February 19, 1997

FOR: The Commissioners

FROM: Hugh L. Thompson, Jr. /s/
Acting Executive Director for Operations

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

PURPOSE:

To provide the Commission with additional information regarding the type of non-safety-related system that would achieve an appropriate balance between prevention and mitigation of severe accidents for the AP600 standardized passive reactor design, and to request the Commission to reconsider, as discussed in its staff requirements memorandum of January 15, 1997, its position on this policy issue and approve the revised, underlined staff position presented in this paper.

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. In accordance with Commission directives, the staff identified policy and key technical issues specific to the AP600 design in SECY-95-172, "Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design," dated June 30, 1995, in SECY-96-128, "Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design," dated June 12, 1996; and in a memorandum from the Executive Director for Operations, dated November 12, 1996, "Clarification of Staff Position in SECY-96-128, 'Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design.'" In its letters dated June 15, 1995, and August 15, 1996, the Advisory Committee on Reactor Safeguards (ACRS) provided comments on some of the technical issues. The staff responded to the first letter in its letter of August 8, 1995.

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In its staff requirements memorandum (SRM) of January 15, 1997, concerning SECY-96-128 and the clarification memorandum of November 12, 1996, the Commission approved two staff positions related to post-72 hour actions and external reactor vessel cooling. The Commission did not approve the two staff-recommended positions related to prevention and mitigation of severe accidents. In its SRM, the Commission stated that it did not

> support the staff's request for the inclusion of additional system(s) for accident management and long term mitigation following a severe accident as presented, not because it may be inappropriate, but because the basic design and performance requirements have not been bounded or specified, and the requested additional system(s) do not appear to be consistent with the concept of a passive design.

The Commission also stated that it was willing to reconsider the matter "if the staff can be more specific in terms of what additional system(s) are contemplated, including the design and performance requirements."

The Commission further stated that it believed that fission product removal coefficients for analyzing the consequences of design-basis accidents "should not be linked to the availability of one or more non-safety systems." Therefore, as directed by the SRM, the staff will not link the availability of non-safety-related system(s) to its review of fission product removal coefficients for analyzing the consequences of design-basis accidents for the AP600. On a related matter, at the request of the Chairman, the staff will be submitting a paper to the Commission in February 1997, providing examples where the staff has used non-safety-related systems to address safety concerns on operating, evolutionary, and passive reactors.

DISCUSSION:

In its SRM of January 15, 1997, the Commission agreed that the AP600 design should include adequate means for accident management. However, the Commission did not support the staff's request as presented, but noted that it was willing to reconsider the matter if the staff was more specific in terms of what additional system(s) was contemplated.

The following discussion is a more detailed description of the additional system contemplated by the staff, including a description of the design and performance requirements. The staff believes that the system described below would resolve its concern that, in view of the uncertainties associated with the reliance on passive systems in mitigating severe accidents and the advantages of having operator intervention as part of a long-term accident management strategy, an additional severe accident mitigative feature should be provided in the AP600 design. The use of such a non-safety-related system in the AP600 would serve to achieve an appropriate balance between prevention and mitigation of severe accidents in this design.

The AP600 containment design represents for the first time a completely passive heat and aerosol fission product removal system. There are far less technical bases and experience supporting the capability of such a passive system to perform these functions than those that exist with operating plants that rely on internal spray systems. At this time, the staff believes that the use of containment sprays (on the order of a few thousand gallons per minute (gpm)) appears to be the best approach to resolve this concern within the current schedule for certification of the AP600 design. However, the staff is in no way limiting the possible resolution of this issue, but is only providing this example to illustrate how simple a spray system can be and still address severe accident concerns.

The staff envisions several uses for the containment spray system in the severe accident management guidelines. A simple containment spray system, which injects into the containment without dedicated pumps and heat exchangers, would provide the following benefits:

(1) Most importantly, the system could provide both short- and long-term benefits by providing site personnel with the capability to quickly and substantially remove aerosol fission products following activation on recognition of elevated radiation levels in the containment atmosphere. For aerosol fission product removal, the staff believes that a single short-term actuation of the spray system will suffice because pH control measures in the containment sump should prevent revolatilization.

(2) In addition, the sprays would be expected to mix the containment atmosphere following a severe accident, especially the boundary layer inside the containment shell. The sprays could be pulsed in order to mix any long-term build up of non-condensible gases within the inner containment boundary layer. This would be done when elevated atmospheric hydrogen concentrations began to build up along with any unexpected heat balances within containment.

(3) Finally, should the containment pressure need to be reduced for a short time, the heat capacity of the subcooled spray water would reduce containment pressure upon injection for a short time.

The staff is not proposing that the additional mitigative feature be safety-related. The staff's assessment would be focused on where the system could be used to its greatest advantage; that is, long-term accident management of a severe accident. The design of the recommended containment spray system could be very simple. For example, such a system could (1) be single-train, (2) be actively or passively driven, (3) employ an external water supply, and (4) be non-safety-related. The system the staff is contemplating for the AP600 is not of the same complexity as those systems currently installed in most operating pressurized-water reactors, which have heat exchangers and dedicated pumps.

The staff believes that the containment spray system could be similar to the ac-independent water addition (ACIWA) system in the Advanced Boiling Water Reactor (ABWR) design. The ACIWA system consists of piping and manual valves connecting the fire protection system to the upper drywell containment spray ring header. The piping and manual valves are of a quality to ensure containment isolation. The diesel-driven firewater pump for the ABWR provides 1500 gpm flow at a differential pressure of 125 pounds per square inch (gauge) (psig). However, because of the piping configuration, the ACIWA system delivers approximately 950 gpm flow with no containment backpressure. Additionally, an external hookup outside the reactor building for connection of a fire truck pump to an alternate water source is provided.

The AP600 fire protection system includes a diesel-driven firewater supply system pump that is rated for 2000 gpm. A containment spray system supplied by such a system would considerably reduce the uncertainty associated with severe accident aerosol fission product removal. The spray coverage area and the number of spray ring headers that could be supplied would have to be appropriately established consistent with this flow rate.

Adverse systems interactions associated with an internal containment spray system with an external water supply (such as boron dilution or the potential to raise the containment water level above the electrical penetrations) would need to be evaluated. These types of interactions would need to be considered in the design, but the evaluation should not be difficult to perform. Westinghouse would need to identify and evaluate the potential for adverse systems interactions to ensure that they are considered in the AP600 design.

Although the staff believes that installation of a containment spray system would be the best option to address this issue, an alternate resolution to this issue could be the use of the containment fan coolers to mitigate the effects of a severe accident. However, the staff believes that the uncertainties associated with fan cooler performance are in large part due to an incomplete data-base. The staff is not aware of any data or information that could demonstrate the capability of fan coolers to support the aerosol removal rates that have been proposed by Westinghouse or reduce containment pressure under severe accident conditions.

The goal of the AP600 passive design philosophy is to use passive systems to meet the design-basis requirements. However, there are numerous active features in the AP600 design (e.g., the hydrogen ignition system) that have been considered for severe accidents. Therefore, the staff believes that the simple system described in this paper for mitigation of severe accidents is consistent with the AP600 passive design philosophy and the Commission's defense-in-depth philosophy.

Therefore, the staff believes that either the use of a simple containment spray system or the use of the fan coolers (backed by supporting data) could be found acceptable in addressing the uncertainties associated with natural removal mechanisms for mitigating severe accidents, and for providing operator intervention capability as part of a long-term accident management strategy.

COORDINATION:

The Office of the General Counsel (OGC) has reviewed this paper and has no legal objection. OGC notes that the Commission's 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 this policy issue during meetings on May 31 and June 9, 1995, and July 19 and August 8, 1996. Comments provided by the Committee in its letter of June 15, 1995, were addressed in SECY-95-172. The Committee endorsed the staff's positions as stated in SECY-96-128 in its letter of August 15, 1996. The type of design aspects the staff was contemplating for a containment spray system has been discussed with the ACRS in general terms. However, the ACRS has not had the opportunity to review this paper.

RECOMMENDATIONS:

On the basis of the additional information provided in this paper, the staff recommends that the Commission approve the staff's position that the AP600 include a containment spray system or equivalent for accident management (both short- and long-term) following a severe accident.

DOCUMENT AVAILABILITY

The staff intends to make this paper publicly available within 5 working days from the date of this paper.

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