June 24, 1996

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

SUBJECT: OPEN ISSUES IN STANDARD SAFETY ANALYSIS REPORT SECTIONS REGARDING FIRE PROTECTION FOR THE AP600 DESIGN

Dear Mr. Liparulo:

As discussed in recent telephone conferences, the Nuclear Regulatory Commission (NRC) Plant Systems Branch has provided a status review for the fire protection review area. A draft version was sent to you by facsimile on June 4, 1996. The enclosed discussion is being sent to you to facilitate Westinghouse's preparation for revisions to the standard safety analysis report and to focus NRC and Westinghouse efforts towards resolution of the open issues. The staff may not be able to follow this course of action for all sections.

The staff has also identified areas in which additional information is required to complete the review. These items are identified as requests for additional information Nos. 280.9 - 280.31 in the enclosed document.

The NRC and Westinghouse staff are in the process of discussing these issues in telephone conferences and resolving the open items. If you have any questions, please contact me at (301) 415-8548.

Sincerely,

original signed by:
Diane T. Jackson, Project Manager
Standardization Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation



Docket No. 52-003

Enclosure: As stated

cc w/enclosure:
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Docket No. 52-003
AP600

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STAFF FOLLOWON QUESTIONS AND REVIEW STATUS CONCERNING
STANDARD SAFETY ANALYSIS REPORT (SSAR) SECTION 9.5.1 - FIRE PROTECTION

9.5.1.1 General Evaluation of the Fire Protection Program

In the draft safety evaluation report (DSER), the staff states that it did not have sufficient information (prior to the issuance of DSER section on fire protection program for the AP600 design) to complete its evaluation concerning the fire protection of safe shutdown capability for the AP600 design. Subsequent to the issuance of the DSER, Westinghouse provided information on safe shutdown capability in amended (Amendments up to and including Amendment 4) SSAR Sections 7.4 and 9.5.1 and responded to staff's request for information relating to safe shutdown capability for AP600. Additionally, in its meeting with staff on April 12 and 13, 1995, Westinghouse provided additional information on safe shutdown capability for the AP600 design. Based on its review of the information relating to safe shutdown capability provided by Westinghouse for the AP600 design, the staff has added a new section (Section 9.5.1.6) in this report, wherein it discusses and evaluates safe shutdown capability provided for the AP600 design.

Westinghouse has not provided information regarding the protection of Defense-in-Depth (DID) equipment identified as important by the regulatory treatment of non-safety systems (RTNSS) process. Westinghouse appears to take credit for the use of non-safety related systems as indicated in Section 9A.2.7.1 of the SSAR, "Criteria and Assumptions," section titled "Offsite Power," which states:

> "For the safe shutdown evaluation it is assumed that either offsite power is available continuously or offsite power is unavailable for first 72 hours, which ever is more conservative. If offsite power is available, non-safety related systems are assumed to operate if a more conservative evaluation would result."

Westinghouse indicates in response to RAI Question 280.1 that; "AP600 relies only upon safety-related equipment for safe shutdown in the event of a fire."

Westinghouse will need to demonstrate that utilizing DID equipment prior to using safe shutdown equipment will not prevent transferring control or prevent the use of safe shutdown equipment in the event of a disabling fire in all areas of the plant. Westinghouse should also demonstrate that the protected train will safely shut down the reactor after the worst case fire, with or without offsite power, and whether or not DID equipment is initially utilized.

Westinghouse agreed to clarify the wording in the SSAR to indicate that only safety related systems are needed to shut down the reactor independent of the DID equipment. Westinghouse should describe fully how one train of safety related equipment will not be damaged by the fire and/or fire fighting

Enclosure

operations should DID equipment be used prior to utilizing safety related equipment (for example, the ability to transfer control from the control room to the remote shutdown station should be maintained). This is a Meeting Open Item in SSAR Section 9.5.1 (Open Item Tracking System database (OITS) #306).

SECY-93-087 provides staff's Commission approved (see staff requirement memorandum (SRM) dated July 21, 1993) recommendations relating to fire protection for evolutionary advanced light-water reactor (ALWR) designs. In the SECY paper, the staff recommended that all evolutionary ALWR designers should ensure that safe shutdown can be achieved assuming that all equipment in any one fire area will be rendered inoperable by fire and that re-entry into the fire area for repairs and operator actions is not possible. In the SECY paper, the staff recommended extension of the above enhanced fire protection criteria for passive plants. Staff's evaluation of safe shutdown capability provided by Westinghouse for the AP600 design is based on application of this criterion for the AP600 design. This is a Meeting Open Item in SSAR Section 9.5.1 (OITS #308).

9.5.1.2 Passive Fire-Protection Features

SECY-90-016 and SECY-93-087 present the staff's positions regarding the design of evolutionary light water reactors that were accepted by the Commission. Specifically, SECY-90-016 and SECY-93-087 indicate that ALWRs must ensure that safe shutdown can be achieved assuming that all equipment in any one fire area will be rendered inoperable by fire, and that re-entry into the fire area for repairs and operator actions is not possible. Because of its physical configuration, the control room is excluded from this approach, provided an independent alternative shutdown capability is physically and electrically independent of the control room is included in the design. In addition, ALWR designers must provide fire protection for redundant shutdown systems in the reactor containment building that will ensure, to the extent practicable, that one shutdown division will be free of fire damage. The ALWR designers must also ensure that smoke, hot gases, or fire suppressant will not migrate into the other fire areas to the extent that could adversely affect safe shutdown capabilities including operator action.

Westinghouse has proposed to revise the SSAR, under Section C.5.a(1)(b) of Branch Technical Position (BTP) 9.5-1, to indicate that the AP600 design will provide 3-hour rated fire barriers to separate redundant divisions, except for the containment, control room and remote shutdown workstation where separate redundant divisions will not be separated by 3-hour rated fire barriers. This is DSER Open Item 9.5.1.2-1 (OITS #1113 and a related Meeting Open Item (OITS #311) and both remain open.

In Section 9.5.1.2.1.1 of the SSAR, Westinghouse indicates the following:

> Fire protection features within the containment fire area provide confidence that one train of safe-shutdown equipment will remain undamaged following a fire. The quantity of combustible material is minimized. The use of canned reactor coolant pumps has eliminated the need for an oil lubrication system. Redundant trains of safe

shutdown components are separated whenever possible by existing structural walls, or by distance. The fire protection systems provides appropriate fire detection and suppression capabilities.

The staff recognizes the need for open communication between compartments inside containment to relieve and equalize pressure following a high-energy line break. Additional information concerning fire protection features (such as detection, suppression, structural walls, and/or distances between redundant safe-shutdown equipment) are needed to determine the acceptability of the AP600 design concerning fire protection inside primary containment. This is a Meeting Open Item in SSAR Section 9.5.1 (OITS #312).

Westinghouse should provide marked drawings indicating redundant safe shutdown cabling routing and safe shutdown equipment location. It is expected that inside containment that safe shutdown redundant safety related cabling will be mineral insulated cable (or equivalent) and widely separated from it's redundant safety related train. In the penetration area it is expected that fire rated assemblies are also used. In all cases where redundant equipment is not separated by three hour fire walls, Westinghouse should clearly identify these areas for review such as the fire zone involving the pressurizer where redundant divisions are in close proximity. The fire hazard analysis should also discuss fully the fire protection features provided for the redundant safety related equipment and cabling inside primary containment. The staff intends to review each of these deviations inside containment and determine their acceptability. This is DSER Open Item 9.5.1.2-2 (OITS #309 and 1114).

The COL applicant's maintenance program is to be developed to ensure that fire-rated assemblies (such as fire doors, fire dampers, and penetration seals) will be maintained in accordance with their respective National Fire Protection Association (NFPA) codes or manufacturer's instructions. The staff will review the COL applicant's maintenance program on a plant-specific basis. This is DSER COL Action Item 9.5.1.2-1 (OITS #1919).

SECY-90-016 and SECY-93-087 indicates that ALWR designers must ensure that smoke, hot gases, or fire suppressant will not migrate to other fire areas to the extent that they could adversely affect safe shutdown capabilities, including operator action. Section 9.5.1.4.4 of this report discusses the Westinghouse smoke control features.

9.5.1.3 Fire Protection System

9.5.1.3.1 Fire Detection

In Table 9.5.1-1 of the SSAR, under BTP CMEB 9.5-1 Guidelines 112-120, Westinghouse indicates that the automatic fire detection systems will be designed and installed in accordance with NFPA Standard 72 in areas that contain or present a fire exposure to safety-related equipment and for all significant hazards. In addition, the fire detectors will be installed as a Class A system defined in NFPA 72D and Class I circuits as defined in NFPA 70. Westinghouse also indicates that there may be design considerations that may result in exceptions to specific guidance.

The staff expects that the selection and installation of fire detectors will also be based on consideration of the type of hazard, combustible loading, type of combustion products, and detector response characteristics. The staff also expects that Westinghouse will provide detection capability for the following:

- major cable concentrations
- safe-shutdown-related/DID major pumps
- switchgear
- motor-control centers
- battery and inverter areas
- relay rooms
- fuel areas
- radwaste areas
- all other areas containing in-situ or potentially transient combustibles.

Westinghouse provided additional information concerning the installation of detector devices that has allowed the staff to complete its review as discussed below. Therefore, DSER Open Item 9.5.1.3-1 (OITS #1115) and a Meeting Open Item in SSAR Section 9.5.1 (OITS #313) are resolved. Detector devices will be selected on the basis of the type of anticipated fire, and will be located on the basis of ventilation, ceiling height, ambient conditions, and burning characteristics of the involved materials. Detection systems will alarm and annunciate in the control room, and will give a distinctive audible and, if necessary (to facilitate fire brigade identification of fire location), visual local alarm. Westinghouse does not anticipate any exceptions, however any exceptions needed by the COL applicant should be identified. The staff will review exceptions to the guidance on a case-by-case basis. This is RAI # 280.9 and is designated as COL Action Item 9.5.1.3-2.

9.5.1.3.2 Fire-Protection Water-Supply System

In Section 9.5.1.2.1.3 of the SSAR, Westinghouse states that, "The fire water supply system is designed in accordance with the BTP 9.5-1 and the applicable NFPA standards."

In Table 9.5.1-1 of the SSAR, under BTP CMEB 9.5-1 Guidelines 121-144, Westinghouse commits to follow the BTP CMEB 9.5-1 Guidelines, but notes that, because of conflicting design considerations, there may be a need to take exception to specific guidance. For example, the water in the passive containment cooling system (PCS) storage tank is not dedicated for fire protection. The staff does not consider the present design a conservative approach to providing water for fire protection and views the present design as a departure from current operating reactors. Westinghouse agreed to provide a detailed explanation in the SSAR of why the water in the PCS tank will not be needed for fire protection simultaneously with PCS operation. The staff will evaluate Westinghouse response and determine whether the proposed design is acceptable. This is RAI #280.10 and designated as Open Item 9.5.1.3-5.

In addition, the COL applicant will identify and address deviations in the Fire Hazards Analysis. The staff will review exceptions to the guidance on a case-by-case basis. This is DSER COL Action Item 9.5.1.3-1 (OITS #1920) and related meeting Open Item (OITS #314).

Westinghouse commits to comply with the guidance of BTP CMEB 9.5-1 concerning the fire protection water supply. Eight key commitments are listed below:

(1) An underground yard fire main is installed according to NFPA 24, "Standard for Outside Protection" (Guideline 121; BTP CMEB 9.5-1, Section C.6.b(1)).

(2) Approved indicator sectional control valves are provided to isolate portions of the fire main for maintenance or repairs without shutting off the supply to primary and backup fire suppression systems serving areas that contain or expose safety-related equipment (Guideline 124; BTP CMEB 9.5-1, Section C.6.b(2)).

(3) Valves are installed to permit isolation of outside hydrants from the fire main for maintenance or repair without interrupting the water supply to automatic or manual fire suppression systems in any area containing or presenting a fire hazard to safety-related or safe-shutdown equipment (Guideline 125; BTP CMEB 9.5-1, Section C.6.b(3)).

(4) One diesel-engine and one electric-driven fire pump are provided that will meet system pressure and flow requirements. A sufficient number of pumps will be provided to ensure that 100-percent capacity will be available assuming failure of the largest pump or a loss-of-offsite-power (LOOP) event (Guideline 128; BTP CMEB 9.5-1, Section C.6.b(6)).

(5) The outside manual hose installation will be sufficient to provide an effective hose stream to any onsite location where fixed or transient combustibles could jeopardize safety-related equipment. Hydrants will be installed approximately every 76.2 m (250 ft) on the yard main. Hose houses equipped with hose and combination nozzle and other auxiliary equipment are to be provided as needed, but will not be located more than 305 m (1000 ft) apart (Guideline 134; BTP CMEB 9.5-1, Section C.6.b(7)).

(6) Threads compatible with those used by local fire department will be provided on all hydrants, hose couplings, and standpipe risers (Guideline 136; BTP CMEB 9.5-1, Section C.6.b(8)).

(7) The fire water supply will be calculated on the basis of the largest flow rate for a period of 2 hours, but not less than 1135 $m^3$ (300,000 gallons). This flow rate will be based (conservatively) on 1.9 $m^3$/min (500 gpm) for manual hose streams plus the largest design demand of any sprinkler or deluge system as determined in accordance with NFPA 13 or 15. The fire water supply will be capable of delivering this design demand over the longest route of the water supply system (Guideline 137; BTP CMEB 9.5-1, Section C.6.b(9)).

(8) When a common water supply is permitted for fire protection and the ultimate heat sink, the following conditions will also be satisfied:

- The additional fire protection water requirements are designed into the total storage capacity.

- Failure of the fire protection system should not degrade the function of the ultimate heat sink (Guideline 143; BTP CMEB 9.5-1, Section C.6.b (13)).

Westinghouse has provided additional information concerning the capacity of the second fire protection water storage tank that has allowed the staff to complete its review as discussed below. Therefore, DSER Open Item 9.5.1.3-2 (OITS #1116) and the related Meeting Open Item (OITS #315) are resolved. In Section 9.5.1.2.1.3 of the SSAR, Westinghouse indicates that the fire protection water supply is comprised of two separate dedicated 300,000 gallon fresh water storage tanks. The primary tank is totally dedicated to provide water to the fire protection water supply system. A second fire protection water storage tank serves the raw water system, but also contains a dedicated 300,000 gallon volume of water for use by the fire protection system if the primary fire protection water tank is unavailable.

9.5.1.3.3 Automatic Fire Suppression Systems

In Section 9.5.1.2.1.4 of the SSAR, Westinghouse indicates that automatic fire suppression systems will consist of the following:

- automatic wet-pipe sprinkler systems
- preaction sprinkler systems
- deluge sprinkler or water spray systems
- automatic foam suppression systems

Westinghouse also indicates that these systems will be installed and maintained in accordance with BTP CMEB 9.5-1 and the applicable NFPA standards. Westinghouse further indicates that the fixed automatic fire suppression systems will be provided based on the results of the fire protection analysis. Additional information regarding the design and installation of the sprinkler system based on results of the fire protection analysis is needed in order for the staff to make its determination regarding Westinghouse design and installation of automatic fire suppression systems. This is DSER Open Item 9.5.1.3-3 (OITS #1117) and related Meeting Open Item (OITS #1117).

9.5.1.3.3.1 Automatic Water Suppression Systems

In Section 9.5.1.2.1.4 of the SSAR, Westinghouse indicates that automatic sprinkler systems and water spray systems will be installed and maintained in accordance with the applicable requirements of NFPA 13 and NFPA 15.

In Table 9.5.1-1 of the SSAR, under BTP CMEB 9.5-1 Guidelines 145-147, Westinghouse indicates that the sprinkler systems (automatic water suppression systems) and hose station will have connections to the plant underground water main so that a single active failure or a crack in a moderate-energy line will

not impair both the primary and backup fire suppression system. Each sprinkler and standpipe system will be equipped with an outside screw and yoke (OS&Y) gate valve or other approved shutoff valve and water flow alarm. Safety-related equipment that does not require automatic water suppression protection, but is subject to unacceptable water damage if wet by sprinkler discharge, will be protected by water shields or baffles. This use of water shields or baffles is in accordance with Section C.6.c.(1) of BTP CMEB 9.5-1, and is acceptable.

In Table 9.5.1-1 of the SSAR, under BTP CMEB 9.5-1 Guidelines 148-149, Westinghouse indicates that control and sectionalizing valves in the fire water system are electrically supervised or administratively controlled. The electrical supervision signal will indicate in the control room. The electrically supervised valves or the use of administrative controls for ensuring proper position of the sectionalizing valves in the fire protection water supply system is in accordance with Section C.6.c(2) of BTP CMEB 9.5-1 and is acceptable.

Westinghouse does not anticipate any exceptions, however any exceptions needed by the COL applicant should be identified. The staff will review exceptions to the guidance on a case-by-case basis. This is considered part of DSER COL Action Item 9.5.1.3-3 (OITS #1920).

9.5.1.3.4 Hose Standpipe System

In Table 9.5.1-1 of the SSAR, under BTP CMEB 9.5-1 Guidelines 151-155, Westinghouse indicates that the manual hose stations will be installed and maintained in accordance with NFPA 14. Westinghouse further indicates that these manual hose stations will be installed to reach any location that contains, or could present a fire exposure hazard to, safety-related equipment with at least one effective hose stream. Standpipes equipped with a maximum of 30 m (100 ft) of 1-1/2 inch woven-jacket, lined fire hose and suitable nozzles should be provided on all floors in all buildings. Section 4-7 of NFPA 14 requires that the maximum hose outlet pressure be limited to 690 kPa (100 psi) (for fire fighter safety). The staff expects that an approved pressure reducing device will be installed at locations exceeding 690 kPa (100 psi). Individual standpipes should be at least 10 cm (4 in) in diameter for multiple hose connections. Hose stations should be located as dictated by the fire hazard analysis to facilitate access and use for fire fighting operations. Alternatively, hose stations will be provided for an area if the fire hazard could block access to a single hose station serving that area.

In Table 9.5.1-1 of the SSAR, under BTP CMEB 9.5-1 Guideline 155, Westinghouse indicates that water will be supplied to standpipes and hose connections for manual fire fighting in areas containing equipment required for safe plant shutdown in the event of an SSE. The piping systems serving these hose stations will be analyzed for SSE loading and will be provided with supports to ensure system pressure integrity. The piping and valves for the portion of the hose standpipe system affected by this functional requirement will, as a minimum, satisfy American National Standards Institute (ANSI) B31.1, "Power

Piping." The water supply will be capable of delivering at least 75 gallons per minute for two hose stations. The staff requires the following additional information:

- The availability of the water dedicated to the manual hose stations from the passive containment water storage tank (There is a concern that water stored in the Passive Containment Cooling Water Storage Tank (PCCWST) for fire fighting may be diverted to providing cooling to the outside of containment. Water is normally dedicated for fire fighting purposes.)

- The pressure required to produce at least two effective hose streams inside containment utilizing the passive containment water storage tank

- Assurance that no possibility exists for channeling water from fire-extinguishing operations in one redundant fire area into another redundant fire area

This is part of DSER Open Item 9.5.1.3-4 (OITS #1996) and is related Meeting Open Item (OITS #317).

9.5.1.3.5 Fire Extinguishers

In Section 9.5.1.2.1.5 of the SSAR, Westinghouse indicates that "Portable fire extinguishers are provided throughout the plant. Portable extinguishers are readily accessible for use in high radiation areas, but are not located within those areas unless the fire protection analysis indicated that a specific requirement exists."

In Table 9.5.1-1 of the SSAR, under BTP CMEB 9.5-1 Guidelines 164-165, Westinghouse indicates that extinguishers will be provided in areas that contain, or present, a fire exposure hazard to safety-related equipment in accordance with the guidelines of NFPA 10. The staff expects that these deviations to BTP CMEB 9.5-1 and/or NFPA 10 will be addressed in the Fire Hazards Analysis to be submitted by the COL applicant. The staff will review the deviations to BTP CMEB 9.5-1, Section C.6.f, and/or NFPA 10 on a plant-specific basis. This is part of DSER COL Action Item 9.5.1.3-1 (OITS #1920) and is related Meeting Open Item (OITS #318), as discussed in Section 9.5.1.3.2 of this report.

9.5.1.4 Fire-Protection Support Systems

9.5.1.4.1 Emergency Lighting and Communication

Section C.5.g of BTP CMEB 9.5-1 stated that fixed self-contained lighting of florescent or sealed-beam units with individual 8-hour minimum battery power supplies should be provided in areas that must be manned for safe shutdown and for access to and egress from all fire areas. Safe shutdown areas include those areas required to be manned if the control room must be evacuated.

In Table 9.5.1-1 of the SSAR, under BTP CMEB 9.5-1 Guidelines 108, Westinghouse indicates that the AP600 complies with Section C.5.g of the BTP 9.5-1;

however, an alternative emergency lighting source is provided for the main control room and the remote shutdown workstation. In Section 9.5.3.2.2, Westinghouse states the following:

> Main control room and remote shutdown area emergency lighting consists of 120 V ac florescent lighting fixtures which are continuously energized. The fixtures are powered from the Class 1E 125Vdc switchboards through the Class 1E 208Y/120Vac inverters.

Westinghouse agreed to update the SSAR to indicate that the control room emergency lights and the remote shutdown work station emergency lights are provided with redundant circuits such that the circuits will be electrically and physically isolated from each other such that at least one circuit will be protected from a fire outside of these rooms. Westinghouse should also indicate that the emergency lighting circuits are electrically and physically isolated between the control room and the remote shutdown work station such that a fire in either of these rooms will not disable the lighting in the other room.

It is our understanding that station batteries and inverters are designed to handle all safety related equipment electrical loads and provide at least 8 hours of power to the emergency lights without the use of transportable AC generators. If DID equipment is utilized and is expected to tie into these safety related batteries, then Westinghouse should discuss this in detail and provide justification that sufficient power will be available to supply safety related equipment and emergency lights (for 8 hours) without the use of transportable AC generators. Additional information will be required for the staff to determine the acceptability of AP600 emergency lighting. This is DSER Open Item 9.5.1.4-1 (OITS #1118) and related Meeting Open Item (OITS #319).

Section C.5.g of BTP CMEB 9.5-1 states that a portable radio communication system should be provided for use by the fire brigade and other operations personnel required to achieve safe plant shutdown. This system should not interfere with the communications capabilities of the plant security force. Fixed repeaters installed to permit use of portable radio communication units should be protected from exposure to fire damage.

Westinghouse provided additional information concerning the emergency communication system utilized by the fire brigade that has allowed the staff to complete its review as discussed below. Therefore, Open Item 9.5.1.4-2 (OITS #1119) is resolved. In Table 9.5.1-1, under BTP CMEB 9.5-1 Guideline 111, Westinghouse agreed to comply to meeting the emergency communication guidelines of Section C.5.g(4) of BTP CMEB 9.5-1 regarding the use of a portable radio communications system by the fire brigade and other operational personnel required to achieve safe plant shutdown. Westinghouse indicates in SSAR, Revision 3, Table 9.5-1, that the combined licensed applicant will address this issue. Additional information is required for the staff to determine the acceptability of the AP600 portable radio communications systems for fire brigade and other operations personnel. This is RAI #280.11 and is designated as COL Action Item 9.5.1.4-1 and is a related Meeting Open Item in SSAR Section 9.5.1 (OITS #320).

9.5.1.4.2 Emergency Breathing Air

Section C.3 of BTP CMEB 9.5-1 states, in part, the following:

> ... an onsite 6-hour supply of reserve air should be provided and arranged to permit quick and complete replenishment of exhausted air supply bottles as they are returned. If compressors are used as a source of breathing air, only units approved for breathing air shall be used; compressors shall be operable assuming a LOOP event. Special care must be taken to locate the compressor in areas free of dust and contaminants.

In Table 9.5.1-1 of the SSAR, under BTP CMEB Guideline 32, Westinghouse states that the AP600 is expected to conform to the guidelines or their intent. The COL applicant will need to provide additional information. The guidelines also indicate that the procedures and administrative controls governing the fire protection program during plant operations are developed for specific plants and covered in the COL application. Westinghouse should provide additional information concerning reserve air to permit quick and complete replenishment of exhausted air supply bottles as they are returned. Westinghouse indicates that the location of air compressors that will be used to replenish the breathing air is tentatively scheduled to be installed in the turbine building. Westinghouse agreed to review the location of the air compressors.

The staff expects that the air compressors will not be located in an area where a fire in any of the safety related areas or potentially high fire exposure areas (such as the turbine building) could damage the air supply equipment or hinder the operation of the equipment (for example, the air compressor electrical circuits or power supply are damaged by the fire and\or the fire produces smoke contaminants that have a pathway to the supply inlet to the air compressors) when the air compressors will likely be needed. Additional information is necessary for the staff to determine the acceptability of the fire brigade emergency breathing air supply. This is DSER Open Item 9.5.1.4-3 (OITS #1120) and a related Meeting Open Item in SSAR Section 9.5.1 (OITS #321).

9.5.1.4.3 Curbs and Drains

Section C.5.a(14) of BTP CMEB 9.5-1 states the following:

> Floor drains sized to remove expected fire fighting water flow without flooding safety-related equipment should be provided in those areas where fixed water fire suppression systems are installed.

In Table 9.5.1-1 of the SSAR, under BTP CMEB Guidelines 67-71, Westinghouse indicates that the AP600 is committed to comply with BTP CMEB 9.5-1. Guideline 71 states that, "water drainage from areas that may contain radioactivity

should be collected, sampled, and analyzed before discharge to the environment." Westinghouse indicates that procedures and administrative controls governing the fire protection program during plant operation are developed for specific plants and covered in the COL application.

Westinghouse has not provided sufficient information regarding floor drains sized to remove water from automatic fire fighting systems and manual fire fighting operations without flooding safety-related equipment. Westinghouse should provide the design capacity and location of the drains in the auxiliary building, inside containment and any other portion of the plant buildings that is adjacent to safety related areas. In addition, in Section 3.4.1.2.2.2 of the SSAR, it indicates that preaction system will be installed in two non-class 1E rooms in the radiological controlled area. Westinghouse should indicate whether these systems are seismically designed and if these systems expose safety related areas to potential flooding. And finally, Westinghouse should clearly describe why the flow rate is limited to 75 gallons per minute from the standpipe when this is the minimum expected flow rate from the standpipe (the standpipes are also connected to the station fire pumps which should be capable of delivering more than 75 gallons per minute to the standpipes). The staff requires additional information regarding the acceptability of the AP600 design for curbs and drains. This is DSER Open Item 9.5.1.4-4 (OITS #1121) and a related Meeting Open Item in SSAR Section 9.5.1 (OITS #322).

9.5.1.4.4 Smoke Control

SECY-90-016 and SECY-93-087 indicate that ALWR designers must ensure that smoke, hot gases, or fire suppressant will not migrate to other fire areas to the extent they could adversely affect safe shutdown capabilities, including operator action.

In Section 9A.3.1.1 of the SSAR, Westinghouse indicates that "Smoke and hot gases are removed from the fire area by portable exhaust fans and flexible ductwork." In other areas, smoke control features consist of fire dampers that close on high temperatures to control the spread of fire and combustion products. Smoke and hot gases are removed from the fire area by reopening the fire dampers after a fire. The nuclear island nonradioactive ventilation system is manually aligned to the smoke purge mode to exhaust smoke and hot gases to the atmosphere.

Section 6, Chapter 8, "Confinement of Fire and Smoke in Buildings," of the 14th edition of the NFPA Handbook indicates that one method of smoke control involves confinement and the use of physical barriers, such as doors, walls, or dampers. Although the physical barrier blocks the movement of smoke, no workable system has been devised that is able to confine smoke by means of physical barriers alone. An alternative to physical barrier confinement is the use of a pressure differential between the smoky atmosphere and the protected area. This pressurization, with or without simultaneous exhausting, creates an effective barrier. The combination of pressurization with physical barriers seems to be the most practical method of protecting an area from the intrusion of any products of combustion.

Based on the current AP600 design concerning smoke control features, it is not clear how smoke will be prevented from migrating to other fire areas. For example, Westinghouse should describe their smoke control system that will prevent the migration of smoke from the control room to the remote shutdown workstation, which is directly below the control room. The description of the smoke control system supported by technical justification should be provided in the SSAR. Therefore, additional information is required from Westinghouse to clarify how smoke and hot gases will not adversely affect safe shutdown, including operator action, for all safe shutdown and safety-related areas. Additional information concerning the AP600 smoke-control features is required in order for the staff to determine the acceptability of the smoke-control features. This is DSER Open Item 9.5.1.4-5 (OITS #1122) and a related Meeting Open Item (OITS #323).

Also, Section 5.f(1) of BTP 9-5-1 states the following:

> To facilitate manual fire fighting, separate smoke and heat vents should be provided in specific areas such as cable spreading rooms, diesel fuel storage areas, switchgear rooms, and other areas where the potential exists for heavy smoke conditions.

Westinghouse indicates that, "No areas requiring separate smoke and heat vents are identified." Westinghouse has not provided sufficient information regarding removal of smoke to facilitate manual fire fighting in areas such as the diesel storage areas, switchgear rooms, and other areas where the potential for heavy smoke conditions exists. The staff requires additional information to determine the acceptability of smoke control for the AP600 design. This is part of DSER Open Item 9.5.1.4-5 (OITS #1122) and is a related Meeting Open Item in SSAR Section 9.5.1 (OITS #324).

9.5.1.4.5 Access/Egress Routes

Section C.5.a of BTP CMEB 9.5-1 indicates that personnel access routes and escape routes should be provided for each fire area. Stairwells outside primary containment serving as escape routes, access routes for fire fighting, or access routes to areas containing equipment necessary for safe shutdown should be enclosed in masonry or concrete towers with a minimum fire rating of 2 hours and self-closing Class B fire doors.

In Table 9.5.1-1 of the SSAR, under BTP CMEB Guidelines 54-55, Westinghouse indicates that they will provide masonry or concrete towers with a minimum rating of 2 hours as described in Section C.5.a of BTP CMEB 9.5-1. The use of masonry or concrete towers with a minimum rating of 2 hours and self-closing Class B fire doors is in accordance with Section C.5.a(6) of BTP CMEB 9.5-1, and is acceptable.

9.5.1.4.6 Construction Materials

Section C.5.a of BTP CMEB 9.5-1 states that interior wall and structural components, thermal insulation materials, radiation shielding materials, and

soundproofing should be noncombustible. The following materials are acceptable for use as interior finish without evidence of test and listing by a nationally recognized laboratory:

- plaster, acoustic plaster, gypsum plaster board (gypsum wallboard), either plain, wallpapered, or painted with oil-or water-base paint
- ceramic tile or panels
- glass or glass blocks
- brick, stone, or concrete blocks (plain or painted)
- steel and aluminum panels (plain, painted, or enameled)
- vinyl tile, vinyl-asbestos tile, linoleum, or asphalt tile on concrete floors

In Table 9.5.1-1 of the SSAR, under BTP CMEB Guidelines 59-62, Westinghouse indicates that the AP600 complies with BTP 9.5-1, regarding the materials used as interior finish. These provisions, which comply with the intent of the guidelines in Section C.5.a.(9) of BTP CMEB 9.5-1, are acceptable.

9.5.1.4.7 Interactions With Other Systems

Section C.1.b(8) of BTP CMEB 9.5-1 states that appropriate protection for inadvertent operation of fire suppression systems should be provided. In Table 9.5.1-1 of the SSAR, under BTP CMEB Guideline 17, Westinghouse indicates that the AP600 complies with BTP 9.5-1 regarding protection for inadvertent operation of fire suppression systems; however, Westinghouse has not described the protection provided regarding the inadvertent operation of fire protection systems. Therefore, additional information from Westinghouse is required for the staff to determine the acceptability of the AP600 design concerning interaction with other systems. DSER Open Item 9.5.1.4-6 (OITS #325) and related Meeting Open Item (OITS #1123) are administratively resolved since there is not adequate information to address this concern and that it will be addressed during a future review of generic safety issue (GSI)-57.

9.5.1.4.8 Preoperational Testing

Section C.4.e of BTP CMEB 9.5-1 states that testing is performed and verified by inspection and audit to demonstrate conformance with design and system readiness requirements. Therefore, the staff expects that all of the active components of the entire fire protection system(s) will pass a preoperational acceptance test in accordance with the appropriate NFPA standard governing design and installation of the system(s). Specifically, the following components and systems must pass the preoperational testing before being placed in service:

- fire pumps (controls, flow volume, and pressure)
- water distribution (flush and hydrostatic pressure test)

- control valves
- fire-detection and alarm systems, including electronic supervision for other fire-detection and fire-suppression systems
- water fire-suppression systems
- emergency radio communication systems
- emergency lights
- emergency breathing-air systems and components.

In Table 9.5.1-1 of the SSAR, under BTP CMEB Guideline 35, Westinghouse indicates that the AP600 complies with paragraph C.4 of BTP 9.5-1. Westinghouse states that "Fire protection quality assurance programs are incorporated so that the guidelines of the regulatory position are included in design and in the procurement documents. Deviations are evaluated and controlled."

Additional information is required from Westinghouse for the staff to determine the acceptability of the preoperational acceptance test for all active components of the entire fire protection system(s). This is DSER Open Item 9.5.1.4-7 (OITS #1124).

9.5.1.5 Administrative Controls

Westinghouse indicated that the procedures and administrative controls governing the fire protection program during plant operation are developed for specific plants and covered in the COL application. The staff will perform a detailed review of the administrative controls during the plant-specific licensing process of a COL application referencing the AP600 system design. Items of interest under the administrative controls review will include the following:

- control of combustible materials such as combustible/flammable liquids and gases, fire-retardant-treated wood, plastic materials, and dry ion-exchange resins
- transient combustible materials and general housekeeping, including health physics materials
- open-flame and hot-work permits and cutting and welding operations
- quality assurance with respect to fire protection system(s) components, installation, maintenance, and operation
- qualification of fire-protection engineering personnel, fire-brigade members, and fire-protection system(s) maintenance and testing personnel
- instruction, training, and drills provided to fire-brigade members.

This is designated as COL Action Item 9.5.1.5-1 (OITS #1921).

9.5.1.6 Safe Shutdown Capability

For AP600, Westinghouse defined the safe shutdown condition as that reactor condition when the reactor is subcritical (i.e., $K_{eff} < 0.99$) and the reactor coolant temperature is greater than 200° F but does not exceed 420°F. In SSAR Section 7.4, "Systems Required for Safe Shutdown," Westinghouse discusses how safe shutdown can be achieved using only safety-related equipment following a transient or accident condition. In SSAR Section 9.A.2.7.2, "Safe shutdown Methodology," Westinghouse identifies the methods used for safe shutdown as it relates to a fire event in the plant. The above section indicates that the safe shutdown process, the systems used and functional requirements for safe shutdown described in Section 7.4 are equally applicable to fire scenarios. SSAR Sections 7.4 and 9.A.2.7.2 imply that following a fire event in the plant, safe shutdown can be achieved within 36 hours using only safety-related equipment. Also, SSAR Section 7.4 describes how nonsafety-related equipment can be used to achieve and maintain safe shutdown, when they are available. SSAR Sections 7.4 and 9.A.2.7.2 credit only safety-related equipment for achieving safe shutdown; however, SSAR Section 7.4.1.2 expects that safety-related equipment will be used only when nonsafety-related equipment is unavailable. SSAR Section 7.4 points out that safe shutdown can be maintained for at least 36 hours using only safety-related equipment after it has been achieved. Based on its review of Section 7.4, the staff has determined that safe shutdown as defined above can be achieved within 36 hours following a fire event using only safety-related equipment and can be maintained long-term (i.e., beyond 36 hours after it has been achieved) provided: (1) the safety-related passive systems used for safe shutdown perform their intended design function; (2) nonsafety-related equipment are available for long-term maintenance of safe shutdown; and (3) all staff's concerns identified in the following sections are resolved. For the above reasons, consistent with SECY-94-084 (approved by Commission, see SRMs dated June 30, 1994 and June 28, 1995) position on safe shutdown requirements for passive plant designs, the staff accepts safe shutdown as defined above as a safe stable shutdown condition for AP600, subject to an acceptable passive system performance and an acceptable resolution of the issue of regulatory treatment of non-safety systems (RTNSS). By letter dated September 24, 1993, Westinghouse submitted WCAP-13856, a summary report on the AP600 implementation of the RTNSS process. The staff is currently reviewing the above report as well as General Electric Advanced Boiling Water Reactor (ABWR) SSAR information as it relates to the performance characteristics of safety-related passive systems. Therefore, safe shutdown condition as defined above in relation to a fire event is RAI # 280.12 and is designated as Open Item 9.5.1.6-1.

AP600 design does not have systems specifically and solely dedicated as safe shutdown systems; however, Westinghouse claims that the design includes a number of plant systems that can establish and maintain safe shutdown conditions. Specifically, Westinghouse states in SSAR Section 9.5.1.1.1 that the design includes separate redundant safe shutdown components and associated electrical Class 1E divisions to safety shut down the plant following a fire event. There are four Class 1E divisions and Westinghouse states that a fire can generally damage safe shutdown components associated with one of these four divisions only, though in a few cases the single fire can damage components in more than one division. Westinghouse states that in such an event,

the remaining unaffected divisional shutdown components will be sufficient for safe shutdown. The AP600 safe shutdown capability which is normally available at the Main Control Room (MCR) includes an alternative shutdown capability at a remote shutdown station (RSS) for a disabling fire in the MCR which requires MCR evacuation. The following sections except Sections 9.5.1.6.5 and 9.5.1.6.6 deal with safe shutdown capability using safety-related equipment since AP600 SSAR credits only such equipment with safe shutdown.

9.5.1.6.1 Systems Required for Safe Shutdown

Section 7.4, "Systems Required for Safe Shutdown," of the standard review plan (SRP) identifies the systems required for safe shutdown both from the MCR and the RSS (the latter to be used generally in the event of a disabling fire in the MCR requiring the MCR evacuation). The above section discusses how safe shutdown is achieved and maintained using safety-related equipment. Additionally, the section identifies the functional requirements for safe shutdown and how these are met. The section evaluates safe shutdown systems from instrument and controls perspective. The staff concerns on the reactivity control function and reactor coolant makeup function (needed to maintain reactor coolant inventory control) are identified as Open Item 9.5.1.6-19 in Section 9.5.1.6.5 of this report.

SSAR Section 7.4.1.2 identifies nonsafety-related systems required for safe shutdown and describes how safe shutdown is achieved and maintained using these systems. Additionally, the SSAR section describes how the functional requirements for safe shutdown are met using the nonsafety-related systems. The evaluation from instruments and controls perspective will be under Section 7.4.

9.5.1.6.2 Protection of Safe Shutdown Capability for a Fire Outside the Containment and the Main Control Room

In SSAR Section 9.5.1.2.1.1, Westinghouse states that outside of the primary containment and the MCR, the arrangement of plant equipment and routing of cable are such that safe shutdown can be achieved with all components (except those protected by 3-hour fire barriers) in any one fire area rendered inoperable by fire. The staff notes that SECY-90-016 recommends that for a fire in any area other than containment or the MCR in an evolutionary ALWR, safe shutdown should be achieved without reliance on any safe shutdown equipment (i.e., components, power and control cabling and instrumentation and controls) in the fire affected area and without entry into that area for performance of operator actions or repairs. SECY-93-087 recommends extension of this enhanced fire protection criteria for passive plants. It is not clear from the SSAR statement given above how AP600 design meets the Commission approved SECY recommendation. Specifically, it is not clear: (1) what components are considered as protected by 3-hour fire barriers in the affected fire areas; (2) how many and which fire areas contain such protected safe shutdown components which are credited in the safe shutdown analysis even though they are in the fire affected areas, and (3) what type of 3-hour fire barriers are provided for each case. On SSAR Page 9.5-5, Westinghouse further states that outside the containment/shield building fire area, MCR and the RSS, 3-hour fire barriers provide complete separation of redundant safe

shutdown components including equipment, electrical cables and instrumentation and controls. It is not clear whether the three hour fire barriers referred to above are structural barriers such as 3-hour fire barrier walls, ceilings or floors between redundant safe shutdown components. If they are not, it is not clear how the AP600 design meets the SECY recommendation. For the above reasons, staff's concern relating to how AP600 design meets the SECY recommendation of not relying on any safe shutdown equipment in a fire affected area, for a fire in any fire area outside the containment/shield building, MCR and the RSS is RAI # 280.13 and is designated as Open Item 9.5.1.6-2.

On SSAR Page 9A-63, Westinghouse states that fire areas within the Annex I and Annex II buildings are separated from safety-related areas of the Nuclear Island by a 3-hour fire barrier wall, except for those fire areas which include portions of the auxiliary building. The staff is concerned that the Fire Area 4031 AF 02 (SSAR Section 9A.3.4.6) which contains safety-related Division A electrical cables (it is not clear whether these are required for safe shutdown) may not be separated by 3-hour fire barrier walls, ceilings or floors from adjoining annex building fire areas. The staff is further concerned that the fire areas in the annex buildings may not be separated by 3-hour structural fire barriers from auxiliary building fire areas which contain safe shutdown components (i.e., equipment, cabling, instrument and controls). During its meeting with the staff on April 12 and 13, 1995, Westinghouse told the staff that the Annex I and Annex II buildings are now considered as one Annex Building and that the Annex building fire areas do not contain safe shutdown components including cables and that the above position will be reflected in a future revision of the SSAR. The staff considers that the proposed revision does not clearly resolve staff's two concerns identified above (for example, it is not clear where the Division A electrical cables, supposedly protected by 3-hour fire barrier in the Fire Area 4031 AF 02 will be relocated). For the above reason, the above concerns are identified as RAI # 280.14 and is designated as Open Item 9.5.1.6-3.

For a number of fire areas outside the containment that contain safe shutdown components, Westinghouse states in SSAR Section 9A that the fire resistance of the boundaries of the fire areas are greater than the equivalent fire duration in those areas as shown in SSAR Table 9A-6. The staff is concerned about this position, since equivalent fire duration does not relate to the actual performance of a fire barrier assembly when exposed to the standard time-temperature fire endurance test as defined by American Society for Testing and Materials (ASTM) E-119. The above concern is RAI # 280.15 and is designated as Open Item 9.5.1.6-4.

Within the RSS, fire barrier separation between redundant divisional safe shutdown components (i.e., shutdown cabling from four Class 1E electrical divisions) is not provided. Following a fire in the MCR which requires MCR evacuation, shutdown capability is transferred from the MCR to the RSS by means of transfer switches which are located in the RSS. Each individual transfer switch is associated with only a single safety-related or nonsafety-related division. The RSS contains controls for safety-related equipment required to achieve safe shutdown. Also, the RSS contains controls for nonsafety-related equipment which can be used for safe shutdown, when such equipment are available. In response to staff's RAI Question No. 280.3,

Westinghouse stated that in the unlikely event a fire in the RSS damages the transfer switch set (this is not an associated circuit problem, since control from the RSS in not normally activated) causing transfer of the control from the MCR to the RSS, the operator will restore control to the MCR by deenergizing the RSS multiplexer cabinets in the instrumentation and control rooms. Thus, the capability to achieve safe shutdown from the MCR following a fire in the RSS will be ensured.

9.5.1.6.3 Protection of Safe Shutdown Capability for a Fire Inside the Containment/Shield Building

In the AP600 design, the containment/shield building constitutes a single fire area. This fire area is divided into 18 fire zones, 15 of which are inside the containment and 3 are outside the containment but within the shield building. The safe shutdown components located in the containment zones are the passive core cooling system (PXS) components, automatic depressurization system (ADS) components, the containment isolation valves and divisional shutdown Class 1E cables. The safe shutdown components located in the shield building zones, i.e., passive containment cooling systems (PCS) valve room and the middle and upper annus outside the containment, are the PCS components and the associated divisional cables and the Class 1E divisional instrumentation and control cables.

Regarding fire protection of safe shutdown components inside the containment, the staff recognizes the need for open communication between compartments inside the containment in order to be able to relieve and equalize pressure following a high-energy line break. Therefore, the staff has stated in SECY-90-016 (approved by Commission, see SRM dated June 6, 1990) that evolutionary ALWRs should provide fire protection for redundant shutdown systems in the reactor containment building that will ensure, to the extent practicable, that one shutdown division will be free of fire damage. SECY-93-087, which has been approved by the Commission as stated above, includes this criterion for passive designs. In SSAR Section 9.5.1.2.1.1, Westinghouse claims that following a fire in any fire zone in the single fire area (except the reactor cavity zone which contains the reactor vessel and no fire need be postulated in this zone), one train of safe shutdown components will remain undamaged and will be available for achieving safe shutdown. Westinghouse states in the SSAR section that the above capability is ensured by: (1) minimizing quantity of combustible materials in the area; (2) using canned reactor coolant pump motors and thus eliminating the need for an oil lubrication system; (3) separating redundant trains of safe shutdown components by structural walls, wherever, possible or by distance; and (4) providing appropriate fire detection and suppression capabilities. Further AP600 SSAR includes fire hazards analysis (Section 9A) for each of the zones and states that the analysis demonstrates that safe shutdown can be achieved following a postulated fire in any zone.

The staff has reviewed the fire hazards analysis for the containment/shield building zones as it relates to safe shutdown capability following a fire in any zone. Based on its review, the staff has the following concerns:

1. The SSAR information on separation between redundant safe shutdown components inside the containment/shield building fire area zones lacks details. The staff needs details on the separation between redundant safe shutdown components (instrumentation and controls and power and control cables are also considered as components) provided in the form of structural walls (their types, thickness, fire rating), containment penetrations (fire rating), horizontal distances with no intervening combustibles, cable trays (fire rating of the cables and distances between divisional cable trays), equipment such as pressurizer or steam generator. The staff needs the above information for each of the fire zones containing any safe shutdown component for which redundant safe shutdown component is credited in the safe shutdown analysis. This concern is RAI # 280.16 and is designated as Open Item 9.5.1.6-5.

2. In SSAR Section 9A, Westinghouse states that fire damage to any single valve does not affect the adjacent valve since the valves are sufficiently separated from one another in the following zones: Fire Zones 1100 AF 11206, 11207, 11208, 11209, 11300A and 11300C. This section does not define what sufficient separation means. Further, it is not clear whether any safety function (e.g., containment isolation needed to maintain safe shutdown over an extended period of time, when only safety-related equipment are used for safe shutdown) will be compromised in the event fire damages all the valves in any zone listed above. If so, it is not clear how the safety function will be performed. Also, it is not clear whether following a fire in any one of the fire zones 1100 AF 11206, 11207, 11300A and 11300C, safe shutdown can be achieved without relying on any safe shutdown component located in the affected fire zone. The above concern arises since SSAR Section 9A refers only to the performance of some specific safe shutdown function (i.e., providing adequate cooling to the reactor vessel) by redundant components in an unaffected fire zone and does not refer to ensuring safe shutdown capability in entirety without relying on any safe shutdown component in the affected fire zone. The above concerns are collectively classified as RAI # 280.17 and is designated as Open Item 9.5.1.6-6.

3. The safe shutdown evaluations for a number of fire zones contain statements listed below:

   "The horizontal separation between the termination boxes for different divisions is at least three feet. Fire in one division does not damage the adjacent division" (Fire Zone 1100 AF 11300B - this area encompasses passive residual heat removal (PRHR) valve area and north quadrant mechanical penetration area)."

   "The horizontal runs of Divisions B and D cable trays are routed adjacent to each other (side by side) approximately 26 feet above the operating deck. A fire in either division of cable trays does not propagate to the other division of cable trays (Fire Zone 1100 AF 11500)."

   "The minimum distance between the instrumentation and control cabling for separate divisions is approximately 3 feet. Adequate protection is

provided between the four divisions of cabling to prevent a fire in one bundle of cabling from propagating to an adjacent cable bundle of another division" (Fire Zone 1200 AF 12356)."

"The cable for these divisions (A and B) is separated from each other and from nonsafety-related cable such that a fire cannot affect both safety-related raceways" (Fire Zone 1200 AF 12556 - this area contains PCS air flow baffles, PCS piping, instrumentation and cables outside of the PCS valve room)."

"The divisional cable and valves are separated from each other and protected such that a fire cannot affect both divisions" (Fire Zone 1200 AF 12701 - PCS valves and cables in this fire zone are assigned to Divisions A and B)."

Based on the above statements, the staff is concerned that horizontal separation of at least 3 feet between safe shutdown cables of different (i.e., redundant) divisions in accordance with Institute of Electrical and Electronics Engineers (IEEE) 384 requirement does not necessarily eliminate fire-induced associated circuit problems which may compromise safe shutdown capability. This is because the 3 feet divisional cable separation eliminates only the problems internally generated due to electrical faults. Furthermore, the staff is concerned that the loss of all PRHR heat exchanger discharge valves of different divisions due to a fire in Fire Zone 1100 AF 11300B will result in loss of safe shutdown capability, particularly, since there is only one PRHR heat exchanger. The above concerns are collectively classified as RAI # 280.18 and is designated as Open Item 9.5.1.6-7 (resolution of Open Item 9.5.1.6-5 will provide partial resolution of this open item).

4. In SSAR Section 9A, Westinghouse does not explain why a fire in either Fire Zone 1100 AF 11303A or AF 11303B can result in loss of only one of the three ADS vent paths in the affected zone. Also, SSAR Section 9A does not clarify whether following a fire in any one of the zones listed above, the first, second and third stages of ADS valves in the unaffected fire zone (the above fire zones contain redundant first, second and third stages of ADS valves) and fourth stage ADS valves in either Fire Zone 1100 AF 11301 or AF 11302 can provide sufficient depressurization capability, should the ADS be required to achieve safe shutdown. The above concerns are classified as RAI # 280.19 and is designated as Open Item 9.5.1.6-8.

9.5.1.6.4 Safe Shutdown Capability for a Fire in the MCR

As stated above, AP600 safe shutdown capability includes alternative shutdown capability from the RSS following a disabling fire in the MCR which requires MCR evacuation. This is because, though the four Class 1E divisional cables, as applicable, for safety-related equipment required for safe shutdown are electrically separated in the MCR in accordance with industry standards, they are not separated by 3-hour rated fire barriers. Therefore, following a fire which requires MCR evacuation, safe shutdown capability is transferred from the MCR to the RSS manually by means of transfer switches located in the RSS.

The RSS is physically independent of the MCR. It is also electrically independent of the MCR in the sense that once control of shutdown capability is transferred to the RSS, subsequent electrical faults (associated circuits interactions) in the MCR will have no effect on the ability to achieve and maintain safe shutdown capability from the RSS. In response to staff's RAI 280.3 regarding manual operations inside the control room, Westinghouse stated that following a disabling fire that requires MCR evacuation, no manual actions are required in the MCR. SSAR Section 7.4 lists tripping of the reactor as part of safe shutdown provisions and states that the tripping can be accomplished either from the MCR or at the reactor trip switchgear. Also in SSAR Section 9A.2.7 (Page 9A-4), Westinghouse states that one of the required manual actions for achieving safe shutdown following a fire is scramming the reactor from the MCR and this is assumed to occur at time zero of the fire event. This is consistent with Generic Letter (GL) 86-10, which states that the only manual action in the MCR which can be credited without justification for the manual action in the safe shutdown analysis for control room fire is tripping the reactor from the MCR before evacuating the MCR. Though the SSAR Section 9.5.1 and Westinghouse's response provide useful information as described above relating to safe shutdown capability following a disabling fire in the MCR, the SSAR does not address concerns identified in NRC Information Notices (IN) 85-09, "Isolation Transfer Switches and Post-Fire Shutdown Capability" and 92-18," Potential for Loss of Remote Shutdown Capability During a Control Room Fire." These INs deal with fire-induced electrical faults due to control room fire prior to MCR isolation rendering transfer of control of needed safe shutdown equipment from the MCR to the remote shutdown panel, impossible. The concern relating to lack of information in the SSAR on how AP600 design addresses the identified concerns in the INs is RAI # 280.20 and is designated as Open Item 9.5.1.6-9.

9.5.1.6.5 Additional Features to Ensure Safe Shutdown Capability

This section provides discussion and the evaluation of design features to preclude fire-induced breaches of high/low pressure interfaces, associated circuit concerns, spurious operations and multiple high-impedance faults that can compromise safe shutdown capability. Additionally, the section addresses safe shutdown instrumentation requirements, man-power requirements, manual actions and safe shutdown performance goals.

In SSAR Section 9A.3.7.1.1, Westinghouse discusses high/low pressure interfaces as it relates to safe shutdown capability following a fire event in the plant. AP600 design includes high/low pressure interface valves between the reactor coolant system (RCS) and the normal residual heat removal system (RNS). The SSAR section points out that RNS is, however, a nonsafety-related system which is not required for safe shutdown and that power to the interface valves is locked out during power operations to preclude fire-induced breach of the interface, and thus safe shutdown capability is protected. In SSAR Section 5.14.12.2, Westinghouse states that the reactor vessel head vent system for AP600, designed to remove non-condensable gases or steam from the RCS, includes two flow paths from the vessel head to the in-containment refueling water storage tank (IRWST) and that each flow path contains two solenoid-operated isolation valves in series. These high/low pressure interface valves are normally de-energized to eliminate spurious opening of

any flowpath. The staff finds the design features described above acceptable. Regarding ADS valves, Westinghouse states on SSAR Page 9A-88 that fire-induced ADS valve actuations cannot damage a low-pressure system; however, the SSAR does not explain the above position. Further contrary to what the subject SSAR page states (i.e., the ADS valves do not represent a high/low pressure interface, since the system is entirely within containment and this is as per GL 81-12), GL 81-12 does not limit considerations of fire-induced breaches of high/low pressure interfaces and their consequences to only fire areas outside the containment. For the above reasons, fire-induced ADS valve actuations and their consequences on low-pressure system is RAI # 280.21 and is designated as Open Item 9.5.1.6-10. The staff also finds that SSAR Section 9A does not explain how other high/low pressure interface valves in the chemical and volume control system (CVS) makeup system, CVS-letdown line and process sampling system are protected against fire-induced breaches and their consequences on safe shutdown capability. The above concern is RAI # 280.22 and is designated as Open Item 9.5.1.6-11.

Regarding fire-induced associated circuit concerns, Westinghouse states in SSAR Section 9.5.1.2.1.1 (Page 9.5-5) that outside the containment/shield building fire area, MCR and the RSS, three hour fire barriers provide complete separation of redundant safe shutdown components including equipment, electrical cables and instrumentation and controls. Based on the SSAR information given above, the staff has determined that a fire in any fire area outside the containment, MCR and RSS will not result in associated circuit concerns that can compromise safe shutdown capability from the MCR. In the MCR and RSS, the divisional safe shutdown cables are not separated by 3-hour fire barriers. However, since control from the RSS is not normally activated, no fire-induced spurious signals are expected in the event of a fire in the RSS. Therefore, the staff finds that a fire in the RSS will not result in associated circuit concerns that can compromise safe shutdown capability from the MCR. Regarding a disabling fire in the MCR, as given in Section 9.5.1.6.4 of this report, once MCR is electrically isolated from the RSS by transferring control of safe shutdown capability from the MCR to the RSS, subsequent electrical faults (i.e., fire-induced associated circuits interactions) in the MCR will have no effect on the ability to achieve safe shutdown from the RSS. However, as stated in the section, fire-induced electrical faults prior to MCR isolation can compromise safe shutdown capability from the RSS. Therefore, subject to resolution of Open Item 9.5.1.6-9 identified in Section 9.5.1.6.4, fire-induced associated circuits problems need not be a concern for a fire in the MCR. Regarding a fire in any fire zone inside the containment/shield building fire area, as discussed in Section 9.5.1.6.3 of this report, Westinghouse has not satisfactorily addressed how fire-induced associated circuit problems, which may compromise safe shutdown capability, is eliminated. This concern is RAI # 280.23 and is designated as Open Item 9.5.1.6-12.

On SSAR Page 9A-5, Westinghouse states that fire-induced multiple high-impedance faults have been considered in the evaluation of safe shutdown capability. However, the SSAR does not explain how such faults which can compromise safe shutdown capability are eliminated in the AP600 design. This concern is RAI # 280.24 and is designated as Open Item 9.5.1.6-13.

On SSAR Page 9A.3.7.1.2, Westinghouse discusses how adverse consequences (i.e., affecting safe shutdown capability) due to spurious actuations other than those that involve high/low pressure interfaces are eliminated. The section indicates that these are eliminated by assigning separate integrated logic cabinets to two valves in series in a flow path (ADS valve actuations in any ADS flow path); operator actions (PCS valve actuation); redundant valves in series assigned to different electrical divisions which cannot be affected by the same fire (containment isolation valve actuation); or redundant sets of trip switchgear in separate fire areas (reactor trip switchgear and reactor coolant pump trip switchgear), as appropriate. Additionally, Westinghouse states in SSAR Section 9.A.3.1.1.15 that power to the normally open motor-operated PRHR heat exchanger inlet isolation valve located in Fire Zone 1100 AF 11590 is removed during normal power operation with the valve secured in the open position and thus fire-induced spurious actuation of this valve is eliminated. The staff finds the above acceptable, except the one for PCS valve spurious actuation. SSAR Page 9A-89 describes the manual actions to correct the consequences of fire-induced spurious actuation of a PCS valve. Since the SSAR described operator actions to eliminate adverse consequences of a PCS valve spurious actuation may involve accessibility to the affected fire zone (Fire Zone 1270 AF 12701), patrolling the fire zone and performance of the SSAR described corrective manual actions in a timely manner, it is not clear why AP600 fire protection system is not designed to eliminate the adverse consequences of fire-induced spurious actuation of a PCS valve without reliance on the SSAR described manual actions. This concern is RAI # 280.25 and is designated as Open Item 9.5.1.6-14.

SSAR Table 7.4-1 lists systems required for safe shutdown. SSAR Tables 9A-2, 9A-3 and 9A-4 list active safe shutdown valves, containment isolation valves inside the containment and containment isolation valves outside containment, respectively. SSAR Table 9A-5 lists the safe shutdown instrumentation provided in the MCR and RSS. Based on its review of the above tables, the staff finds that AP600 design provides for needed instrumentation both in the MCR and the RSS for achieving safe shutdown; however, the staff has the following concerns regarding safe shutdown instrumentation:

1. On SSAR Pages 9A-14 and 9A-15, Westinghouse states that the majority of the transmitters for the RCS and the steam generator (SG) system associated with the instruments for the 2 cold legs and single hot leg are located outside the SG compartments (Fire Zone 1100 AF 11301 and 1100 AF 11302). However, the SSAR does not clarify whether: (a) this majority is sufficient to monitor process variables such as reactor coolant hot leg and cold leg temperatures; (b) the instruments will not be affected by fire and if so, why; and (c) the horizontal distance of these transmitters is at least 20 feet with no intervening combustibles from the associated fire zones. Also, it is not clear whether following a fire in one of the two SG compartments, the redundant instrumentation and transmitters for the unaffected SG compartment can be used to monitor the process variables. All these concerns are collectively classified as RAI # 280.26 and is designated as Open Item 9.5.1.6-15.

2. The SSAR Section 9A has neither identified the locations of SG wide range level instrumentation nor described how these safe shutdown instrumentation are protected from fire. This lack of information in the SSAR is RAI # 280.27 and is designated as Open Item 9.5.1.6-16.

3. On SSAR Pages 9A-40 and 9A-41, Westinghouse states that a fire in main steam isolation valves compartment A or B can disable main steam pressure transmitters and that these are not required to achieve safe shutdown. However, these are listed as safe shutdown instrumentation in SSAR Table 9A-5. This inconsistency is identified as RAI # 280.28 and is designated as Open Item 9.5.1.6-17.

The SSAR does not provide details of man-power requirements for achieving safe shutdown following a fire event in any plant fire area which requires safe shutdown. This is RAI # 280.29 and is designated as Open Item 9.5.1.6-18. About manual operations, Westinghouse states (SSAR Page 9A-4) that manual actions such as manual operation of valves, circuit breakers and hand switches are utilized in exercising control over shutdown systems, provided sufficient time, personnel and accessibility to shutdown equipment (located anywhere outside the fire area or fire zone) are available. From the above statement, it is not clear whether safe shutdown can be achieved when any one of the above is unavailable. This concern is RAI # 280.30 and is designated as Open Item 9.5.1.6-19.

Regarding safe shutdown functions, SSAR Section 7.4 (Page 7.4-1) lists the following as needed for safe shutdown: decay heat removal, RCS inventory control, RCS pressure control and reactivity control. Though SSAR Section 7.4 describes how safe shutdown is achieved and maintained, it does not clearly state how the reactivity control function and reactor coolant makeup function (needed to maintain reactor coolant inventory control) are ensured. The staff is particularly concerned regarding ensuring the reactor coolant makeup function to maintain safe shutdown over long-term, once it has been achieved (see SECY-94-084, Pages 13 and 14). The above concerns which deal with the performance goals of safe shutdown capability, namely, ensuring reactivity control function and reactor coolant makeup function, particularly over long-term, are collectively classified as RAI # 280.31 and is designated as Open Item 9.5.1.6-20.