August 31, 1994

MEMORANDUM TO: R. W. Borchardt, Director
Standardization Project Directorate
Associate Directorate for Advanced Reactors

FROM: Conrad E. McCracken, Chief
Plant Systems Branch
Division of Systems Safety and Analysis

SUBJECT: DRAFT SAFETY EVALUATION REPORT FOR CHAPTERS 3 AND 5 OF THE AP600 STANDARD SAFETY ANALYSIS REPORT (TAC NOS. 85041 AND 85043)

Plant Name: AP600 Standard Safety Analysis Report
Applicant: Westinghouse Corporation
Review Status: Complete

Attachments 1 and 2 provide the Plant Systems Branch's input to the Draft Safety Evaluation Report (DSER) for Chapters 3 and 5, respectively, of the AP600 Standard Safety Analysis Report (SSAR). This DSER is prepared by my staff based on their review of the AP600 SSAR for which we have primary review responsibility. Section 3.11 the attached DSER was prepared by Harold Walker, all other sections were prepared by Butch Burton. The staff's conclusion on this review is addressed in the attached DSER.

Docket No. 52-003

Attachments: As stated

cc w/attachments:
Frederick Hasselberg
Tom Kenyon

Contacts: W. Burton
504-2853

H. Walker
504-2827

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up to grade. Although grade elevation is defined as 100 feet, the actual grade may be a few inches lower to prevent surface water from entering doorways. The PMF results from site-specific events such as river flooding, dam failure, or other natural causes. The COL applicant will identify and evaluate all potential flooding events at the site and demonstrate that the site meets all interface requirements. The COL applicant may propose measures to protect safety-related equipment from floods beyond those postulated in the AP600 design.

SSAR Table 2.0-1, "Site Interface Requirements," defines the PMP as 49.3 cm/hr (19.4 in/hr) and the maximum static roof load due to snow and ice buildup as 366 kg/m^2 (75 pounds/ft^2). Flooding does not occur due to the PMP. Water from roof drains and/or scuppers flow to catch basins, underground pipes, or open ditches. The COL applicant will identify and evaluate flood, precipitation, and snow loading hazards beyond those postulated in the AP600 design and provide the design features necessary to ensure that SSCs important to safety will not be adversely affected by these hazards.

The roofs are designed for snow loads in accordance with ASCE 7-88 (formerly ANSI A58.1 82), "Minimum Design Loads for Buildings and Other Structures." The roofs do not have drains or parapets. The roofs are sloped such that rainfall is directed toward gutters along the edges of the roof. Therefore, ponding on the roofs does not occur.

Westinghouse identified components which are postulated to be sources of external flooding. These include:

(1) two fire water tanks (350,000 an 425,000 gallons) which are not located near structures housing safety-related equipment.

(2) the condensate storage tank (300,000 gallons) located near the turbine building.

(3) the demineralized water storage tank (150,000 gallons) located near the Annex II building.

(4) the boric acid storage tank (62,000 gallons) located next to the demineralized water storage tank.

(5) two diesel fuel oil tanks (100,000 gallons each) which are not located near structures housing safety-related equipment and which include dikes to retain leaks and spills.

Failure of the cooling tower, service water piping, or circulating water piping also constitute potential sources of external flooding. However, they are not located near structures housing safety-related equipment and all are bounded by the analysis provided in SSAR Section 10.4.5.

All safety-related systems are housed in the seismic Category I containment or auxiliary buildings. Seismic Category I structures are located such that the land slopes away from the structures. This assures that external flood water will drain away from the building and prevent pooling near the building. In addition, and as stated previously, the actual grade is a few inches lower than building entrances to prevent surface water from entering doorways.

The portions of seismic Category I structures located below the grade elevation are protected from external flooding by waterproofing membranes and waterstops. The waterproofing membranes are installed on both vertical and horizontal exterior surfaces below grade. Waterstops are installed in exterior construction joints below grade.

The AP600 design minimizes the number of penetrations through exterior walls below grade. Penetrations below the maximum flood level will be watertight and any process piping penetrating an exterior wall below grade either will be embedded in the wall or will be welded to a steel sleeve embedded in the wall. Exterior walls are designed for maximum hydrostatic loads as are penetrations through the walls.

The base mat and exterior walls of all seismic Category I structures are designed to accomodate the maximum lateral and buoyancy forces associated with the PMF and high groundwater level. Hydrodynamic forces were not considered in the structural design because the PMF and high groundwater level are below the finished grade.

RG 1.59 discusses the design basis floods that nuclear power plants should be designed to withstand without loss of capability to achieve and maintain a cold shutdown condition. Position 1 of RG 1.59 states that the conditions resulting from the worst probable site-related flood at a nuclear power plant, with attendant wind-generated wave activity, constitutes the design basis flood condition from which safety-related SSCs must be protected. The design basis flood level for the AP600 design takes into account the PMF generated by the PMP or other combinations of less severe environmental and man-made events, along with seismic and wind effects. SSAR Table 2.0-1 and SSAR Section 2.4 provide the design basis flood information, as discussed above. The applicant referencing the AP600 design will verify that the site-specific flood conditions are within the interface parameters assumed in the AP600 design. Should the site-specific conditions exceed those assumed for the design, the referencing applicant will provide additional protective features to ensure that safety-related SSCs are protected from the additional flood hazard. Based on this information, and subject to resolution of the open item below, the staff concludes that Westinghouse has identified the design basis flood assumed for the AP600 design and has provided adequate guidance for the referencing applicant to ensure that SSCs important to safety will be adequately protected from the worst-case site-specific flood conditions. Therefore, the staff concludes that the AP600 design conforms to the guidelines of Position C.1 of RG 1.59, subject to satisfactory resolution of the open item below.

Position C.2 of RG 1.59 provides alternate guidance for flood protection when the "hardened protection" method (as defined in footnote 7 of RG 1.59) is not used. The "hardened protection" method requires that passive structural provisions be incorporated into the plant design to protect safety-related SSCs from the static and dynamic effects of floods. These provisions must in place during normal plant operation. Examples of this method are provided in RG 1.102.

RG 1.102 describes the types of flood protection acceptable to the NRC staff for safety-related SSCs. Position C.1 of RG 1.102 provides definitions of the various types of flood protection acceptable to the staff. One of the acceptable methods of flood protection incorporates a special design of walls and penetrations. The walls are reinforced concrete designed to resist the static and dynamic forces of the design basis flood and incorporates waterstops at construction joints to prevent inleakage. Penetrations are sealed and also capable of withstanding the static and dynamic forces of the design basis flood. As discussed earlier in this report, the AP600 design has incorporated these protective features. Therefore, the staff concludes that the AP600 design conforms with the guidelines of Position C.1 of RG 1.102.

Position C.2 of RG 1.102 discusses technical specification and emergency operating procedures necessary to utilize Position C.2 of RG 1.59. Subject to satisfactory resolution of the open item below, the staff concludes that the AP600 design conforms to the guidelines of Position C.2 to of RG 1.102 and of Position C.2 of RG 1.59.

Based on the evaluation of the information provided in the SSAR, the staff concludes that Westinghouse has adequately characterized the PMP and PMF for the AP600 design and has provided design features to protect safety-related equipment from the external flood effects associated with the PMP, PMF, groundwater seepage, and component failures. Furthermore, Westinghouse has required the applicant referencing the AP600 design to identify flood-related hazards beyond those postulated for the design and to provide the design features necessary to protect safety-related systems from these additional external flood-related hazards. Therefore, the design meets the guidelines of RG 1.59 with regard to the methods used for establishing the probable maximum flood (PMF) and probable maximum precipitation (PMP), and RG 1.102 with regard to acceptable external flood protection methods, subject to satisfactory resolution of the open item discussed below.

Internal Flooding

Safety-related systems and components are located inside the containment and auxiliary buildings. These seismic Category I structures are designed to withstand the effects of floods, tornadoes, and missiles. Redundant safety-related systems and components are physically separated from each other as well as from nonsafety-related components. Therefore, the failure of a system or component may render one division of a safety-related system inoperable while the redundant division is available to perform its safety function. Protection mechanisms used to minimize the consequences of internal flooding include:

- structural enclosures
- structural barriers
- curbs and elevated thresholds
- leakage detection systems
- drainage systems

The SSAR included the results of an internal flooding analysis which described the consequences of compartment flooding for various postulated component failures. The analysis included:

- identification of flood sources
- identification of safety-related equipment in each area
- determination of maximum flood levels
- evaluation of flood effects on safety-related equipment

The flood sources consist of:

- high-energy piping breaks and cracks
- moderate-energy through-wall cracks
- storage tank ruptures
- actuation of fire suppression systems
- flow from upper elevations and adjacent areas

The criteria of SSAR Section 3.6, "Protection Against the Dynamic Effects Associated with the Postulated Rupture of Piping," were used to define break and crack configurations and locations for both high- and moderate-energy pipe failures. The staff evaluated the ability of the AP600 design to protect SSCs important to safety from the effects of pipe ruptures in Sections 3.6.1, 3.6.2, and 3.6.3 of this report.

Storage tanks are assumed to fully discharge their inventory upon a tank rupture. Except for floor drains, no credit is taken for nonsafety-related equipment.

There are no watertight doors used in the AP600 design. Instead, all safety-related equipment is located above the maximum anticipated flood levels for the area. Interior walls are designed to withstand the maximum hydrostatic loads associated with the maximum flood level in a given area. The design minimizes the number of penetrations through interior walls below the maximum flood level. Those penetrations below the maximum flood height are watertight and can withstand the maximum hydrostatic load associated with the maximum flood height. Process piping penetrating below the maximum flood height either will be embedded in the wall or will be welded to a steel sleeve embedded in the wall.

Safety-related systems and components needed for safe shutdown are identified in SSAR Section 7.4. The safe shutdown systems and components located inside containment are the passive core cooling system (PXS), the automatic depressurization system (ADS), and containment isolation valves

The SSAR identifies seven compartments inside containment which are subject to full or partial flooding. These are the reactor vessel cavity, two steam generator compartments, a vertical access tunnel, the chemical and volume control system (CVS) compartment, and two PXS compartments (PXS-A in the southeast quadrant of containment and PXS-B in the northeast quadrant of containment). Of these compartments, only the two PXS compartments contain safety shutdown equipment. Both compartments are below the maximum flood water height (108'-2"). The RCS cavity and the two steam generator compartments are connected by the vertical access tunnel. These compartments are combined into one floodable volume called the RCS compartment. The PXS-A, PXS-B, and CVS compartments comprise the remaining separate flood volumes and are isolated from each other as well as from the RCS compartment. Flooding in the PXS-A, PXS-B, or CVS compartments may result in some flooding of the RCS compartment (which does not contain any safety-related equipment) but will not result in flooding of any other compartment. The maximum flood height in the containment assumes that the combined water inventory from all available sources inside containment flood the reactor and steam generator compartments to a level above the reactor coolant system (RCS) piping during a loss-of-coolant accident (LOCA). The flood water would cover the break location and allow backflow either through the break or via the PXS recirculation system flow path. The available flooding sources are the RCS, two accumulators, two core makeup tanks (CMTs), and the in-containment refueling water storage tank (IRWST). The resulting maximum flood height inside containment is 108'-2."

The reactor vessel cavity and the adjoining equipment room are located at the lowest level of the containment (71'-6"). The equipment room contains the containment sump pumps. Floor drains from the PXS-A, PXS-B, and CVS compartments are routed to the containment sump. Reverse flow to these three compartments is prevented by the use of redundant safety-related backflow preventers. The backflow preventers will be required to have a near-zero leakage rate (i.e. no visible leakage) for a wide range of differential pressures. Each compartment drain line is monitored by its own non-safety-related flow sensor. Each sensor can detect flow as small as 0.2 gpm. Flow through each drain line, as well as total flow from all drain lines, is monitored in the MCR. Containment flooding is detected through the use of the containment sump level monitoring system and the containment flood-up level instrumentation. The containment sump level monitoring system uses redundant, seismically qualified level sensors to detect sump level. Level signals are transmitted to the MCR and to the leak detection system. The leakage detection system monitors plant leakage and initiates appropriate safety actions (see Section 5.2.5 of this report). The containment flood-up level instrumentation consists of redundant, Class 1E sensor racks which monitor water level from the bottom of the reactor vessel cavity to the top of the vertical access tunnel. Level indications are transmitted to the MCR.

The PXS-A and PXS-B compartments inside containment are physically separated and isolated from each other by a structural wall so that flooding in one compartment cannot cause flooding in the other compartment. They are located below the maintenance floor level (107'-2"). A 12" (30 cm) curb is provided around the openings that penetrate the maintenance floor, thus providing the required protection up to the maximum flood height of 108'-2". Should flooding continue, the water would overflow the curb and spread over the maintenance floor at elevation 107'-2". From there, the water would flow into the RCS compartment via the vertical access tunnel (which has no 12" [30 cm] curb).

Inside the PXS compartments, all containment isolation valves (CIVs) are located above the maximum flood height with the exception of one normally closed CIV for the spent fuel pit cooling system in PXS-A and three normally closed CIVs for the normal RHR system in PXS-B. These CIVs are not required for safe shutdown operation and will not fail open under flooded conditions. In addition, redundant CIVs are provided on each line outside of containment. Each PXS compartment also contains a set of normally closed air-operated CMT isolation valves at elevation 97'-6". These compartments also contain one normally open accumulator isolation valve and one normally open IRWST isolation valve. Because these valves are normally open, they do not require repositioning during flooded conditions. In addition, each PXS compartment contains two normally closed, motor-operated valves arranged in series as part of the PXS recirculation subsystem. These valves are opened during a flood event to provide a redundant flow path from the RCS compartment to the reactor vessel.

The internal flood analysis considered single failures such as a break of the 8" (20 cm) direct vessel injection line, the 12" (30 cm) normal RHR line, the 8" (20 cm) accumulator injection line, and the 6" and 10" (15 cm and 25 cm) IRWST lines. The worst flood conditions result from a break in the 8" (20 cm) direct vessel injection line. In this case, flooding would occur as a result of blowdown of the RCS, as well as from the CMT and the accumulator. The resulting flood would affect only one PXS compartment, allowing the redundant PXS division to perform it safety function.

Inside containment, separate drains are provided to the containment sump from the PXS and CVS compartments. The drain backflow preventers and piping upstream are classified as AP600 Equipment Class B (ASME Safety Class 2) and seismic Category I.

There are several duct penetrations into the CVS and PXS compartments. These penetrations (through the floor at 107'-2") are designed to prevent the flooding of these rooms from the maintenance floor level.

The Fire Protection System (FPS) and Demineralized Water Transfer and Storage system (DMWS) are open-cycle systems that enter the containment. These systems are isolated during plant operation and are not a potential flooding source.

The auxiliary building upper annulus provides the air flow path for the PCS. The annulus floor has a curb with a flexible seal connected to the shield building, which blocks communication with the middle annulus below. The upper annulus has redundant, physically separated drains which discharge to the yard drainage system to limit water accumulation. These drains are required for operation of the Passive Containment Cooling System (PCS) and are classified as AP600 Equipment Class C (ASME Safety Class 3). The worst-case flooding in the annulus occurs when one drain is blocked concurrent with an inadvertent opening of a PCS cooling water isolation valve. During this postulated event, the maximum water height is less than 6". This will not effect any other safety-related equipment. Flooding in the annulus is detected by Class 1E level switches which provide an alarm in the MCR.

The PCS valve room at elevation 266' of the shield building contains two redundant safety-related valve trains for the PCS. A through-wall crack of the PCS piping is the only flooding source for this room. The valve room door is not watertight. Leakage flows under the door and down the containment wall to the upper annulus floor, where it drains to the yard drainage system. The leakage under the valve room door is sufficient to prevent excessive water accumulation in the valve room. However, a non-safety-related floor drain is also available. The isolation valves are located above the maximum flood level. Level switches in the valve room drain sump alarm in the MCR. No safety-related equipment is affected by this worst-case flood scenario.

Based on the evaluation of the information provided in the SSAR, and subject to the resolution of the open item below, the staff concludes that Westinghouse has properly identified all equipment important to safety inside the AP600 containment, has properly identified all flood hazards inside containment, and has provided adequate means of protecting all equipment important to safety from the identified flood hazards inside containment.

The SSAR identifies safety-related equipment in the auxiliary building which requires flood protection on a room-by-room basis. The auxiliary building is separated into radiologically controlled areas (RCAs) and nonradiologically controlled areas (NRCAs). On each floor, these areas are separated by structural walls and floor slabs 2 to 3 feet wide. These structures are designed to prevent fires or floods which may occur in one area from propagating to the another area.

Non-safety-related level sensors in the sumps serving the RCA and NRCA provide indication and alarm to the control room and to the plant instrumentation system. Safety-related instrumentation is not needed because postulated flooding is controlled such that safe shutdown is not affected.

The NRCA is divided into a mechanical equipment area and an electrical equipment area. The electrical equipment area is further divided into an area housing Class 1E electrical equipment and non-Class 1E electrical equipment.

The safe shutdown equipment located in the NRCA is associated with the protection and safety monitoring system (I&C cabinets in Level 3), the Class 1E dc system (Class 1E batteries on Level 1 and Level 2 and dc electrical equipment on Level 2), and containment isolation. The NRCAs are designed to provide maximum separation between the mechanical equipment and electrical equipment areas.

The mechanical equipment areas located in the NRCAs include the valve/piping penetration room (Level 3) and two main steam tunnel (MST) and mechanical equipment rooms (Levels 4 and 5). Flood water in these areas is routed to the turbine building or the annex I building via drain lines, controlled accessways, or blowout panels from the MST to the TB.

The NRCAs are also designed to provide maximum separation between Class 1E and non-Class 1E electrical equipment. Only the non-Class 1E electrical rooms have sprinklers (dry pre-action with limited water supply). These areas drain to a sump on Level 1 (elevation 66'-6").

The AP600 design minimizes water sources in those portions of the NRCAs housing Class 1E electrical equipment. In these areas, the only water sources are associated with fire fighting and eyewash stations. No water accumulates on the upper floors of the auxiliary building in these areas. Instead, flooding from these sources is directed to Level 1 via floor drains, stairwells, and elevator shafts. The maximum postulated water height on Level 1 is 6 inches (15 cm). The terminal height on the first row of batteries on Level 1 is 31 inches (79 cm). Therefore, the safety-related electrical equipment on Level 1 is adequately protected from the anticipated worst-case flood conditions. Although the operation of the sump pumps is not required for flood protection, the Level 1 sump pumps are designed to remove approximately 150 gpm (568 L/min) which is equivalent to the maximum flow associated with the operation of two fire hose stations.

Water associated with the actuation of the dry pre-action sprinkler system in NRCAs housing non-Class 1E electrical equipment on Levels 3 (100'-0") and 4 (117'-6") is routed either to level I of the auxiliary building or to the annex I building.

The MCR and the remote shutdown workstation (RSW) are also located in the NRCA. The MCR and RSW are adequately protected from flooding due to limited sources of flood water, pipe routing, and drainage paths.

At least one of the following measures are used to protect equipment from the effects of spray wetting:

(1) Equipment will be qualified for submergence due to flooding/wetting.

(2) Equipment will be protected from wetting due to spray.

(3) Equipment will be evaluated to show that failure of the equipment due to flooding/wetting is acceptable since its safety-related [RTNSS, DID] function is not required or has otherwise been accomplished.

In the NRCA, mechanical and electrical equipment are separated by concrete walls and floors that form a watertight barrier. Class 1E components in the mechanical equipment area are the CIVs, the main steam and feedwater isolation valves and the main steam and feedwater line instrumentation. This equipment is either protected from spray wetting or is environmentallly qualified for spray conditions. The doors for the battery rooms are normally closed since they also serve as fire barriers (these doors utilize automatic closers). These doors will prevent spray from sources outside the battery room from affecting equipment inside the room.

The four Class 1E electrical divisions in the NRCA of the auxiliary building are separated by 3-hour rated fire barriers. Portions of these fire barriers also serve as flood barriers. HVAC ducts that penetrate these barriers and are below the maximum flood height are required to be watertight. Since the maximum flood height in most of the Class 1E electrical areas is 3" (12" on Level 1), none of the wall penetrations will need to be watertight. Floor penetrations between rooms of the same division are not required to be watertight.

Fire dampers and watertight penetrations provide divisional separation for the HVAC ductwork. The division A & C electrical rooms and the division B & D electrical rooms are served by separate HVAC subsystems.

The FPS is the only open-cycle system that enters the mechanical equipment area of the NRCA. Fire water will drain from this area to the turbine building or annex I building. FPS and DMWS are open-cycle systems that enter the electrical equipment area of the NRCA. The maximum diameter of the DMWS piping is 1" and therefore is not considered a credible flooding source. As stated before, dry pre-action sprinklers with a limited water volume are used in the non-Class 1E electrical equipment area and has no effect on safe shutdown capability. Limited water volume hose stations are used in the Class 1E electrical equipment areas.

Each divisional area housing Class 1E equipment has a separate drain to the auxiliary building sump. Protection of safety-related equipment in this area or in the mechanical equipment area is not dependent on proper drain operation because other drain paths are available which limit the maximum water level in these areas. Therefore the drain system in the NRCA is classified as AP600 Equipment Class E (non-safety-related). However, drains near safety-related equipment are classified as seismic Category II if their collapse or failure could adversely affect safety-related equipment.

Based on the evaluation of the information provided in the SSAR, and subject to the resolution of the open item below, the staff concludes that Westinghouse has properly identified all equipment important to safety inside the NRCA, has properly identified all flood hazards inside the NRCA, and has provided adequate means of protecting all equipment important to safety from the identified flood hazards inside the NRCA.

The safe shutdown equipment located in RCAs are primarily containment isolation valves located near the containment vessel and above the maximum flood level for the area. These valves are either normally closed or are closed during a safe shutdown operation.

Flood sources in the RCA include CCW, central chilled water, hot water, spent fuel pit cooling, normal RHR, and CVCS. Flood water which results from component failures in the RCA is directed to the level 1 drain collection sump via the vertical pipe chase, floor gratings, floor drains, stairwells, and elevator shafts. The maximum anticipated water height due to water accumulation on Level 1 is less than 17 inches (43 cm). There is no safety-related equipment on Level 1. Safety-related equipment in the RCA is located on Level 2 and at the upper levels of the vertical pipe chase. Because flood water is directed to Level 1, there is little accumulation of water in the RCAs at higher levels inside the building. The maximum anticipated flood level in areas which contain safety-related equipment is 4". HVAC duct penetrations in the walls in these areas are above this level. Therefore, safety-related systems and equipment in the RCA in the auxiliary building are protected from the effects of flooding.

No credit is taken for drains in the RCA and therefore are classified as AP600 Equipment Class D (non-safety-related). However, drains near safety-related equipment are classified as seismic Category II if their collapse or failure could adversely affect safety-related equipment.

FPS, DMWS, and CVS are open-cycle systems which enter the RCA. The FPS has the largest volume. All water drains to the lowest level where no safe shutdown equipment is located. Safety-related valves are located above the 82'-6" elevation. If the contents of both fire water storage tanks were emptied into the building, the resulting flood height would be less than 82'-6".

Some doorways between the auxiliary building and the adjacent turbine, annex I, annex II, and radwaste buildings are double doors located above grade elevation. These doors are not water tight. Water from internal flooding in areas adjacent to the auxiliary building is directed away from or prevented from entering the auxiliary building.

The design of the auxiliary building is such that water from internal flooding in areas adjacent to the building is directed away from or prevented from entering the building.

The containment and auxiliary building, which house all safety-related equipment, have a common basemat and there are no below-grade tunnels between these buildings and any other buildings.

As stated above, open cycle systems serve the containment, RCA, and NRCA. The Fire Protection System (FPS) and demineralized water system (DMWS) are open-cycle systems that enter the containment. These systems are isolated during plant operation and are not a potential flooding source. The FPS is an open-cycle system that enters the mechanical equipment area of the NRCA. Fire water will drain from this area to the turbine building or annex I building. FPS and DMWS are open-cycle systems that enter the electrical equipment area of the NRCA. The maximum diameter of the DMWS piping is 1" and therefore is not considered a credible flooding source. As stated earlier, dry pre-action sprinklers with a limited water volume are used in the non Class 1E electrical equipment area and have no effect on safe shutdown capability. Limited water volume hose stations are used in the Class 1E electrical equipment areas. FPS, DMWS, and CVS are open-cycle systems which enter the RCA. The FPS has the largest volume. All water drains to the lowest level where no safe shutdown equipment is located. Safety-related valves are located above the 82'-6" elevation. If the contents of both fire water storage tanks were emptied into the building, the resulting flood height would be less than 82'-6".

Based on the evaluation of the information provided in the SSAR, and subject to the resolution of the open item below, the staff concludes that Westinghouse has properly identified all equipment important to safety inside the RCA, has properly identified all flood hazards inside the RCA, and has provided adequate means of protecting all equipment important to safety from the identified flood hazards inside the RCA.

Based o[illegible] the [illegible]luation [illegible] the information provided in the SSAR, and subj[illegible] to resolution of the open item identified below, the staff concludes that

Westinghouse has provided adequate features in the AP600 design to ensure that systems important to safety will be adequately protected from flood-related effects associated with both natural phenomena and system failures. Therefore, the staff concludes that the AP600 design meets the requirements of GDC 2 as it relates to protecting structures, systems, and components (SSCs) important to safety from the effects of floods.

The AP600 design does not use a permanent dewatering system. The SSAR states that the need for a permanent dewatering system is site-specific and will be determined by the COL applicant. This is acceptable.

The applicant referencing the AP600 design is responsible for identifying external flood and precipitation hazards beyond those assumed in the AP600 flood analysis and providing adequate protective features to ensure that equipment important to safety is adequately protected from these hazards. In addition, the COL applicant must verify that the as-built design conforms with the certified design.

During staff review of flood protection for the AP600 standard design, several issues were identified which require resolution. These issues include:

1. Incorporation of RAI responses into the SSAR.

2. Provide information regarding flood protection for systems classified under Regulatory Treatment of Non-Safety Systems and Defense-in-Depth systems.

3. Correction of RAI responses.

4. COL applicant responsibilities.

5. Conformance with RGs.

6. Discrepancies in the SSAR.

7. Design requirements for instrumentation.

8. Locations and design requirements for certain isolation valves and structural walls.

9. Design requirements for drains.

10. Backflow protection from buildings not housing safety-related equipment to buildings housing safety-related equipment.

11. Interconnecting tunnels between buildings

Collectively, these issues constitute Open Item 3.4.1-1.

The flood protection review included all systems and components whose failure could prevent safe shutdown of the plant and maintainance thereof, or result in significant uncontrolled release of radioactivity. Based on the review of the proposed design criteria, design bases, and safety classifications for safety-related SSC necessary for a safe plant shutdown during and following the flood condition from either external or internal causes, and subject to satisfactory resolution of the open item identified above, the staff concludes that the design of the facility for flood protection conforms to the Commissions regulations as set forth in General Design Criteria 2 and 10 CFR Part 100 Appendix A. This conclusion is based on the ability of the design to protect SSC important to safety from the effects of floods by:

(a) meeting RG 1.59 Position C.1 regarding the conditions used for design of SSCs important to safety for the worst site-related flood probable at a nuclear power plant and Position C.2 regarding [alternatives to hardened protection of SSC important to safety].

(b) meeting RG 1.102 Position C.1 regarding the type of flood protection provided and C.2 regarding provision of guidance in establishing shutdown technical specfications and emergency operating procedures related to flooding.

(c) The method used by the AP600 design for protection of SSC important to safety from flooding from external and internal causes has been reviewed by the staff and found acceptable, and

(d) Protecting safety-related SSCs from external and internal flooding by locating systems and components in individual flood-proof enclosures.

The staff also concludes that, subject to resolution of the above open item, those systems that have been determined to be risk significant as identified through the analysis described in SECY-94-084 regarding the regulatory treatment of non-safety systems in passive plants have been provided with design features appropriate for their risk significance.

As a result, the staff concludes that the AP600 design meets the requirements of GDC 2 and 10 CFR Part 100, Appendix A, Section IV.C as they relate to protecting structures, systems, and components (SSCs) important to safety from the effects of external and internal floods. The staff also concludes that those systems that have been determined to be risk significant as identified through the analysis described in SECY-94-084 regarding the regulatory treatment of non-safety systems in passive plants have been provided with design features appropriate for their risk significance.

Consequently, the staff concludes that the AP600 design meets the guidelines of SRP Section 3.4.1 and is acceptable, subject to satisfactory resolution of the open item above.

3.5 Missiles

General Design Criteria (GDC) 4 requires that SSCs important to safety be protected from the effects of missiles. Missiles may be generated by pressurized components, rotating machinery, explosions, tornadoes, transpotation accidents, and dropped loads. In the AP600 design, protection of SSCs from these missiles is achieved by minimizing the sources of the missiles and by arranging structures and equipment so as to minimize or prevent missile damage.

Westinghouse provided criteria for identification of missiles and protection requirements for equipment as well as an evaluation procedure to determine if the identification criteria and protection requirements have been met.

3.5.1.1 Internally-generated Missiles (Outside Containment)

The staff reviewed the AP600 design for protecting SSCs important to safety against internally-generated missiles outside the containment in accordance with SRP Section 3.5.1.1. Specifically, the review included the missile protection design features for the SSCs whose failure could prevent safe shutdown of the facility or result in significant uncontrolled release of radioactivity. The SRP acceptance criteria specify that the design meet GDC 4, "Environmental and Dynamic Effects Design Bases," as it relates to protecting the SSCs outside the containment against the effects of missiles that can be internally generated during facility operation. Acceptance is based on meeting the guidelines of RG 1.115, "Protection Against Low-Trajectory Turbine Missiles," Positions C.1 and C.3 as they relate to the identification and protection of SSC important to safety from the effects of turbine missiles and staff verification that safety-related SSCs are protected from internally-generated missiles outside containment by location in missile-proof structures or by special localized protective shields or barriers. The staff review of turbine-generator missiles is provided in Section 3.5.1.3 of this report. This review included all areas outside the containment that are within the scope of the AP600 design.

SSAR Section 3.5.1.1.2.1 discusses the criteria used to justify why missiles are not considered credible:

(1) Catastrophic failure of safety-related rotating equipment is not considered a credible missile generation source because the components have insufficient energy to move the masses of their rotating parts through their housings. Also, material characteristics, inspections, quality control during fabrication and construction, and prudent operation also ensure that this equipment does not become a credible source of missiles.

(2) Catastrophic failure of non-safety-related rotating equipment is not considered a credible missile generation source when measures are used that are similar for those of safety-related rotating equipment. Separation is normally used to protect safety-related equipment from non-safety-related equipment. Non-safety-related rotating equipment located in compartments with safety-related equipment are designed with

a housing, barrier, or enclosure to retain missile fragments associated with a failure of the rotating component.

(3) Protection from missiles generated as a result of the failure of the turbine generator are discussed in SSAR Section 3.5.1.3 and evaluated in Section 3.5.1.3 of this report. The turbine generator is located in the turbine building with thick concrete structural walls separating it from safety-related equipment in containment and in the auxiliary building. These walls protect the equipment from turbine generator missiles. In addition, the orientation of the turbine generator is such that all safety-related structures, systems, and components are located outside the high-velocity, low-trajectory missile strike zone as defined in RG 1.115.

(4) Missiles generated from non-high-energy fluid systems are not considered credible due to insufficient stored energy within the system.

(5) Missiles generated by the valve bonnets of pressure-seal, bonnet-type valves and of bolted bonnet-type valves are not considered credible because the valves are constructed in accordance with ASME Code, Section III requirements.

(6) Valve stems are not considered credible missiles if at least one feature (in addition to the stem threads) is included in their design to prevent ejection (e.g. backseats, valve actuators, etc.)

(7) Nuts, bolts, nut and bolt combinations, and nut and stud combinations are not considered credible missile sources because of limited stored energy.

(8) Thermowells and other fittings welded to piping or pressurized equipment are not considered credible missile sources where the welded joint is stonger than the parent metal.

(9) Missiles generated as a result of ASME Code, Section III vessel ruptures are not credible due to conservative design and fabrication measures.

(10) Rotating components which operate less than 2% of the plant operating time are not considered credible sources of missiles because of the limited risk for missile generation.

(11) Missiles generated from hydrogen explosions are not considered credible due to the design of systems which use or generate hydrogen. Battery compartments are well ventilated, hydrogen bottles have a limited release volume, and storage areas for plant gases are located away from the nuclear island.

The staff finds this criteria acceptable.

There is no safety-related equipment which requires protection from internally generated missiles outside containment since the AP600 design has no credible missile sources as defined above.

SSAR Section 3.5.1.1.2.4 states that all safe shutdown systems are located inside containment and are protected from missiles generated outside containment (including turbine generator missiles) by thick reinforced concrete walls. Missile sources outside the containment which could adversely effect safety-related equipment is limited to a few rotating components (fans, pumps, compressors, etc.) in the auxiliary building. Rotating components in the auxiliary building are not considered credible sources of missiles for one or more of the reasons stated above. This section further states that the portion of the CVS from the makeup pumps to the containment and system isolation valves is a high-energy system inside the auxiliary building that contains pressurized components in the high-energy portions of the system that are not constructed to ASME Code, Section III requirements.

3.5.1.1.2.4 also states that the outlet pipes, valves, and attached piping for the MCR habitability system (VES) high-pressure air storage bottles meet ASME Code, Section III standards and are designed for seismic loads.

Secondary missiles (e.g. concrete fragments) are considered in barrier design (see Section 3.5.3 of the SSAR). The consequences of scabbing are evaluated if the wall thickness is less than the minimum thickness to preclude scabbing. The exterior walls above grade and the roof of the nuclear island structures are 24" and 15", respectively. These thicknesses exceed the minimum thickness to preclude scabbing due to a tornado missile strike. Typical structural concrete interior walls are 24" thick. Based on this information, and subject to resolution of the open item below, the staff concludes that interior wall thicknesses are sufficient to prevent scabbing and the subsequent generation of secondary missiles.

The AP600 design provides physical separation between safety-related equipment and nonseismic SSCs to the extent practicable. Any nonseismic component identified as a potential missile source is evaluated in accordance with the guidelines of SSAR Section 3.7.3.13 and appropriate protection provided. SSAR Section 3.7.3.13 provides criteria and guidelines for evaluating the interaction between seismic Category I systems and nonseismic systems.

The concentration of hydrogen in areas outside containment was considered. The maximum postulated volume percent of hydrogen outside containment is ~4.4%. This occurs as a result of a break in the hydrogen supply line from the hydrogen storage area to the CVS. This concentration assumed that the break occurs in the most limiting area of the auxiliary building (the valve/piping penetration room) and assumes uniform mixing. Because this concentration is within the limits of NUREG/CR-2017 [TITLE], a failure of this line will not result in hydrogen concentrations which could lead to an explosion.

Movements of heavy loads are controlled to protect safety-related SSCs, as discussed in SSAR Section 9.1.5. Gas storage cylinders and attached valves and piping can generate missiles if struck by a dropped object. The only gas storage bottles in the the auxiliary building are the air storage bottles for the VES. As stated earlier, these bottles are constructed in accordance with ASME Code, Section III standards. In addition, the bottles are housed in a steel frame and located in an area with no activity directly above. Based on this information, the staff concludes that safety-related equipment is adequately protected from gravitational missiles outside containment.

The remote shutdown workstation (RSW) is located in the non-radiologically controlled area (NRCA) of the auxiliary building in its own compartment. The RSW is separated from rotating and pressurized equipment by the compartment walls and the auxiliary building outside wall. Therefore, the RSW is protected from internally generated missiles. The MCR is similarly situated on elevation 117'-6" of the auxiliary building and is also protected from internally generated missiles.

Based on the above information, and subject to resolution of the open item below, the staff concludes that safety-related equipment is protected from the effects of internally generated missiles outside containment by minimizing the sources of credible missiles, designing potential missile sources so that missiles are contained, and separation of safety-related equipment and vital areas from potential missile sources.

Position C.1 of RG 1.115 states that safety-related systems should be protected against low-trajectory missiles from failed TG sets. This is accomplished in the AP600 design by placing all safety-related equipment outside the TG missile strike zone.

Position C.3 of RG 1.115 states that when protection of safety-related systems is provided by barriers, dimension plans and layout drawings should include information on wall and slab thicknesses and materials of pertinent structures. Protection is acceptable if no missile can compromise the final barrier protecting the SR system. As stated earlier, minimum wall thicknesses were evaluated in SSAR Section 3.5.3. The wall thicknesses were determined to be greater than the minimum necessary to contain an internally generated missile and therefore protect safety-related systems from these missiles.

Based on the information provided in the SSAR and in the responses to RAIs, the staff concludes that the AP600 design meets the guidelines of RG 1.115, Positions C.1 and C.3 as they relate to protection of safety-related equipment from the effects of internally generated missiles outside containment.

During staff review of missile protection for the AP600 standard design, several issues were identified which require resolution. These issues include:

1. Incorporation of RAI responses into the SSAR.

2. Provide information regarding missile protection for systems classified under Regulatory Treatment of Non-Safety Systems and Defense-in-Depth systems.

3. Discrepancies between the SSAR and RAI responses.

4. Nonconservatisms in missile evaluation.

Collectively, these issues constitute Open Item 3.5.1.1-1.

The staff review of possible effects of internally-generated missiles outside containment included structures, systems, and components whose failure could prevent safe shutdown of the plant or result in significant uncontrolled release of radioactivity. Based on the review of the AP600 design bases and criteria for safety-related SSCs necessary to maintain a safe plant shutdown, the staff concludes that the SSCs to be protected from internally-generated missiles outside containment meet the requirements of GDC 4. This conclusion is based on the staff determination that the AP600 design:

1. meets Positions C.1 and C.3 of RG 1.115 as they relate to the identification and protection of SSCs important to safety from the effects of turbine missiles,

2. has used methods for identification of potential sources of internal missiles and for demonstrating the adequacy of the protection provided which have been reviewed by the staff and found acceptable, and

3. has shown that safety-related SSC functions will be protected from internally generated missiles outside containment by locating the systems or components in individual missile-proof structures.

As a result of the staff review of the information provided in the AP600 SSAR and the responses to RAIs, the staff concludes that the AP600 design meets the requirements of GDC 4 as it relates to the protection of safety-related equipment from the effects of internally generated missiles inside containment. The staff also concludes that those systems that have been determined to be risk significant as identified through the analysis described in SECY-94-084 regarding the regulatory treatment of non-safety systems in passive plants have been provided with design features appropriate for their risk significance.

Therefore, the staff concludes that the AP600 design meets the guidelines of SRP 3.5.1.1 and is acceptable, subject to satisfactory resolution of the open item identified above.

3.5.1.2 Internally-Generated Missiles (Inside Containment)

The staff reviewed the AP600 design for protecting SSCs important to safety against internally-generated missiles inside the containment in accordance with SRP Section 3.5.1.2. Specifically, the review included the missile protection design features for the SSCs whose failure could prevent safe shutdown of the facility or result in significant uncontrolled release of radioactivity. The SRP acceptance criteria specify that the design meet GDC 4, "Environmental and Dynamic Effects Design Bases," as it relates to protecting the SSCs important to safety against the effects of internally generated missiles inside containment.

SSAR Section 3.5.1.2 provides a discussion of the methodolgy used to identify credible missile sources inside containment and the features provided in the

AP600 design to protect safety-related equipment from the effects of these missiles.

SSAR Section 3.5.1.2.1.1 discusses the criteria used to justify why missiles are not considered credible:

(1) Reactor coolant pump (RCP) design requirements are such that missiles generated as a result of pump failure are retained in the casing.

(2) Catastrophic failure of safety-related rotating equipment is not considered a credible missile generation source because the components have insufficient energy to move the masses of their rotating parts through their housings. Also, material characteristics, inspections, quality control during fabrication and construction, and prudent operation also ensure that this equipment does not become a credible source of missiles.

(3) Catastrophic failure of non-safety-related rotating equipment is not considered a credible missile generation source when measures are used that are similar for those of safety-related rotating equipment. Separation is normally used to protect safety-related equipment from non-safety-related equipment. Non-safety-related rotating equipment located in compartments with safety-related equipment are designed with a housing, barrier, or enclosure to retain missile fragments associated with a failure of the rotating component.

(4) Failure of the reactor vessel, steam generators, pressurizer, core makeup tanks, accumulators, RCP castings, passive RHR heat exchangers, and associated piping are not considered to be credible missile sources due to conservative design, fabrication, and operation.

(5) A control rod drive ejection or the creation of a missile from part of the control rod drive mechanism housing are not considered to be credible missile sources due to conservative design, fabrication, and testing.

(6) Missiles generated from non-high-energy fluid systems are not considered credible due to insufficient stored energy within the system.

(7) Missiles generated by the valve bonnets of pressure-seal, bonnet-type valves and of bolted bonnet-type valves are not considered credible because the valves are constructed in accordance with ASME Code, Section III requirements.

(8) Valve stems are not considered credible missiles if at least one feature (in addition to the stem threads) is included in their design to prevent ejection (e.g. backseats, valve actuators, etc.)

(9) Nuts, bolts, nut and bolt combinations, and nut and stud combinations are not considered credible missile sources because of limited stored energy

(10) Thermowells and other fittings welded to piping or pressurized equipment are not considered credible missile sources where the welded joint is stonger than the parent metal.

(11) Hydrogen is supplied by the CVS inside containment. In the event of a supply line failure, the hydrogen released to the containment is limited to the contents of one hydrogen bottle. This amount of hydrogen would not lead to an explosion.

(12) Pressurized components in the high-energy portions of the high energy systems inside containment are constructed to ASME Code, Section III standards.

(13) There are no high-pressure gas storage containers inside containment. The only gas cylinders located inside containment are the gas accumulators associated with the fourth stage automatic depressurization system (ADS) valves. These accumulators are designed and constructed in accordance with ASME Code, Section III standards.

(14) Rotating equipment used less than 2% of the plant operating time (e.g. reactor coolant drain pumps, containment sump pumps, motors for valve operators, and mechanical handling equipment) are not considered credible missile sources because of the limited risk for missile generation.

(15) Rotating equipment located in enclosures which will contain missile fragments are not considered credible missile sources.

(16) Non-safety-related equipment in compartments with safety-related equipment [RTNSS,DID] and have design requirements for the housing or an enclosure to retain missile fragments from postulated failures.

There is no safety-related equipment which requires protection from internally generated missiles inside containment since the AP600 design has no credible missile sources as defined above.

No sources of primary or secondary missiles inside containment have been identified from which safety-related equipment must be protected. A limited number of fans inside containment have the needed design provisions to ensure that they are not a potential missile source. Secondary missiles are discussed in SSAR Section 3.5.3.

Movements of heavy loads are controlled to protect safety-related SSCs as discussed in SSAR Section 9.1.5. In addition, movement of heavy loads inside containment occur during shutdown conditions when most high-energy systems are depressurized. The gas accumulators mentioned earlier are protected from dropped objects by its supporting structure.

Loads greater than that of a new fuel assembly and its associated handling tool are prevented from being routed over the new and spent fuel racks, as stated in SSAR Section 9.1.1.2. Load drop analyses are performed on the new and spent fuel racks which demonstrate that the racks can withstand the loads associated with a dropped fuel (or control rod) assembly and its associated handling tool from a height of 3 feet (0.91 meters). Loads heavier than this are not moved over the fuel racks.

Safety-related SSCs inside containment are protected from nonseismic SSCs inaccordance with the evaluation guidelines in SSAR Section 3.7.3.13.

The MCR (located in the auxiliary building) is protected from missiles generated inside the containment by the structural concrete walls, roof, and floors of the auxiliary building. Similar protection is provided for the remote shutdown workstation (RSW).

During staff review of missile protection for the AP600 standard design, several issues were identified which require resolution. These issues include:

1. Incorporation of RAI responses into the SSAR.

2. Provide information regarding missile protection for systems classified under Regulatory Treatment of Non-Safety Systems and Defense-in-Depth systems.

3. Consideration of all postulated missiles.

Collectively, these issues constitute Open Item 3.5.1.2-1.

Based on the information provided in the SSAR, and subject to resolution of the open item above, the staff concludes that the Westinghouse has properly identified those structures, systems, and components which require protection from internally generated missiles inside containment, has identified potential sources of missiles inside containment, and has incorporated proper features into the AP600 design to protect safety-related equipment from the effects of these missiles. Therefore, the staff concludes that the AP600 design meets the requirements of GDC 4 as it relates to protecting the SSCs important to safety against the effects of internally generated missiles inside containment.

This review of possible effects of internally-generated missiles inside containment included structures, systems, and components whose failure could prevent safe shutdown of the plant or result in significant uncontrolled release of radioactivity. Based on the review of the AP600 design bases and criteria for safety-related SSCs necessary to maintain a safe plant shutdown, the staff concludes that the SSCs to be protected from internally-generated missiles inside containment meet the requirements of GDC 4. This conclusion is based on the staffs determination that the AP600 design:

1. has used methods for identification of potential sources of internal missiles and for demonstrating the adequacy of the protection provided which have been reviewed by the staff and found acceptable, and

2. has shown that safety-related SSC functions will be protected from internally generated missiles inside containment by locating the systems or components in individual missile-proof structures.

Therefore, as a result of the staff review of the information provided in the AP600 SSAR and the responses to the RAIs, the staff concludes that the AP600 design meets the requirements of GDC 4 as it relates to the protection of safety-related equipment from the effects of internally generated missiles inside containment. The staff also concludes that those systems that have been determined to be risk significant as identified through the analysis described in SECY-94-084 regarding the regulatory treatment of non-safety systems in passive plants have been provided with design features appropriate for their risk significance.

Therefore, the staff concludes that the AP600 design meets the guidelines of SRP 3.5.1.2 and is acceptable, subject to satisfactory resolution of the open item above.

3.5.1.4 Missiles Generated by Natural Phenomena

The staff reviewed the design of the facility for protecting SSCs important to safety from missiles generated by natural phenomena in accordance with SRP Section 3.5.1.4. The SRP acceptance criteria specify that the design meet GDC 2 and 4. GDC 2 requires that SSCs important to safety be protected from the effects of natural phenomena. GDC 4 requires that SSCs important to safety be designed to accommodate the effects of, and to be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents (LOCAs). The design is considered to be in compliance with GDC 2 and 4 if it meets the guidelines of RG 1.76, "Design Basis Tornado for Nuclear Power Plants," Positions C.1 and C.2, and RG 1.117, "Tornado Design Classification," Positions C.1 through C.3.

The regulatory position of RG 1.76 has been reevaluated by an NRC contractor using more recent tornado data. The contractors reevaluation is documented in NUREG/CR-4664, "Tornado Climatology of the Contiguous United States," dated May 1, 1988. The contractor found that the tornado strike probabilities range from near 10^{-7} per year for much of the western United States to about 10^{-3} per year in the central United States. The wind speeds associated with a tornado having a strike probability of 10^{-7} range from less than 350 km/hr (153 mph) to 600 km/hr (332 mph). These wind speed estimates are 54 to 180 km/hr (30 to 100 mph) lower than the speed estimates presented in WASH-1300 and RG 1.76 for most of the United States. The contractor concluded in its report that it would be reasonable to reduce DBT wind speeds to 360 km/hr (200 mph) for the United States west of the Rocky Mountains and to 540 km/hr (300 mph) for the United States east of the Rocky Mountains. The staff accepted the revised tornado parameters.

SSAR Section 3.3.2.1 provides the design parameters for the Design Basis Tornado (DBT):

- Maximum wind speed - 483 km/hr (300 mph)

- Maximum rotational speed - 386 km/hr (240 mph)
- Maximum translational speed - 97 km/hr (60 mph)
- Radius of maximum rotational wind from center of DBT - 46 m (150 feet)
- Atmospheric pressure drop - 14 kPa (2.0 psi)
- Rate of pressure change - 8 kPa/sec (1.2 psi/sec)

According to RG 1.76, Position C.2, if a DBT is proposed which has characterisitics less conservative than those for the DBT in Position C.1 of RG 1.76, a comprehensive analysis should be provided to justify the selection of the less conservative DBT. As discussed above, an analysis has been provided and documented in NUREG/CR-4664 to support modifications in the maximum wind speed for the DBT. The atmospheric pressure drop has also been modified from 2.25 psi in RG 1.76 to 2.0 psi to be consistent with the lower maximum wind speed. The estimated DBT missile strike probability for wind speeds greater than the 483 km/hr (300 mph) DBT is between 10^{-6} and 10^{-7} per year for the AP600 design at a worst location anywhere within the contiguous United States. The staff finds this acceptable.

SSAR Section 3.5.1.4 identified the missiles associated with the DBT. Specifically, safety-related equipment is protected from:

- A massive high-energy missiles defined as a 1800 kg (4000 lb) automobile impacting the structure housing the safety-related equipment with a horizontal velocity of 169 kph (105 mph) or a vertical velocity of 119 kph (74 mph). The missile is considered at all elevations up to 9 m (30 feet) above grade.

- A rigid missile of a size sufficient to test penetration resistance. This is assumed to be a 125 kg (275-lb), 20 cm (8 inch) armor-piercing artillery shell impacting on the structure housing the safety-related equipment at normal incidence with the horizontal and vertical velocities identified above.

- A small rigid missile able to pass through openings in protective barriers. This is assumed to be a 2.5 cm (1 inch) diameter solid steel sphere impinging on on barrier openings in the most damaging direction at 169 kph (105 mph).

These missiles are identified as Spectrum I missiles in Subsection III.4 of SRP Section 3.5.1.4. Because the postulated missiles proposed by Westinghouse in the AP600 design meet the guidelines in the SRP, the staff finds the proposed missiles acceptable as the standard from which safety-related equipment must be protected.

SSAR Section 3.5.4 states that the applicant referencing the AP600 design must demonstrate that the site satisifies the interface requirements provided in SSAR Section 2.2. This requires an evaluation of external events which may generate missiles that are more hazardous than missiles generated by the DBT along with an assessment of the capability of the AP600 design to accommodate the additional missile hazard.

Based on this information, and subject to resolution of the open item identified below, the staff concludes that Westinghouse has identified an acceptable DBT which meets the revised DBT guidelines and has provided adequate guidance to an applicant referencing the AP600 design regarding assessment of external missile hazards beyond those postulated for the AP600 design. Therefore, the staff concludes that the AP600 design conforms with the guidelines of RG 1.76 as they relate to the identification of an acceptable DBT.

Positions C.1 through C.3 of RG 1.117 identify SSCs important to safety that should be protected from the effects of a DBT. Respectively, these include:

(1) Those SSCs necessary to ensure the integrity of the RCPB.

(2) Those SSCs necessary to ensure the capability to shut down the reactor and maintain it in a safe shutdown condition (including hot standby and cold shutdown).

(3) Those SSCs whose failure could lead to radioactive releases resulting in calculated offsite exposures greater than 25% of the guideline exposures of 10 CFR Part 100.

Safety-related equipment is located within seismic Category I structures (the containment and auxiliary buildings) on the nuclear island. The thickness of the exterior walls and roof of these structures are adequate to prevent missile perforation and scabbing by the missiles identified in SSAR Subsection 3.5.1.4 and, therefore, provide protection for the safety-related systems and components from missiles generated by natural phenomena.

Both the MCR and the RSW are located inside structures with exterior walls, roofs, and floors designed to withstand a missile generated by the DBT phenomena.

Based on this information, and subject to the resolution of the open item identified below, the staff concludes that structures, systems, and components important to safety in the AP600 design have been identified and are housed in seismic Category I structures designed to withstand the effects of natural phenomena. Therefore, the staff concludes that the AP600 design conforms with the guidelines of Positions C.1 through C.3 of RG 1.117.

As a result of information provided in the SSAR and in response to RAIs, the staff concludes that the AP600 design conforms to the guidelines of RGs 1.76 and 1.117, and, therefore, to the requirements of GDC 2 and 4.

During staff review of missile protection for the AP600 standard design, several issues were identified which require resolution. These issues include:

1. Incorporation of RAI responses into the SSAR.

2. Provide information regarding missile protection for systems classified under Regulatory Treatment of Non-Safety Systems and Defense-in-Depth systems.

Collectively, these issues constitute Open Item 3.5.1.4-1.

The basis for staff acceptance of the AP600 design is the conformance of the design and design criteria for protection of SSCs from the effects of natural phenomena to the Commission's regulations as set forth in the General Design Criteria, and to the applicable regulatory guides.

The staff concludes that the assessment of possible hazards due to missiles generated by the DBT is acceptable and conforms to the requirements of GDC 2 and GDC 4 as they relate to tornado-generated missiles. This conclusion is based on the AP600 design meeting:

(1) RG 1.76, Positions C.1 and C.2, as it relates to the criteria for determining the Design Basis Tornado, and

(2) RG 1.117, Positions C.1 through C.3, as it relates identification of SSCs important to safety that should be protected from the Design Basis Tornado.

Therefore, the staff finds that the design meets the requirements of GDC 2 as it relates to protection of SSCs important to safety from the effects of natural phenomena, and GDC 4 as it relates to the ability of SSCs important to safety to accommodate the effects of, and be compatible with, the environmental conditions associated with normal plant operation and accidents conditions. The staff also concludes that those systems that have been determined to be risk significant as identified through the analysis described in SECY-94-084 regarding the regulatory treatment of non-safety systems in passive plants have been provided with design features appropriate for their risk significance.

Based on the review of the information, the staff concludes that the AP600 design conforms to the guidelines of SRP Section 3.5.1.4 and is acceptable, subject to satisfactory resolution of the open item identified above.

3.5.2 Externally-Generated Missiles

The staff reviewed the AP600 design for its ability to protect SSCs important to safety against externally-generated missiles in accordance with SRP Section 3.5.2. The SRP acceptance criteria specify that the design must meet GDC 2, "Design Bases for Protection Against Natural Phenomena" and GDC 4, "Environmental and Dynamic Effects Design Bases." The design is considered to be in compliance with GDC 2 and 4 if it meets RG 1.13, "Spent Fuel Storage Facility Design Basis," as it relates to the capability of the spent fuel pool systems and structures to withstand the effects of externally-generated missiles and prevent missiles from contacting stored fuel assemblies; RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants" as it relates to the capability of the ultimate heat sink and connecting conduits to withstand the effects of externally-generated missiles; RG 1.115, "Protection Against Low-Trajectory

Turbine Missiles" as it relates to the protection of SSCs important to safety from the effects of turbine missiles; and RG 1.117, "Tornado Design Classification," as it relates to the protection of SSCs important to safety from the effects of tornado missiles. Protection of low-trajectory turbine missiles, including compliance with RG 1.115, is discussed in Section 3.5.1.3 of this report.

SSAR Section 3.5.2 identifies the systems and areas that must be protected from the effects of externally-generated missiles and states that the safety class, seismic category, and quality group of these systems are identified in SSAR Section 3.2. In addition, systems required for safe shutdown can be found in SSAR Chapter 7. Specifically, SSAR Section 7.4 and Table 7.4-1 identify the AP600 systems that are required for safe shutdown.

Based on information provided in SSAR Table 3.2-3, all safe shutdown systems are located in the containment or the auxiliary building. These buildings are seismic Category I structures designed to withstand the effects of the worst case externally-generated missiles which occur as a result of the DBT as discussed in SSAR Sections 3.3 and 3.5.1.4 and reviewed in Section 3.5.1.4 of this report.

As discussed in Section 3.5.1.4 of this report, the AP600 design conforms with the guidelines of Positions C.1 through C.3 of RG 1.117 regarding identification of SSCs important to safety which must be protected from the DBT. Based on the information in Section 3.5.1.4 of this report, and subject to resolution of the open item in that section as well as the open item below, the staff concludes that Westinghouse has adequately identified all systems important to safety which require protection from externally-generated missiles.

The guidelines of Position C.2 of RG 1.13 state that the spent fuel facility should be designed to (a) keep tornadic winds, and missiles generated by these winds, from causing significant loss of the watertight integrity of the fuel storage pool and (b) keep missiles generated by tornadic winds from contacting fuel within the pool. SSAR Section 9.1.2 states that the spent fuel storage facility is located in the seismic Category I auxiliary building and is protected from the effects of tornadic winds, missiles generated by these winds, and other natural phenomena. Missiles generated by external events beyond those postulated for the design will be identified by the applicant referencing the AP600 design and will provide the design features necessary to protect SSCs important to safety from the identified hazard. Based on this information, the staff concludes that Westinghouse has provided adequate external missile protection for the spent fuel facility and conforms with the guidelines of Position C.2 or RG 1.13.

The outside environment serves as the Ultimate Heat Sink (UHS) for the AP600 design and cannot be lost due to externally-generated missiles. Therefore, the design meets the guidelines of RG 1.27, Positions C.2 and C.3 and is acceptable.

As was stated in Section 3.5.1.1 of this report, protection from missiles generated as a result of the failure of the turbine generator are discussed in

SSAR Section 3.5.1.3, and are evaluated in Section 3.5.1.3 of this report. The turbine generator is located in the turbine building with thick concrete structural walls separating it from safety-related equipment in containment and in the auxiliary building. These walls protect the equipment from turbine generator missiles. In addition, the orientation of the turbine generator is such that all safety-related structures, systems, and components are located outside the high-velocity, low-trajectory missile strike zone as defined in RG 1.115. Therefore, based on this information, the staff concludes that safety-related equipment is adequately protected from missiles generated by the failure of the turbine generator. Therefore, the AP600 design meets the guidelines of Position C.1 of RG 1.115.

Subject to resolution of the open item identified below, the staff concludes that the AP600 design conforms with the applicable guidelines of RGs 1.13, 1.27, 1.115, and 1.117 and therefo meets the requirements of GDC 2 as it relates to the protection of SSCs important to safety from the effects of natural phenomena, and GDC 4 as it relates to the ability of SSCs important to safety to accommodate the effects of environmental conditions associated with normal plant operations and accident conditions.

During staff review of missile protection for the AP600 standard design, several issues were identified which require resolution. These issues include:

1. Incorporation of RAI responses into the SSAR.

2. Provide information regarding missile protection for systems classified under Regulatory Treatment of Non-Safety Systems and Defense-in-Depth systems.

3. SSAR discrepancies.

Collectively, these issues constitute Open Item 3.5.2-1.

The staff review of SSCs to be protected from externally-generated missiles included all safety-related SSCs provided to support the facility. Based on the review of the AP600 design criteria, design bases, and safety classifications for SSC necessary for safe reactor shutdown, the staff concludes that the SSCs to be protected from externally generated missiles meet the requirements of GDC 2 and 4. This conclusion is based on:

- identifying all SSCs requiring protection against the effects of externally-generated missiles.

- meeting Position C.2 of RG 1.13 by preventing missiles generated by tornado winds from causing significant loss of watertight integrity of the spent fuel pit.

- meeting Positions C.2 and C.3 of RG 1.27 so that the UHS is capable of withstanding the effects of externally-generated missiles.

- meeting Position C.1 of RG 1.115 such that safety-related systems are protected from low-trajectory turbine missiles by proper turbine orientation or by missile barriers.

- meeting Positions C.1 through C.3 of RG 1.117 such that SSCs important to safety are protected from the effects of missiles generated by the DBT by providing missile barriers for components, locating redundant systems or components in missile-protected structures, or by underground locations at a depth sufficient to protect against missiles.

The staff also concludes that those systems that have been determined to be risk significant as identified through the analysis described in SECY-94-084 regarding the regulatory treatment of non-safety systems in passive plants have been provided with design features appropriate for their risk significance.

Therefore, the staff concludes that the AP600 design conforms with the guidelines of SRP 3.5.2 and is acceptable, subject to satisfactory resolution of the open item above.

3.6.1 Piping Failures Outside Containment

The staff reviewed the AP600 design as it relates to protection of SSCs important to safety against postulated piping failures in fluid systems outside the containment (but within the AP600 design scope) in accordance with SRP Section 3.6.1. The SRP acceptance criteria specify that the design meet GDC 4, "Environmental and Dynamic Effects Design Bases," as it relates to accommodating the dynamic effects of postulated pipe rupture, including the effects of pipe whipping and discharging fluids. The design is considered to be in compliance with GDC 4 if it conforms to Branch Technical Position (BTP) ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," and BTP MEB 3-1, "Postulated Rupture Locations in Fluid System Piping Inside and Outside Containment," with regard to high- and moderate-energy fluid systems outside the containment.

SSAR Section 3.6.1 provides the design bases and criteria for the analysis required to demonstrate that safety-related systems are protected from pipe failures. It lists the high- and moderate-energy systems which are potential sources of dynamic effects and provides separation criteria.

Evaluation of the dynamic effects of postulated breaks in the reactor coolant loop, reactor coolant loop branch lines, main steam (MS) and feedwater (FW) lines out to the anchors adjacent to the isolation valves, and other primary and secondary system piping inside containment which meets the mechanistic pipe break (leak-before-break [LBB]) criteria is eliminated from the pipe break analysis for the AP600 design. Many of the high- and moderate-energy piping systems meet the LBB criteria and therefore are not subject to the dynamic effects associated with a pipe failure. The AP600 design as it relates to mechanistic pipe break is evaluated in Section 3.6.3 of this report. High-energy piping that meets the LBB criteria is evaluated for the effects of leakage cracks. Those high- and moderate-energy fluid systems which do not meet the LBB criteria are evaluated for the dynamic effects of postulated pipe failures. Safety-related equipment subject to the resulting dynamic effects are protected from these dynamic effects by protective structures, pipe restraints, and separation.

Westinghouse identified in SSAR Section 3.6.1 those safety-related systems which require protection from the dynamic effects of postulated piping failures. These systems are the reactor coolant system (RCS), steam generator system (SGS), the passive core cooling system (PXS), and the passive containment cooling system (PCS). In addition, the protection and safety monitoring system, Class 1E dc system, Uninterruptible Power Supply (UPS), main control room (MCR), and MCR habitability systems are also protected from pipe failures. Finally, containment penetrations and isolation valves, including those for non-safety-related systems, are protected from pipe failures.

Westinghouse also provided the pipe failure design bases in SSAR Section 3.6.1.1. High-energy systems are defined as those systems or portions of systems containing fluid where the maximum normal operating temperature exceeds 200 °F and/or the the maximum normal operating pressure exceeds 275 psig. Moderate-energy systems are defined as those systems or portions of systems whose pressures exceed atmospheric pressures during normal operation but are less than 275 psig. In addition, those systems that exceed 200 °F and 275 psig for 2% or less of the time during which the system is in operation are defined as moderate-energy. Based on these definitions, Westinghouse provided SSAR Table 3.6-1 which identified all high- and moderate energy systems in the AP600 design.

Pipe failure evaluations are made based on circumferential or longtitudinal pipe breaks, through-wall cracks, or leakage cracks. Pressurization, jet impingement, jet impingement thrust, internal fluid decompression loads, spray wetting, flooding, and pipe whip are considered for pipe breaks. Spray wetting and flooding are considered for high- and moderate-energy through-wall and leakage cracks. Pressurization effects on structures and components are considered for both breaks and leakage cracks. Structures inside containment are evaluated for pressurization effects. Through-wall cracks are not postulated in the break exclusion zone. Pressurization, spray wetting, and flooding effects for pipe failures in the break exclusion zone for high-energy lines (including MS and FW lines) near containment penetrations assume a 1 ft^2 break. Postulated break, through-wall crack, and leakage crack locations are determined according to SSAR Subsections 3.6.2 and 3.6.3 and are evaluated in Sections 3.6.2 and 3.6.3 or this report.

The assumptions used in the dynamic effects analysis include:

(1) Offsite power is not required for actuation of the passive safety systems. Only the Class 1E dc and UPS electrical systems are required to function.

(2) A single active component failure (SACF) occurs in systems needed to mitigate the consequences of the piping failure or to safely shut down the reactor. The SACF occurs in addition to the pipe failure (including any direct consequences of the pipe failure, such as a unit trip or loss of offsite power (LOOP)).

(3) Secondary components (e.g. turbine stop moisture separator reheater stop, and turbine bypass valves) are credited with mitigating the consequences of a postulated steam line rupture (given a SACF).

(4) A whipping pipe can break pipes of smaller diameter, regardless of pipe-wall thickness and can cause a through-wall crack in pipe of equal or larger size with equal or thinner wall thickness.

(5) If the direction of the initial pipe movement caused by the thrust force is such that the pipe impacts a flat surface normal to its direction of travel, its assumed that the pipe comes to rest against the surface with no pipe whip in other directions. Pipe whip restraints are used wherever pipe breaks could impair the functioning of safety-related systems or components.

(6) Regarding components impacted by jets from breaks in high-pressure fluid piping; components within 10 diameters of the broken pipe are assumed to

fail while components beyond 10 diameters of the broken pipe do not fail.

(7) When the mechanistic pipe break approach is used, subcompartment pressure loads on structures and components is determined by the leakage crack used in the mechanistic pipe break approach. In subcompartments containing lines not qualified for LBB, the pressuization effects are determined from the line with the greatest effect.

(8) Where a non-safety-related high-energy system failure could cause a failure of a safety-related system or a non-safety-related system whose failure could affect a safety-related system, pipe whip protection is evaluated.

(9) Steam, water, gases, heat, and combustible or corrosive fluids which escape from a pipe rupture will not prevent:

- subsequent access to any areas to recover from the pipe rupture

- habitability of the MCR

- capability of safety-related instrumentation, electric power supplies, components, and controls from performing their safety functions.

In SSAR Section 3.6.1.2, Westinghouse states that equipment is considered to be adequately separated from the dynamic effects of a postulated pipe failure when the equipment is in a different compartment and the compartment walls are designed to withstand the dynamic effects. For pipe whip, adequate separation is based on the distance between the equipment and the pipe, and the length of the whipping pipe. For jet impingement, equipment located more than 10 pipe diameters from the source of the jet is considered to be adequately protected from the jet.

In subcompartments inside containment (except the IRWST and reactor vessel annulus) which contain lines no greater than 3" in diameter, the pressurization analysis and evaluation of venting provisions are based on a 3" pipe break. The pressurization loads for the IRWST are based on the loads due to the maximum discharge of the first- second- and third stages of the automatic depressurization system valves. The pressurization loads for the reator vessel annulus are based on a 5 gpm leakage crack in the primary loop piping.

The main steam line and the main feedwater line are the lines closest to the MCR. They are located in the main steam isolation valve subcompartment (part of the break exclusion area) which is separated from the MCR by two walls composed of thick, reinforced concrete. Between these walls is the portion of the control room used for nonessential office and administrative space for the MCR. The main steam isolation valve subcompartment is evaluated for the effects of flooding, spray wetting, and pressurization from a 1 ft^2 break from from the main steam or feedwater line. The subcompartment wall closest to the MCR is also evaluated for jet impingement from a 1 ft^2 longtitudinal break in the main steam or feedwater line. The MCR is also evaluated for the dynamic and environmental effects from line breaks in the auxiliary and turbine buildings.

Westinghouse discussed the protection measures used in the AP600 design to protect safety-related equipment from the dynamic effects of pipe failures. These measures include physical separation of systems and components, barriers, equipment shields, and pipe whip restraints. The specific method used depends on goals such as accessibility and maintenance.

Separation between redundant safety systems is the basic means used to protect against the dynamic effects of pipe ruptures. This is achieved by:

- locating safety-related systems away from high-energy piping
- locating redundant safety systems in separate compartments
- enclosing specific components to ensure protection and redundancy
- providing drainage systems for flood control

The review of the AP600 design for protection against postulated piping failures outside containment included all high- and moderate-energy piping systems located outside containment.

During staff review of pipe failure protection for the AP600 standard design, several issues were identified which require resolution. These issues include:

1. Adequacy of responses to RAIs.
2. Incorporation of RAI responses into the SSAR.
3. Information regarding pipe failure protection for systems classified under Regulatory Treatment of Non-Safety Systems and Defense-in-Depth systems.
4. Mechanistic pipe break

Collectively, these issues constitute Open Item 3.6.1-1.

Based on this information, the staff concludes that, subject to resolution of this open item, the AP600 design conforms with the guidelines of BTP 3-1 and therefore meets the requirements of GDC 4.

3.11 Environmental Qualification of Mechanical and Electrical Equipment

3.11.1 Introduction

Equipment that is used to perform a necessary safety function must be demonstrated to be capable of maintaining functional operability under all service conditions postulated to occur during its installed life, for the time it is required to operate. This requirement, which is embodied in GDC 1 and 4 of Appendix A to 10 CFR Part 50 and Criteria III, XI, and XVII of Appendix B to 10 CFR Part 50, is applicable to equipment located inside and outside the containment. More detailed requirements and guidance related to the methods and procedures for demonstrating this capability for electrical equipment are in 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants," NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," which supplements IEEE 323 and various RGs and industry standards, and RG 1.89, Revision 1.

3.11.2 Background

The staff issued NUREG-0588 in December 1979 to promote a more orderly and systematic implementation of equipment qualification programs by industry and to guide the staff in its use in ongoing licensing reviews. The positions in NUREG-0588 provide guidance on (1) how to establish Environmental Qualification (EQ) service conditions, (2) how to select methods that are considered appropriate for qualifying equipment in different areas of the plant, and (3) other areas such as margin, aging, and documentation. A final rule on EQ of electrical equipment important to safety for nuclear power plants became effective on January 21, 1983. This rule, 10 CFR 50.49, specifies the requirements for demonstrating the EQ of electrical equipment important to safety that is located in harsh environments. Each item of electric equipment important to safety must be qualified by one of the following methods: (1) testing an identical item of equipment under identical conditions or under similar conditions with a supporting analysis to show that the equipment to be qualified is acceptable, (2) testing a similar item of equipment with a supporting analyses to show that the equipment to be qualified is acceptable, (3) experience with identical or similar equipment under similar conditions with a supporting analysis to show that the equipment to be qualified is acceptable and (4) analysis in combination with partial type test data that supports the analytical assumptions and conclusions. In RG 1.89, Revision 1 (June 1984), the staff specifies guidelines for complying with the rule. The applicant or licensee shall prepare a list of electrical equipment important to safety covered by the qualification requirements. In addition, the applicant or licensee shall include the following information for electric equipment important to safety in a qualification file: (1) the performance specifications under conditions existing during and following design basis accidents, (2) the voltage, frequency, load, and other electrical characteristics for which the performance specified in accordance with (1) above can be ensured, and (3) the environmental conditions, including temperature, pressure, humidity, radiation, chemicals, and submergence at the location where the equipment must perform as specified in accordance with (1) and (2) above. The applicant or licensee shall keep the list and information in the file current and retain the file in auditable form for the entire period during which the covered item is installed in the nuclear power plant or is stored for future use to permit verification that each item of electric equipment important to safety meets the requirements. In conformance with 10 CFR 50.49, electrical equipment for PWRs referencing the AP600 design must be qualified according to the criteria in Category I of NUREG-0588 and RG 1.89, Revision 1.

The qualification requirements for mechanical equipment are principally contained in Appendices A and B to 10 CFR Part 50. The qualification methods defined in NUREG-0588 can also be applied to mechanical equipment.

To document the degree to which the EQ program for the AP600 design complies with the EQ requirements and criteria, Westinghouse submitted the AP600 SSAR Section 3.11, "Environmental Qualificationn of Mechanical and Electrical Equipment," and SSAR Appendix 3D, "Methodology for Qualifying AP600 Safety-Related Electrical and Mechanical Equipment," and responded on November 30, 1992 (ET-NRC- 92-3777) to an NRC staff RAI dated September 23, 1992, and on June 27, 1994 (NTD-NRC-94-4181) and July 15, 1994 (NTD-NRC-94-4202) to an NRC staff RAI dated May 19,1994.

3.11.3 Staff Evaluation

The staff limited its evaluation of the EQ program for the AP600 design to a review of Westinghouse submittals on its approach for selecting and identifying equipment required to be environmentally qualified for the AP600 design, qualification methods proposed, and completeness of information in SSAR Appendix 3D. The bases for the staff's evaluation are SRP Section 3.11, Revision 2; NUREG-0588, Category 1; RG 1.89, Revision 1; and 10 CFR 50.49. For COL applicants referencing the AP600 certified design, the staff will review specific details of the EQ programs for their plants using the evaluation bases mentioned above.

3.11.3.1 Completeness of Qualification of Electrical Equipment Important to Safety

The following three categories of electrical equipment important to safety must be qualified in accordance with the provisions 10 CFR 50.49(b)(1), (b)(2), and (b)(3):

- (b)(1) - safety-related electrical equipment (relied on to remain functional during and after design-basis events)

- (b)(2) - non-safety-related electrical equipment whose failure under the postulated environmental conditions could prevent satisfactory performance of the safety functions by the safety-related equipment

- (b)(3) - certain postaccident monitoring equipment (Categories I and II postaccident monitoring equipment as specified in RG 1.97, Revision 2, "Instrumentation for Light-Water-Cooled Nuclear Power Plants To Assess Plant and Environs Conditions During and Following an Accident").

AP600 SSAR Table 3.11-1, provides a list of safety-related electrical and active mechanical equipment that is essential to emergency reactor shutdown, containment isolation, reactor core cooling, or containment and reactor heat removal or that is otherwise essential in preventing significant release of radioactive material to the environment. The NRC staff reviewed this list and concluded that additional discussions with Westinghouse are necessary before a final conclusion can be reach.

For the design basis accident source term, Westinghouse has elected to use the EPRI source term (DOE/ID-10321). The acceptability of the source term is discused in chapter 15 of this report.

The radiation qualifications for individual safety-related components should be develop on the basis of two conditions:

- the radiation environment expected at the component location from equipment installation to the end of qualified life, including the time the equipment is required to remain functional after the accident, and

- the limiting design-basis accident for which the component provides a safety function.

These design-basis accidents conditions are discussed in chapter 15 of this report.

3.11.3.2 Qualification Methods

3.11.3.2.1 Electrical Equipment in a Harsh Environment

Detailed procedures for qualifying safety-related electrical equipment located in a harsh environment are defined in NUREG-0588 and RG 1.89. The criteria in these documents are also applicable to other equipment important to safety defined in 10 CFR 50.49.

The methodology used by Westinghouse for the AP600 relies primarily of IEEE Standard 323-1983. To date the NRC staff has not endorsed IEEE 323-1983; therefore, references to this standard in its entirety or in part are not acceptable. As indicated in the footnote to 10CFR 50.49, and stated in NUREG-0588 and Regulatory Guide 1.89, the guidance in IEEE Standard 323-1974 is aceptable to the NRC staff for qualifying equipment within the scope of 10 CFR 50.49. Based on Westinghouse's response to the staff RAIs on this issue, further discussions between the staff and Westinghouse will be necessary for the resolution of this issue.

In addition, for current-generation operating reactors, the staff's definition of what constitutes a mild radiation environment for electronic components such as semi-conductors, or any electronic component containing organic materials, is different from what it is for other equipment. The staff position is that a mild radiation environment for electronic equipment is a total integrated dose of less than 10 Gy (10^3 Rad). For other equipment it is less tha 10^2 (10^4 Rad) With the expected significant increase in the quantity and variety of electronic components in newer generation plants, the staff has increasing concerns about the efforts being made and the ability of these components to be environmentally qualified. Westinghouse should address the staff's concerns on this issue.

3.11.3.2.2 Safety-Related Mechanical Equipment in a Harsh Environment

Although no detailed requirements exist for mechanical equipment, GDC 1 and 4 and Appendix B to 10 CFR Part 50 (Criteria III, "Design Control," and XVII, "Quality Assurance Records") contain the following requirements related to equipment qualification:

- Components should be designed to be compatible with the postulated environmental conditions, including those associated with LOCAs.
- Measures should be established for the selection and review for the suitability of application of materials, parts, and equipment that are essential to safety-related functions.
- Design control measures should be established for verifying the adequacy of design.
- Equipment qualification records should be maintained and should include the results of tests and materials analyses.

For mechanical equipment, the staff concentrates its review on materials that are sensitive to environmental effects, for example, seals, gaskets, lubricants, fluids for hydraulic systems, and diaphragms. A review and evaluation should be done to

- identify safety-related mechanical equipment located in harsh environment areas, including required operating time
- identify non-metallic subcomponents of this equipment
- identify the environmental conditions for which this equipment must be qualified (The environments defined in the electrical equipment program are also applicable to mechanical equipment.)
- identify non-metallic material capabilities
- evaluate environmental effects

AP600 SSAR Table 3.11-1 include both electrical and mechanical equipment without a clear destinction between the two classes of equipment. To eliminate potential confusion in the EQ program, Westinghouse should clearly identify which items of equipment is classified as electrical and separate those items from those that are classified as mechanical equipment.

3.11.3.3 Conclusions

On the basis of its review of the the AP600 SSAR, other applicant submittals, and NRC staff policies and practices, the staff concludes that the program proposed by Westinghouse for environmentally qualifying electrical equipment important to safety and safety-related mechanical equipment, requires additional discussions with Wesinghouse before a final conclusion can be reach.