as specified in the proposed rule change, the difference in gap release initiation timing does not significantly change the radiological consequence assessments; however, an alternative construction for the 2-hour dose evaluation period could have an appreciable impact on the DBA assessment. In SECY-95-172, Item X, the staff stated that the 53-minute delay of gap release proposed by Westinghouse for the AP600 design was under review and believed to be in the correct time range. More detailed analyses by Westinghouse and the staff led to Westinghouse's April 1, 1996, proposal, which is under review by the staff.

In its June 15, 1995, letter, the ACRS states that it believes that the staff position on the source term as discussed in SECY-95-172 is appropriate. The staff is still reviewing Westinghouse's proposals to address this issue. The above discussions show how the staff is implementing earlier Commission guidance. The staff does not consider these matters to be policy issues.

II. Prevention and Mitigation of Severe Accidents

The Commission has long used the term "safety-related equipment" to refer to those structures, systems, or components (SSCs) necessary to assure, among other things, the capability to prevent or mitigate the consequences of design basis accidents which could result in potential offsite exposures comparable to the guideline exposures of 10 CFR Part 100, Appendix A. Operating and evolutionary designs have relied, in part, on internal safety-related containment sprays for fission product removal to assure compliance with 10 CFR Part 100, Appendix A. The staff has allowed the use of non-safety related SSCs for severe accident mitigation. The hydrogen ignition system, which is installed in ice condenser and boiling water reactor Mark III containments, is an example of an important feature outside the safety-related category.

In SECY-88-203, "Key Licensing Issues Associated with DOE-Sponsored Advanced Reactor Designs," dated July 15, 1988, the staff stated that the criteria it proposed to use to implement the Advanced Reactor Policy Statement would allow a tradeoff between plant protection and accident mitigation to achieve an equivalent level of safety as current generation LWRs; however, the criteria were not intended to allow elimination of either plant protection or mitigation. In its June 15, 1990, staff requirements memorandum, the Commission directed the staff to ensure there is an appropriate multi-barrier, defense-in-depth balance between prevention and mitigation in advanced reactor design.

The AP600 design emphasizes *prevention* of severe accidents; to achieve a more appropriate balance, additional mitigative features may be required. The AP600 currently provides equipment such as the hydrogen ignitor, cavity flooding, and automatic depressurization systems to mitigate the consequences of a severe accident. However, the AP600 relies solely on natural processes for fission product removal, in contrast to operating plants with an internal containment spray system. As part of the review of the AP600 design, the staff is evaluating thermal-hydraulic processes and passive fission product removal mechanisms; the state-of-the-science for evaluating the effectiveness of these processes has uncertainty levels greater than those for current operating plants which employ active systems. These uncertainties involve the quantification of the passive fission product removal processes, the size and distribution of radioactive aerosols, the turbulent motion in containment, the potential for stratification of non-condensible gases, and the long-term containment pressure reduction. Because of these uncertainties, the staff cannot conclude that these natural processes are sufficient to mitigate the consequences of a severe accident.

In SECY-95-172, Item X - **Long Term Severe Accident Radiological Consequences**, dated June 30, 1995, the staff stated that it was concerned about

> the capability of the containment to mitigate offsite consequences in accidents that progress beyond the design basis, including accidents involving significant core damage. In particular, during severe accident conditions, the AP600 containment may remain at elevated pressures for extended periods. Consequently, any leakage path or containment bypass would result in higher leakage rates than those in the current generation of containment designs. Additionally, in the absence of active removal systems internal to the containment, the concentration of airborne radionuclides would be higher and would remain higher for extended periods. The range of uncertainty in staff estimates of the concentration of airborne radionuclides would be greater than for currently operating plants because of the reliance of the AP600 design solely on natural processes for fission product removal, in contrast to operating plants with an internal containment spray system.

The combined effect of elevated containment pressure and higher concentrations of airborne radionuclides for longer periods could lead to higher offsite consequences after a core damage accident.

Therefore, as further discussed in SECY-95-172, the staff concludes that single-train, active, non-safety-related systems with non-safety-grade support systems are necessary to provide the mitigative capability sought to achieve an acceptable balance between prevention and mitigation of a severe accident. Such systems would need to be designed, operated, maintained (in accordance with 10 CFR 50.65), and tested to ensure availability and reliability, and would be supported by reliable power sources and equipment cooling systems. Procedures for the use of the systems and appropriate personnel training would be included as part of the accident management strategy for the plant. The level of equipment qualification for such systems is discussed in SECY-93-087, Item L - **Equipment Survivability**.

Therefore, in light of the enhanced safety that is expected from the AP600 design, the staff recommends that the Commission approve for the AP600 the use of non-safety-related system(s) to address the uncertainties associated with the passive natural fission product removal mechanisms for design basis analysis and for balance between prevention and mitigation of severe accidents.

Westinghouse has proposed to address this issue through the use of its non-safety-related fan coolers. The staff is reviewing Westinghouse's proposal, including its April 1, 1996, responses to requests for additional information, to determine whether the system can acceptably mitigate the consequences of a severe accident. There are a number of uncertainties associated with the use of the fan coolers, such as particulate deposition rates. The uncertainties associated with fan cooler performance are in large part due to the lack of a complete data base. For example, the staff does not know of any experimental data that would support any aerosol removal rate proposed by Westinghouse for the containment fan coolers. No testing program has been proposed by Westinghouse to demonstrate the capability of the fan coolers to remove radioiodine particulates or reduce containment pressure. The staff believes that initiation, implementation, and evaluation of such a testing program would affect the design certification schedule for the AP600. Because of the uncertainties associated with containment fan cooler operation and the impact a testing program would have on the AP600 design certification schedule, the staff has concluded that Westinghouse should evaluate alternative solutions to provide severe accident mitigative capability for the AP600.

One alternative solution is the use of containment sprays to augment the mitigative capability of the AP600 containment. The staff informed the Commission that it was still evaluating the need for a containment spray system for passive LWR designs in SECY-93-087, Items I.A - **Use of a Physically Based Source Term**, II.G - **Containment Bypass**, and III. F - **Radionuclide Attenuation**. Westinghouse has stated that containment sprays are not necessary for the AP600 design, but has not provided an acceptable alternative mitigation system. Due to the uncertainty associated with passive system and containment fan cooler aerosol removal mechanisms, the staff concludes that the fan coolers may not be as effective as sprays in providing defense-in-depth accident mitigation. Therefore, the staff will pursue the merits of adding a containment spray system for the mitigation of offsite consequences for accidents that progress beyond the design basis in parallel with its evaluation of the mitigative capability of the fan coolers. The staff expects to issue RAIs on the effect of containment sprays in reducing pressure and temperature as well as airborne radioactive aerosols inside the AP600 containment. In addition, the staff will evaluate the acceptability of any alternative mitigation systems proposed by Westinghouse.

The ACRS has not yet been briefed on the underlined position taken in this paper. However, in its June 15, 1995 letter, the ACRS states:

> We believe that the issues associated with the potential for radioactive leakage and the source term should be treated separately. We believe that the staff position on the source term is appropriate. The radioactive leakage from the proposed containment design, however, should be considered with respect to public risk and the safety goals.

The staff believes that issues associated with containment leakage and the source term are integrally linked. The DBA dose consequence assessment, compared against the DBA dose criteria, is an integrated performance measure of accident mitigation systems design. The containment is an essential element of accident mitigation, and the containment leak rate is an important parameter in the assessment of DBA dose consequences. The timing, quantity, and form of fission products available for release into containment (the source term) and the effectiveness of in-containment removal mechanisms are also important elements in the assessment.

The staff does consider public risk and the Commission's safety goals in its evaluation of severe accidents for the AP600. In its evaluation, the staff has considered the uncertainties discussed in this section and Section I of this paper. The staff believes that judgements concerning the acceptability of the advanced LWR designs cannot be based solely on consideration of systems or passive processes that mitigate DBAs, but should also include consideration of how these systems or processes mitigate the consequences of severe accidents. As part of that consideration, the staff believes it is appropriate to include the level of uncertainty of analytical methods used to approximate the interaction of complex physical and chemical phenomena in its assessment of the capabilities of the design to mitigate the potential consequences of a design basis or severe accident.

The addition of non-safety-grade pressure reduction and fission product removal systems would improve the capability of the AP600 design to mitigate the potential consequences of a severe accident. Such systems would provide a wider range of tools for use in severe accident management. Such systems would also give the staff additional confidence in the capability of the AP600 design to mitigate the potential consequences of a DBA. The staff believes that this approach is technically sound and prudent, in keeping with the Commission's defense-in-depth philosophy.

III. Passive System Thermal-Hydraulic Performance Reliability and Regulatory Treatment of Non-Safety-Related Systems (RTNSS)

In SECY-95-172, Item V - **Passive System Thermal-Hydraulic Performance Reliability**, the staff described the need to assess the uncertainties associated with the use of passive safety systems in the AP600. The staff's concerns in this area are related to the RTNSS issue (see SECY-95-172, Item VI - **Regulatory Treatment of Non-Safety Systems**). Westinghouse has stated that the AP600 can respond in an acceptable manner to risk-significant PRA accident sequences by using only passive safety systems and that as a result, no regulatory oversight of active, non-safety-related systems is required. To support this statement, Westinghouse has proposed using the NOTRUMP small-break loss-of-coolant-accident (LOCA) computer code to perform sensitivity studies on accident sequences that are risk-significant in the focused PRA (which assumes no availability of active systems), using conservative, bounding inputs and assumptions, and to demonstrate thereby that there are large margins to core damage. The sequences to be analyzed will be selected using the MAAP4 computer code to "screen" sequences from the focused PRA. The margins approach is undertaken in lieu of attempting to quantify thermal-hydraulic uncertainties in the PRA, related to passive system performance.

The staff believes that quantification of thermal-hydraulic uncertainties is unnecessary for the AP600, and agrees in principle with a margins approach. However, the staff has requested further information from Westinghouse detailing how the approach will be implemented, including (1) complete documentation on how the NOTRUMP sensitivity analyses will be performed; (2) the basis by which the risk-significant sequences will be screened and selected; and (3) documentation of and justification for the selection of the bounding parameters for the sensitivity analyses. The staff is continuing to discuss this issue with Westinghouse and to review Westinghouse's documentation. Westinghouse has also agreed to address how uncertainties associated with long-term cooling will be evaluated, but the staff has not yet received any information related to this issue.

In SECY-95-172 (Item VI), the staff noted that Westinghouse had proposed a systematic approach to identification of potential systems interactions between safety- and non-safety-related systems in the AP600. Westinghouse has submitted WCAP-14477, "The AP600 Adverse Systems Interactions Evaluation Report." The staff is currently reviewing this report.

The staff will review the results of Westinghouse's margins-based approach to RTNSS when submitted, and will discuss this issue with the ACRS. Insights from this process could potentially result in modifications to the design or involve regulatory oversight of non-safety-related systems, and could thus affect the AP600 review schedule. Resolution of these issues could also affect other key aspects of the review, including development of the technical specifications (Limiting Conditions for Operation on equipment or administrative controls); inspections, tests, analyses, and acceptance criteria (ITAAC); and the initial test program. As noted, the staff is still reviewing Westinghouse's proposals to resolve these issues. Therefore, the staff is not requesting Commission guidance on these matters at this time.

In its June 15, 1995, letter the ACRS states that the risk-based margins approach discussed in SECY-95-172 "may be expedient, but [the ACRS] believes efforts should continue on the quantification of the uncertainty for use in probabilistic risk assessments." The staff has recently initiated a program to evaluate thermal-hydraulic uncertainties related to AP600 PRA sequences. The program is designed, in the short term, to support the staff's review of Westinghouse's margins approach, and in the long term, to gain insight into the quantification of thermal-hydraulic uncertainties in PRAs. Lessons learned from this program will help to shape the staff's review strategy for future advanced passive reactor designs.

IV. Post-72 Hour Actions

By letter dated September 24, 1993, Westinghouse submitted WCAP-13856, "AP600 Implementation Report for Regulatory Treatment of Nonsafety-Related Systems." Section 6.0 of the report provides a discussion of operator actions that would be credited for the licensing design basis analysis beginning 72 hours after the start of a DBA (post-72 hour actions). By letter dated May 25, 1995, the staff forwarded a request for additional information to Westinghouse, to which Westinghouse responded by letter dated April 3, 1996.

The passive safety-related systems of the AP600 are designed to be capable of establishing and maintaining the plant in a safe-shutdown condition without operator action for the first 72 hours following design basis events, including an extended loss of offsite ac power sources. Westinghouse has chosen not to qualify certain systems such as the diesel generators; therefore, they are considered non-safety-related and are not credited in the design basis of the plant. Instead, Westinghouse proposes to credit the use of offsite support for the purpose of the AP600 licensing basis after 72 hours.

In Section 6.1 of WCAP-13856, Westinghouse stated that the following functions are relied upon 72 hours after an accident: (1) core cooling, inventory and reactivity control; (2) containment cooling and ultimate heat sink; (3) main control room habitability; (4) main control room post-accident monitoring; and (5) spent fuel pit cooling. To support these safety functions following a loss of all ac power for more than 72 hours, the AP600 design includes safety-related connections for use with transportable equipment and supplies to provide extended support actions. The transportable equipment and supplies include portable pumps with direct diesel drives, portable electric generators, air cooler and fans, compressed air bottles, water to cool the exterior of the containment, and makeup water (1) to the interior of the containment for core cooling, and (2) for spent fuel pit cooling. Westinghouse states that fluid inventory losses from inside the containment and from the spent fuel pit would not require makeup supplies for approximately 30 days and 7 days, respectively.

This issue was discussed in SECY-95-172, Item VI - **Regulatory Treatment of Non-Safety Systems**, where the staff stated that reliance on offsite support for post-72 hour actions raised significant concerns regarding long-term cooling after an event. The staff stated that this issue was still under review.

Only qualified and permanently installed safety-related equipment is credited for recovery from design basis accident scenarios for currently licensed plants. No offsite equipment is credited. Offsite support is required for long-term accident mitigation of events involving loss of offsite power. However, the only commodity which licenses for operating reactors permit to be credited from offsite is a consumable - diesel generator fuel oil. Typically, the onsite supply of diesel fuel oil must be sufficient for 7 days. A lengthy loss-of-offsite-power event occurred after Hurricane Andrew struck the Turkey Point site on August 24, 1993. For 6 1/2 days, the site was without reliable offsite power and continuously ran the emergency diesel generators. Due to the severity of the storm and the damage to the area, all roads to the site were initially blocked, and diesel fuel oil supply trucks were unable to reach the site for 2 days.

The Westinghouse proposal uses offsite equipment that is not qualified, and consumable supplies such as fuel oil, cooling water, and breathable air. The proposed offsite equipment would be out of the licensee's control in that it is assumed to be commercially available at pre-identified sources, and therefore, there would be no assurance of equipment operability. Further, in situations where a lengthy loss of offsite power occurs due to a natural disaster, it would be more likely that there would be difficulty in bringing equipment and supplies onsite, particularly within the first 72 hours, due to transportation difficulties (such as those which occurred following Hurricane Andrew) and the demand for such items in the surrounding community. Conditions at the site may even preclude outside deliveries for scenarios in which there is a radiation release.

The staff does not believe that local communities struggling with disaster response should be given the additional burden of providing for nuclear power plant safety. In addition, because Westinghouse is proposing the use of equipment with no protection or demonstration of its ability to withstand natural phenomena, the equipment may be susceptible to damage from environmental conditions such as water, wind, or earthquake aftershocks. The staff does not believe that offsite equipment and supplies should be credited in the design basis of the plant and, therefore, concludes that credit for the use of offsite transportable equipment and supplies cannot be given for supporting safety functions for the design basis of the AP600 for event scenarios with a loss of offsite power for more than 72 hours.

Therefore, staff recommends that the Commission approve the position that the site be capable of sustaining all design basis events with onsite equipment and supplies for the long term. After 7 days, replenishment of consumables such as diesel fuel oil from offsite suppliers can be credited. The equipment required after 72 hours need not be in automatic standby response mode, but must be readily available for connection and be protected from natural phenomena including seismic events (per GDC 2).

In its June 15, 1995 letter, the ACRS stated that it expected that the staff will need to be satisfied that the AP600 design can be brought to a stable condition using onsite equipment, and that any additional needed resources are reasonably available. This conclusion was based on the information in SECY-95-172. However, the ACRS has not yet been briefed on the underlined position in this paper.

V. Technical Specifications

The safe-shutdown end-state for the AP600 was discussed in SECY-95-172, Item III - **Technical Specifications**, where the staff stated that Westinghouse is proposing that Limiting Condition for Operation (LCO) 3.0.3 specify MODE 4 (hot shutdown) instead of MODE 5 (cold shutdown) as the safe-shutdown end state for the AP600 design.

The Commission approved the staff's recommendation of 420°F or below as a safe stable condition (rather than the cold shutdown condition identified by Regulatory Guide 1.139) that the passive decay heat removal systems must be capable of achieving and maintaining following post-transient, non-LOCA events. The staff assumed that all passive systems are available and working, and the plant will be in a safe stable condition if the reactor coolant system temperature is 420°F or below. However, Westinghouse's proposal includes situations where the resulting system configuration has not been anticipated by the LCO action statement. That is, an unusual combination of inoperable systems could place the plant in the default LCO 3.0.3. For these unanticipated configurations, the staff concludes that, as in operating plants today, the safe shutdown end state for AP600 be defined as MODE 5 (cold shutdown). COLD SHUTDOWN is the preferred state because it is a low-energy, depressurized condition. However, in recognition of the safety function capabilities of the AP600 design, the staff will consider MODE 4 end states for particular Limiting Conditions of Operation, on a case-by-case basis, if Westinghouse provides specific justification for the loss of that particular function and modifies the associated technical specification action statement.

The staff considers this position to be an interpretation of earlier Commission guidance, and therefore does not consider this matter to be a policy issue. The implementation of this position will require the availability of non-safety-grade equipment, e.g., the normal residual heat removal system. The ACRS withheld comment on this issue in its June 15, 1995, letter based on the information in SECY-95-172.

VI. External Reactor Vessel Cooling

External reactor vessel cooling (ERVC) is a severe accident management strategy for the AP600 design that involves flooding the reactor cavity to submerge the reactor vessel and cool core debris that has relocated to the reactor vessel lower head, with the objective of preventing reactor vessel failure and the occurrence of ex-vessel phenomena. In SECY-95-172, Item VIII - **External Reactor Vessel Cooling**, the staff described the merits of this strategy and outlined several associated technical issues that would need to be resolved before any regulatory endorsement of the strategy. The staff also indicated that the ERVC strategy is consistent with Commission guidance provided in the July 21, 1993, SRM pertaining to SECY-93-087. Specifically, under the topic of core debris coolability, the Commission stated that the staff should not limit vendors to only one method for addressing containment responses to severe accident events but permit other technically justified means for demonstrating adequate containment response.

As part of the certification process for the AP600 design, the Department of Energy (DOE) has evaluated the effectiveness of the external reactor vessel cooling strategy for an AP600-like reactor/cavity design using the risk-oriented accident analysis methodology (ROAAM). The ROAAM provides a probabilistic framework for systematically addressing and examining uncertainties in underlying processes and phenomena and for resolving severe accident issues by demonstrating whether or not the threat to the containment is "physically unreasonable." This same methodology has been previously used in NRC-sponsored work to address the issues of Mark I containment failure by melt-attack of the liner (NUREG/CR-6025) and PWR containment failure by direct containment heating (NUREG/CR-6075). DOE issued a final draft report on "In-Vessel Coolability and Retention of a Core Melt" in July 1995, and is completing resolution of peer review comments on this document. Westinghouse has taken the position that the DOE report provides a technically defensible basis for demonstrating that reactor vessel integrity will be maintained and for eliminating ex-vessel phenomena from further consideration in the AP600 design and the staff's review. Westinghouse has indicated that it will ensure that the conditions and assumptions in its technical analysis are met in the AP600 design by verifying that the reactor coolant system (RCS) depressurization system and cavity flooding system are reliable and demonstrating that the reactor vessel coatings and insulation system will not interfere with vessel cooling. The staff met with DOE and Westinghouse in February and March of 1996 to further discuss policy and technical issues concerning this approach, and is continuing to evaluate the ROAAM application for ERVC.

During a March 20 and 21, 1996, meeting with Westinghouse, the staff indicated that ERVC could be an appropriate alternative to detailed analyses and possible design changes to address ex-vessel phenomena and related design criteria set forth in SECY-93-087. However, the staff expressed concern about Westinghouse's plans to rely solely on the ERVC strategy in lieu of evaluating the impact of reactor vessel failure on containment integrity and about the adequacy of the containment design for ex-vessel loads. The staff views the technical issues impacting the reliability of the ERVC strategy to be complex, and associated uncertainties in those issues could be large enough to erode the margins to vessel failure predicted in the DOE study. Research activities are in progress to further address several key issues related to the effectiveness of the ERVC strategy, as discussed in SECY-96-088, "Status of the Integration Plan for Closure of Severe Accident Issues and the Status of Severe Accident Research," dated April 29, 1996, but uncertainties are likely to remain. Furthermore, the level of review necessary to conclude that sole reliance on the ERVC strategy is adequate for the AP600 design would take a long time. Adding to this concern are the facts that a supporting DOE/Westinghouse study concerning in-vessel steam explosions and mechanical loads under late reflood of the reactor vessel has not yet been submitted to the staff and that the Level 1 PRA, which forms the basis for assessing the reliability of the depressurization and cavity flooding systems, will not be finalized until later this year.

Therefore, the staff recommends that the Commission approve the position that Westinghouse use a balanced approach, involving reliance on in-vessel retention of the core complemented with limited analytical evaluation of ex-vessel phenomena, to address the adequacy of the AP600 design for ex-vessel events.

Based on discussions with the staff, Westinghouse has agreed to provide additional, deterministic analyses to demonstrate that failure of the reactor vessel and release of core debris will not result in a breach of containment. Additional discussions with Westinghouse are planned to establish the approach, analytical tools, and assumptions to be used for these calculations, and the schedule for completing the work.

In its June 15, 1995 letter, the ACRS stated that it believed the staff is following an appropriate path pursuing ERVC based on the information in SECY-95-172, but that it would closely follow the resolution of the technical issues associated with the approach. The Committee has not yet been briefed on the underlined position taken in this paper.

VII. Passive Autocatalytic Recombiners

This issue was discussed in SECY-95-172, Item IX - **Passive Hydrogen Control Measures**, where the staff identified potential issues involving the use of passive autocatalytic recombiners (PARs) for controlling hydrogen generated during a design basis accident. Some of these issues are (1) adequacy and applicability of experimental tests and facilities, (2) potential for degraded performance as a result of catalytic poisons, (3) number and location of hydrogen control measures, (4) need for operability testing or surveillances, (5) impact of recombiner discharge on circulation of the containment atmosphere and on surrounding equipment, and (6) the response time of passive measures to mitigate hydrogen. During a recent meeting with Westinghouse, the staff concluded that environmental qualification of the PARs remains a key technical issue.

The Office of Research is currently conducting confirmatory performance testing of PARs to support the licensing of these devices in advanced and operating plants. The resulting experimental data base will give the staff a level of expertise so that a more informed licensing decision can be made.

Resolution of this issue could potentially result in modifications in the design and, therefore, affect the AP600 review schedule. The staff is still reviewing the proposed resolution of this issue. Therefore, evaluation of this issue has not yet reached a stage where a final conclusion regarding the acceptability of this system can be reached. The staff regards this to be a key technical issue and concludes that it does not involve a policy matter.

In its June 15, 1995 letter, the ACRS stated that it believed that approval of the PARs system contingent on the resolution of the technical issues was appropriate, based on the information in SECY-95-172.

VIII. Spent Fuel Pool Cooling System

The major functions of the AP600 spent fuel pool (SFP) cooling system and the corresponding modes of operation are:

(1) *Spent fuel pool cooling* - removing heat from the water in the spent fuel pool during operation to maintain the pool water temperature within acceptable limits.

(2) *Spent fuel pool purification* - providing purification and clarification of the spent fuel pool water during operation.

(3) *Refueling cavity purification* - providing purification of the refueling cavity during refueling operations.

(4) *Water transfers* - transferring water between the in-containment refueling water storage tank (IRWST) and the refueling cavity during refueling operations.

(5) *In-containment refueling water storage tank purification* - providing purification of the in-containment refueling water storage tank during normal operation.

The SFP cooling system for the AP600 is not a safety-related system and is not required to operate following events such as earthquake, fire, passive failures, or multiple active failures. Westinghouse states that the only safety-related functions of the SFP cooling system are containment isolation and temporary emergency makeup connections to provide cooling for the spent fuel pool. The AP600 design provides passive heat removal by allowing the SFP to boil with no makeup for the first 72 hours. A safety-related connection is provided for makeup after 72 hours. The fuel handling area ventilation subsystem is not safety-related.

The design of the AP600 does not meet the guidance provided in Standard Review Plan (SRP) Section 9.1.3, "Spent Fuel Pool Cooling and Cleanup System." In accordance with the SRP, the spent fuel pool cooling system should be designed to seismic Category I, Quality Group C requirements, or the makeup water system and its source and the fuel pool building and its ventilation and filtration system must be seismic Category I. The makeup, ventilation, and filtration systems must also be capable of withstanding a single active failure.

The staff has determined that the AP600 design for the SFP cooling system does not conform to the guidance of the SRP, nor does it meet the requirements of GDC 2 as it relates to structures, systems, and components important to safety being designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The staff has determined that there is nothing unique about the AP600 SFP cooling system that would justify not meeting the requirements of GDC 2. The likelihood of a station blackout caused by an external event that would cause loss of the SFP cooling system is greater for the AP600 than for current and evolutionary plants.

Therefore, the staff has determined that additional onsite capability to remove decay heat from the spent fuel pool should be provided. This could be provided by making the SFP cooling system seismic Category I and providing additional onsite ac power capability. The onsite ac power capability need not be in automatic standby response mode, but must be readily available for connection and be protected from natural phenomena including seismic events (per GDC 2).

The staff is reviewing data regarding SFP cooling systems of current plants to identify specific plant design features and operating practices which are candidates for safety enhancements. The results of this review will be applied to the AP600, if appropriate.

This issue has only recently been identified for the AP600; therefore, the ACRS has not yet been briefed on the staff's position in this matter.

IX. Initial Test Program

This issue was discussed, in part, in SECY-95-172, Item IV - **Initial Test Program**, where the staff identified two major issues related to the proposed initial test program (ITP) test abstracts that describe the test details for the AP600 systems. First, the staff identified its concerns regarding the capability of proposed testing methods to subject the AP600 passive systems, components, and/or design features to representative (actual or simulated) design-basis operating conditions to demonstrate the capability of the passive systems to perform their design functions. Second, the staff identified a concern regarding Westinghouse's proposal to perform certain preoperational tests only on the first AP600 plant. Westinghouse proposed that these tests not be conducted on subsequent plants because of the standardization of the AP600 design and the experience gained during the startup of the first plant.

Because AP600 ITP testing will also satisfy portions of the inspections, tests, analyses, and acceptance criteria (ITAAC), the staff anticipates that the overall review schedule may be impacted by the timeliness of both the ITP and ITAAC submittals. A pilot set of the AP600 ITAAC is expected in May 1996, which will be used to provide comments on Westinghouse's approach to developing the complete ITAAC. Information on the initial test program is expected by

July 1996. After receiving this information, the staff will evaluate Westinghouse's integrated approach to resolving these issues.

These issues are expected to be difficult areas of review because of the unusual nature of the AP600 design. The staff's experience with the evolutionary reviews suggests that as the review nears completion, issues become more difficult to resolve and consequently, take more time to reach an acceptable resolution. The staff's evaluation of these issues has not yet reached a stage where final conclusions about the acceptability of these proposals can be reached. Therefore, after submittal of the AP600 ITAAC document and the initial test program, the staff will determine whether any potential policy issues exist.

In its June 15, 1995 letter, the ACRS stated that the staff was approaching the matter appropriately, based on the information in SECY-95-172. However, the Committee stated that it may be in a better position to comment on the ITP when more information becomes available.

X. Security Design

This issue was discussed in SECY-95-172, Item II - Security Design, where the staff stated that Westinghouse is proposing a conceptual design for the AP600 security program that differs significantly from current site security programs. The staff considers that Westinghouse's proposal has merit. The proposed design would reduce the number of security personnel and the amount of intrusion detection and alarm assessment equipment needed. The conceptual design locates security personnel with the necessary weaponry in hardened defensive structures at the potentially vulnerable penetration points for external attacks. The design, however, is likely to require the development of security ITAACs.

The staff is awaiting additional documentation from Westinghouse in order to complete its review. The staff's evaluation of this issue has not yet reached a stage where a final conclusion about the acceptability of this proposal can be reached. When its review of the Westinghouse proposal progresses further, the staff will determine whether any potential policy issues exist.

In its June 15, 1995 letter, the ACRS stated that it believes that

> the proposed security design could meet the safety and security requirements when implemented.... [The Committee] noted that the design seems to offer less flexibility for the many work access points that operating plants need during outage periods