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Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: **Submittal Supporting Accelerated ABWR Review Schedule - Flooding Protection**

Dear Chet:

Enclosed are SSAR markups for Subsection 3.4 on Flooding. These markups were mentioned to NRC staff at the Bethesda ITAAC meetings. These changes address a Utility request to eliminate curbs and sills where not required.

Please provide a copy of this transmittal to Butch Burton.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Gary Ehlert (GE)
Norman Fletcher (DOE)

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3.4 WATER LEVEL (FLOOD) DESIGN

The types and methods used for protecting the ABWR safety-related structures, systems and components from external flooding shall conform to the guidelines defined in RG 1.102.

Criteria for the design basis for protection against external flooding shall conform to the requirements of RG 1.59. The design criteria for protection against the effects of compartment flooding shall conform to the requirements of ANSI/ANS-56.11. The design basis flood levels are specified in Table 3.4-1.

3.4.1 Flood Protection

This section discusses the flood protection measures that are applicable to the standard ABWR plant Seismic Category I structures, systems, and components for both external flooding and postulated flooding from plant component failures. These protection measures also apply to other structures that house systems and components important to safety which fall within the scope of plant specific.

3.4.1.1 Flood Protection Measures for Seismic Category I Structures

The safety-related systems and components of the ABWR Standard Plant are located in the reactor and control~~, and radwaste~~ buildings which are seismic category 1 structures. These structures together with those identified in Table 3.4-1 are protected against external flood damage. Flood protection of safety-related systems and components is provided for all postulated design flood levels and conditions described in Table 2.0-1. Postulated flooding from component failures in the building compartments does not adversely affect plant safety nor does it represent any hazard to the public.

Structures which house the safety-related equipment and offer flood protection are identified in Table 3.4-1. Descriptions of these structures are provided in Subsection 3.8.4 and 3.8.5. Exterior or access openings and penetrations that are below the design flood level are identified in Table 6.2-9.

Pipe penetrations below design basis flood level will be sealed against resulting hydrostatic head from a moderate energy pipe failure inside the tunnel, or in a connecting building.

3.4.1.1.1 Flood Protection from External Sources

Seismic Category I structures that may be affected by design basis floods are designed to withstand the floods postulated in Table 2.0-1 using the hardened protection approach with structural provisions with incorporated in the plant design to protect safety-related structures, systems, and components from postulated flooding. Seismic Category I structures required for safe shutdown remain accessible during all flood conditions.

Safety-related systems and components are flood-protected either because of their location above the design flood level or because they are enclosed in reinforced concrete Seismic Category I structures which have the following ~~requirements~~ features:

(1) wall thicknesses below flood level of not less than two feet;

(2) water stops provided in all construction joints below flood level;

(3) watertight doors and equipment hatches installed below design flood level; and

(4) waterproof coating of external surfaces.

(5) roofs are designed to prevent pooling of large amounts of water in accordance with RG 1.102.

Waterproofing of foundations and walls of Seismic Category I structures below grade is accomplished principally by the use of water stops at expansion and construction joints. In addition to water stops, waterproofing of the plant structures that house safety related systems and components is provided up to 8 cm (3 in) above the plant ground level to protect the external surfaces from exposure to water.

The flood protection measures that are described above also guard against flooding from on-site storage tanks that may rupture. The largest is the condensate storage tank that has

a capacity of 2,110 cubic meters. This tank is constructed from stainless steel and is located between the turbine building and the radwaste building where there are no direct entries to these buildings. All plant entries start one foot above grade. Any flash flooding that may result from tank rupture will drain away from the site and cause no damage to site equipment.

Additional specific provisions for flood protection include administrative procedures to assure that all watertight doors and hatch covers are locked in the event of a flood warning. If local seepage occurs through the walls, it is controlled by sumps and sump pumps.

In the event of a flood, flood levels take a relatively long time to develop. This allows ample lead time to perform necessary emergency actions for all accesses which need to be protected.

The safety-related components located below the design flood level inside a Seismic Category I structure are shown in the Section 1.2 plant layout drawings. All safety-related components located below the design flood level are protected using the hardened protection approach described above.

3.4.1.1.2 Compartment Flooding from Postulated Component Failures

All piping, vessels, and heat exchangers with flooding potential in the reactor building are seismically qualified ~~with one exception~~, and complete failure of a non-seismic tank or piping system is not applicable. ~~The one exception is the radwaste building which contains no safe shutdown equipment.~~

In accordance with Reference 2, leakage cracks are postulated in any point of moderate-energy piping larger than nominal one-inch diameter. The leakage flow area is assumed to be a circular orifice with flow area equal to one-half of the pipe outside diameter multiplied by one-half of the pipe nominal wall thickness. Resulting leakage flow rates are approximated using Equation 3-2 from Reference 1 with a flow coefficient of 0.59 and a normal operating pressure in the pipe.

The MSL tunnel area is instrumented with radiation and air temperature monitors that are used to automatically isolate the MSL isolation valves upon detection of high abnormal limits.

However, in the event of worst case flooding involving a feedwater line break, the maximum flow rate from this high energy line break will not exceed 3.6 cubic meters per minute (950 gpm) over a 2 hour period. Refer to Table 15.6-16 for feedwater line leakage parameters. Water discharged from a postulated feedwater line break will be contained in the Seismic Category I structure of the MSL tunnel area and will not flood any safety related equipment in the reactor building. The flooded area will be allowed to drain through normally closed floor drains in the tunnel area which are routed to the HCW sumps in the reactor building for collection and discharge.

No credit is taken for operation of the drain sump pumps although they are expected to operate during some of the postulated flooding events.

After receiving a flood detection alarm, the operator has a ten-minute grace period to act in cases when flooding can be identified and terminated by a remote action from the control room. In cases involving visual inspection to identify the specific flooding source in the affected area (except ECCS areas) followed by a remote or local operator action, a minimum of 30 minutes is provided for the operator.

In all instances of compartment flooding, a single failure of an active component is considered for systems required to mitigate consequences of a particular flooding condition. The emergency core cooling system (ECCS) rooms are also evaluated on the basis of a loss-of- coolant accident (LOCA) and a single active failure or a LOCA combined with a single passive failure 10 minutes or more after the LOCA.

There are no interface requirements made upon the remainder of the plant from possible flooding in the ABWR Standard Plant buildings. Other lines, such as storm drains and normal waste lines, interface with plant yard piping. However, provisions are made in these lines that, should the yard piping become plugged, crushed, or otherwise inoperable, they will vent onto the ground relieving any flooded condition.

Considering the above criteria and assumptions, analyses of piping failures and their consequences are performed to demonstrate the adequacy of the ABWR design. These analyses are provided separately for the reactor, ~~and~~ control, ~~buildings~~ radwaste, service and turbine buildings.

Analysis of the worst flooding due to pipe and tank failures and their consequences are peformed in this subsection for the reactor building, control building, radwaste building and the service building. No credit is taken for safety-related equipment within these structures if the equipment becomes partially flooded. However, in accordance with Section

3.11, all safety-related equipment is qualified to high relative humidity.

For those structures outside the scope of the ABWR Standard Plant (e.g., the ultimate heat sink pump house), the COL applicant will demonstrate the structures outside the scope will meet the requirements of GDC 2 and the guidance of RG 1.102. See Subsection 3.4.3.4 for Col license information requirements.

3.4.1.1.2.1 Evaluation of Reactor Building Flood Events

Analysis of potential flooding within the reactor building is considered on a floor-by-floor basis. The potential consequences of the high energy breaks in the reactor building are evaluated in Subsection 6.2.3.3.1.

3.4.1.1.2.1.1 Evaluation of Floor 100 (B3F)

Worst case flooding on this floor level would result from leakage of the RHR 18" suction line between the containment wall and the system isolation valve (this applies also to the HPCF, RCIC, and SPCU suction lines, although in smaller line sizes). Leakage from this source may cause flooding of the affected RHR heat exchanger (HX) room and the neighboring ECCS room of the same division at a rate of 1.04 cubic meter/minute (275 gpm) and may continue until the line is repeated or equalization of water level occurs between ~~this room~~ these rooms with the suppression pool level. Flooding in the room may cause loss of functions for that particular divisional system loop. This will not impair the safe shutdown capability of the reactor system. Flooding of other ~~areas~~ divisions is prevented by water tight doors. Suction lines to other services always remain submerged. Other flooding incidents mat result from failures of other piping systems penetrating the RHR HX rooms for each division; these events, however, upon detection by sump pump alarms, are controllable by terminating flow with closure of valves and shutdown of pressure sources.

HPCF and RCIC systems, while having the susceptibility to flood their respective compartments from the suppression pool, do so at lower rates than the RHR system. Failure, however, is guarded against by watertight doors so that flooding in one ~~compartment~~ division does not propagate to other ~~areas~~ divisions.

A failure in a nondivisional area, the failure of the 8" suppression pool cleanup system suction line before the isolation valve will permit flooding of the fourth quadrant uncontrollably by system elements. The flooding rate, driven by suppression pool head, would not exceed .27 cubic meter/minute (or 70 gpm) and, depending upon the rate of manual repair, may permit 25-30 cubic meters of water to escape into the fourth quadrant. Certain functions of the SPCU, CUW, and backwash systems may be lost, but because of watertight doors on divisional areas no essential functions would be lost and plant integrity would not be in question.

Firefighting in the divisional rooms on this floor will be done by sprinklers in the watertight rooms. Manual firefighting in the fourth quadrant and in the HCU room will bring in .57 cubic meters/minute (150 gpm). Such activities would not create a water depth which would cause concern.

3.4.1.1.2.1.2 Evaluation of Floor 200 (B2F)

Flooding events on this floor may result from piping failures in the RHR pipeways, or from piping systems of the HPCF and RCIC. Maximum flooding would occur from a 10" RHR pressure line at a flow rate of 1.34 cubic meter/minute (354 gpm). ~~Division B and C areas have ample area to spread this water (13.4 cubic meters by the end of the ten minute response period) but Division A has limited flood spread area and will have watertight doors to prevent a depth of 0.3-0.4 meters (fifteen inches) from flooding Division C area. Division C has an area adequate to minimize water depth on floors but will have watertight hatches between Division C areas on Floor 200 and Division A areas on Floor 100. Leakage alarms are provided in these areas for detection and operator response~~. insert 'a' →

In associated divisional compartments failures of 16" RCW pressure lines may also occur. Prior to system isolation this would result in a flooding rate of 2.8 cubic meters/minute (745 gpm). ~~Twenty eight cubic meters in Divisions B and C are spread over a minimum of 360 square meters, and therefore can be restrained by raised sills at divisional entries; the area in Division A is limited and watertight sealed doors will prevent further flooding~~. ← insert 'b'

In the fourth quadrant, SWCU and CUW F/D valve rooms, holding pumps and HNH pump and HX rooms, may experience flooding from various system line failures. The maximum flooding will be from an 8" line at pump pressure resulting in discharge of .92 cubic meter/minute (240 gpm). A total of 27 cubic meters spilled.

The leakage may propagate ~~over the fourth~~ quadrant but an area of 300 square meters is available, so that depth ~~adequate to intrude into divisional areas, over raised sills will not occur~~. ← insert 'c' Alarming and prompt operator isolation of these systems is then performed.

Firefighting on this floor will be accomplished manually with a flow of .57 cubic meter/minute (150 gpm). Areas of activity are rather large so that this quantity of water (less than for other events above) presents no problem.

~~Firefighting in the RIP & FMCRD maintenance rooms will also have little impact; 20 cm (8 inch) high sills and curbs prevent movement of water from area of application and thus maintain divisional integrity.~~

3.4.1.1.2.1.3 Evaluation of Floor 300 (B1F)

Primary flooding events on this floor are associated with pipeways and pipechases utilized by RHR, HPCF, and RCIC systems. Maximum leakage is that postulated for a 10" RHR pressure line ~~failure in rooms that are connected to rooms below, raised sills in these rooms prevent intrusion of water from a failed division into another division while clean access-control access walls prevent propagation into emergency electric rooms. Water may spread after a few minutes over the sill and into the corridors, but the area is sufficiently large to keep the level to 4-5 cm (1-2 inches) during the response period ending in system isolation. Equipment hatches in the controlled access area are sealed watertight to prevent propagation of a failure~~ ← insert 'd'

into a different division below. Minor water flooding down stairwells may also occur.

Flooding in the emergency electric rooms A, B and C and the remote shutdown rooms may occur from leakage or failures in the heating and ventilating chilled water supply or Emergency HVAC cooling water system. These failures are limited in potential water release by line inventory and surge tank capacity and will not exceed 8 cubic meters (2000 gallons), causing a total water depth of 4-5 cm (1-2 inches).

Equipment mounted on pedestals of 20 cm (8") and door sills at area entrances will prevent propagation and provide containment for this water quantity until response to the failures is made.

Firefighting activity in all areas of this level are carried out by manual means at a maximum rate of .57 cubic meter/minute (150 gpm) and no greater effects than those already considered will occur. Raised door sills prevent intrusion of firefighting water into unaffected division rated rooms.

Failures in the CUW and SPCU systems filter/demineralizers and associated piping may occur as on Floor 200 but will spread over a comparable area or drain down to Floor 200 or 100 so that adequate time is available for detection and subsequent system isolation.

3.4.1.1.2.1.4 Evaluation of Floor 400 (1F)

Flooding from the RHR, HPCF, and RCIC systems may occur in valve rooms A, B and C. Maximum flooding is a failure of the 10" RHR pressure line with leakage flow of 1.34 cubic meter/minutes (354 gpm). insert 'e' → With a room area of about 34 square meters flow over 20 cm (8") sills occur in 3-4 minutes but a much larger area is available in corridors and rooms outside these division rooms, so that by the end of the ten minute response period, a water level of 2-3 cm (one inch) maximum is seen generally outside the affected room. Raised sills on entry doors to other divisions prevent flooding propagation into other divisions; separation walls between controlled access and clean access areas prevents flood propagation to diesel generator areas. Flooding may penetrate the fourth quadrant at a minimum depth, and leakage may also occur through hatches to nondivisional areas below.

Emergency diesel generator A, B and C rooms contain cooling water piping to components of this system. Flooding may occur from failures of 8" RCW piping serving these cooling needs at a maximum rate of .9 cubic meter/minute (240 gpm), which will fill the floor area and escape into the corridor, with potential cascading down the stairwell. The water will spread over the side areas on the lower floor while action to isolate the failed system takes place. Intrusion of water into other divisional areas is prevented by raised sills on the entry passages. ← insert 'f'

Leakage of lubricating oil is also possible in the diesel generator rooms, but level indication provides a continuing control on this source. Even major leakage will be contained in the subject rooms due to the small inventory of fluid available.

Firefighting in the diesel generator area will be provided by a foam sprinkler system. Other firefighting will be by hoses but will be of smaller volumes than those considered, and will be of limited duration.

3.4.1.1.2.1.5 Evaluation of Floor 500 (2F)

This floor contains the following equipment areas:

(a) The emergency diesel generator A, B, and C equipment areas including fans, control panels, air storage tanks and associated piping.

(b) The fuel pool cooling and cleanup system consisting of two circulating pumps, two heat exchangers, two filter demineralizers, instrumentation and associated valves and piping.

(c) The SGTS monitor room.

(d) The stack monitor room.

(e) The MSL tunnel area.

← insert 'g'

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3.4.1.1.2.1.6 Evaluation of Floor 600 (3F)

Flooding events at this floor level may involve fuel oil as well as water. Those divisional rooms associated with the emergency diesel generator fuel tank and cooling system, have the potential of leakage from the fuel storage tanks. These rooms must accommodate leakage of 11.4 cubic meter (3000 gallons) for each division. Twenty cm (8 inches) sills on entry to these areas successfully contain all the volume in the tanks. Leakage from these tanks will also be monitored through safety grade level indication and alarm equipment so that protracted leakage as well as gross leakage can be identified. The rooms are protected ~~by CO_2 firefighting~~ by a foam sprinkler system. Water flooding may occur from the cooling system at about .15 cubic meter/minutes (41 gpm). If undetected for several hours water may begin cascading down the nearest stairwell but is prevented from ~~entering other division areas by raised sills~~ insert 'h'.

In the SGTS areas, the room cooling equipment may cause flooding at a rate .15 cubic meter/minute (41 gpm). Raised sills prevent intrusion of water into rooms of another division. Flooding may also occur from manual firefighting in equipment maintenance areas or from leakage from the standby liquid control tanks. Maximum tank leak rate will be .1 cubic meter/minute (25 gpm) so that a response to tank level alarms within 10 minutes will limit loss to one cubic meter (or 250 gallons). Large floor areas permit spread of water at limited depth.

3.4.1.1.2.1.7 Evaluation of Floor 700 (M4F)

Flooding in the FMCRD panel rooms may occur from firefighting activities at an input rate of .57 cubic meters/minute (150 gpm). Since these activities are manually controlled, any excessive depth of water will be noted and action taken to mitigate water intrusion to other areas.

Flooding on this level may also occur from room cooling systems or from firefighting efforts. Cooling system failures in air supply, exhaust or filter rooms may allow flooding at the rate of .3 cubic meter/minute (80 gpm) which will flow out into adjacent corridor areas. If undetected for 10 minutes, the approximate 3 cubic meter (800 gallons) released may create a depth of a few millimeters over the available floor area; a very limited amount of water will cascade down the stairwells. Divisional areas encompassing the three emergency electric supply fans ~~and the RIP A exhaust will include raised sills to preclude water intrusion although water depth will be slight. Equipment pedestals will also minimize flooding impact on all equipment~~ insert 'i'.

Firefighting activities in this area would cause water inflow of .57 cubic meter/minute (150 gpm) under controlled conditions and expected water intrusion is no more than that above.

3.4.1.1.2.1.8 Evaluation of Floor 800 (4F)

Flooding on this floor can be caused by rupture of the RCW surge tanks A, B & C piping. However, each tank and its associated piping is located in a separate compartment which can be sealed off in the event of accidental flooding. ~~The use of raised sills on entry ways will contain the seepage to the flooded area~~. Also, the use of pedestals for equipment installation of the RIP supply and exhaused fans and for the DG-C exhaust fans will guard against flooding this equipment.

Flooding in the main reactor hall may occur from reactor service operations, but will be drained into service pools. Firefighting water expended into this area would occur at a maximum rate of .57 cubic meter/minute (150 gpm) but will spread over the large service area available. Minor amounts of water may find the way to stairwells, but would not impede operations.

3.4.1.1.2.1.9 Flooding Summary Evaluation

Floor-by-floor analysis of potential pipe failure generated flooding events in the reactor building shows the following:

due to a suppression pool suction line failure

(1) Where extensive flooding ~~may occur~~ in a ~~division rated~~ compartment, propagation to other divisions is prevented by watertight doors ~~or sealed hatches~~. Flooding in one division is limited to that division and flood water cannot propagate to other divisions.

(2) Leakage of water from large circulating water lines, such as reactor building cooling water lines may flood rooms and corridors, but through sump alarms and leakage detection systems the control room is alerted and can control flooding by system isolation. ~~Divisional areas are protected by watertight doors, or where only limited water depth can occur, by raised sills with pedestal mounted equipment within the protected rooms.~~

insert 'j'

(3) Limited flooding that may occur from manual firefighting or from lines and tanks having limited inventory ~~is restrained from entering division areas by raised sills and elevation differences~~.

Therefore, within the reactor building, internal flooding events as postulated will not prevent the safe shutdown of the reactor.

3.4.1.1.2.2 Evaluation of Control Building Flooding Events

The control building is a seven story building. It houses in separate areas, the control room proper, control and instrument cabinets with power supplies, closed cooling water pumps and heat exchangers, mechanical equipment (HVAC and chillers) necessary for building occupation and environmental control for computer and control equipment, and the steam tunnel.

The only high energy lines in the control building are the mainsteam lines and feedwater lines which pass through the steam tunnel connecting the reactor building to the turbine building. There are no openings into the control building from the steam tunnel. The tunnel is sealed at the reactor building end and open at the turbine building end. It consists of reinforced concrete with 1.6 meter thick walls. Any break in a mainsteam or a feedwater line will flood the steam tunnel with steam. The rate of blowdown will cause most of the steam to vent out of the tunnel into the turbine building. Water or steam cannot enter the control building. See Section 3.6.1.3.2.3 for a description of the subcompartment pressurization analysis performed for the steam tunnel.

Moderate energy water services in the control building comprise 28-inch service water lines, 18-inch cooling water lines, 6-inch cooling water lines to the chiller condenser, 6-inch fire protection lines, and 6-inch chilled water heater lines. Smaller lines supply drinking water, sanitary water and makeup for the chilled water system. ~~Areas with water pipe routed through are supplied with floor drains and curbs~~ All rooms are supplied with floor drains to route leakage to the basement floor so that control or computer equipment is not subjected to water. ~~In those areas where water infusion cannot be tolerated, the access sills are raised~~.

Maximum flooding may occur from leakage in a 28-inch service water line at a maximum rate of 12.0 cubic meters/minute (3150 gpm). Early detection by alarm to control room personnel will limit the extent of flooding which will also be mitigated by drainage to exterior of the building. The expected release of a service water leak is limited to line volume plus operator response time times leakage rate. The assumed operator response time is 30 minutes to close isolation valves and turn off the pump in the affected service water division. Water will be contained inside a division of closed cooling water equipment rooms in the bottom level of the control building. A maximum of 5.0 meters of water in a divisional room is expected. Water tight doors will confine the water to a division.

The failure of a cooling water line in the mechanical rooms of the ~~turbine~~ control building may result in a leak of 0.6 cubic meter/minute (160 gpm). Early detection by control room personnel will limit the extent of flooding. Total release from the chilled water system will be limited to line inventory and surge tank volume, spillage of more than 6 cubic meters (1500 gallons) is unlikely. Elevation differences and separation of the mechanical functions from the remainder of the control building prevent propagation of the water to the control area.

~~maximum of 2.15 meters of water in a divisional room is expected. Water tight doors will confine the water to a division.~~

~~The failure of a cooling water line in the mechanical rooms of the turbine building may result in a leak of 0.6 cubic meter/minute (160 gpm). Early detection by control room personnel will limit the extent of flooding. Total release from the chilled water system will be limited to line inventory and surge tank volume, spillage of more than 6 cubic meters (1500 gallons) is unlikely. Elevation differences and separation of the mechanical functions from the remainder of the control building prevent propagation of the water to the control area.~~

insert → k

~~Flooding events that may result from the failure of the fire fighting systems within the control building do not inhibit plant safety.~~ There are no sprinkler systems in the control building. Hose and standpipes are located in the corridors. Service equipment rooms may build up limited water levels from either service water, cooling water, or chilled water leaks, but elevation differences ~~and raised sills~~ prevent intrusion of water into control areas. Control room responses to those various levels of flooding may extend from system isolation and correction to reduction of plant load or shutdown, but control room capability is not compromised by any of the postulated flooding events.

3.4.1.1.2.3 Evaluation of Radwaste Building Flooding Event

The radwaste building is a reinforced concrete structure designed as Seismic Category I, consisting of a substructure 13.8 meters below grade and a super-structure 16 meters above grade. This building does not contain safety-related equipment and is not contiguous with other plant structures except through a pipe tunnel. In case of a flood, the building substructure serves as a large sump which can collect and hold any leakage within the building. Also, the medium and large radwaste tanks are housed in sealed compartments which are designed to contain any spillage or leakage from tanks that may rupture. The piping that trans-, fers the liquid waste from the other buildings traverses through a sealed water-tight tunnel to the radwaste building at an elevation of -3,500 mm, which is 3 meters above the radwaste building basement slab. This tunnel connects to the turbine and reactor buildings at the same elevation.

The structural design of this building is such that no internal flooding is expected or will occur under the worst case conditions from those tanks that are isolated by the Seismic Category I compartments.

Flooding from other sources within the building such as internal radwaste and non-radwaste piping, plant drains, small tanks, and pumps is not expected to cause the water level to rise more than 1 meter above the flood depth of 3 meters to reach the tunnel and spread radioactive liquid waste to other buildings that house safety-related systems.

Therefore, it can be concluded from the above analysis that there is no uncontrolled leakage path of radioactive liquid from the radwaste building under the conditions of worst-case internal flooding.

3.4.1.1.2.4 Evaluation of Service Building Flooding Events

The service building is a non-seismic concrete structure consisting of four floors, two above and two below grade. It serves as the main security entrance to the plant and provides the controlled access tunnels to the control building, the turbine building, and the reactor building. This building does not house any safety-related equipment.

The connecting access tunnels to other buildings are below plant grade as indicated in Table 3.4-1. These passage ways are water tight to prevent seepage into the tunnels. Also, the controlled access chambers employ curbs and closed doors at both ends of the tunnel that guard against water leakage into structures that house safety-related equipment.

The only plant piping that run through this building are those needed for fire protection, water services, HVAC heaters and chillers, and for draining the sumps. This building has floor drains and two sump pumps (HCW & HSD) for collecting and transferring the liquid waste. Under worst-case conditions, flooding from line

ruptures is unlikely and can be contained from spreading to the structures that house safety-related equipment.

3.4.1.1.2.5 Evaluation of Turbine Building Flooding Events

Circulating water system and turbine building service water system are the only systems large enough to fill the condenser pit; therefore, only these two systems can flood into adjacent buildings.

A failure in either of these systems will result in the total flooding of the turbine building up to grade. Water is prevented from crossing to other buildings by two means. The first is a normally closed alarmed door in the connecting passage between the turbine building and service building. The second is that the radwaste tunnel will be sealed at all ends to prevent water from either entering the tunnel or leaving the tunnel. A large hydrostatic head is prevented by a large non-water-tight truck door at grade to provide a release point for any water.

Because of the large size of the circulating water system, a leak will fill the condenser pit quickly. Monitors were added in the condenser pit of the turbine building to provide leak detection and an automatic means to shutdown the circulating water system in the event of flooding in the turbine building (see Subsection 10.4.5.2.3 and 10.4.5.6).

3.4.1.2 Permanent Dewatering System

There is no permanent dewatering system provided for in the flood design.

3.4.2 Analytical and Test Procedures

Since the design flood elevation is one foot below the finished plant grade, there is no dynamic force due to flood. The lateral hydrostatic pressure on the structures due to the design flood water level, as well as ground water and soil pressures, are calculated.

Structures, systems, and components in the ABWR Standard Nuclear Island designed and analyzed for the maximum hydrostatic and hydrodynamic forces in accordance with the loads and load combinations indicated in Subsection 3.8.4.3 and 3.8.5.3 using well established methods based on the general principles of engineering mechanics. All Seismic Category I structures are in stable condition due to either moment or uplift forces which result from the proper load combinations including the design basis flood.

3.4.3 COL License Information

3.4.3.1 Flood Elevation

The design basis flood elevation for the ABWR Standard Plant structures is one foot below grade.

3.4.3.2 Ground Water Elevation

The design basis ground water elevation for the ABWR Standard Plant structures is two feet below grade.

3.4.3.3 Flood Protection Requirements for Other Structures

The COL applicant will demonstrate, for the structures outside the scope of the ABWR Standard Plant, that they meet the requirements of GDC 2 and the guidance of RG 1.102. (See Subsection 3.4.1.1.2)

3.4.4 References

1. Crane Co., *Flow of Fluids Through Valves, Fittings, and Pipe,* Technical Paper No. 410, 1973.

2. ANSI/ANS 56.11, Standard, *Design Criteria for Protection Against the Effects of Compartment Flooding in Light Water Reactor Plants.*

3. Regulatory Guide 1.59, Rev. 2 *Design Basis Floods for Nuclear Power Plants.*

insert a

These lines are inside pipe chases. Hence, leakage from these breaks accumalates on floor 100 (B3F).

insert b

A total of 84 cubic meters of water are spilled.

insert c

The leakage may propagate between divisions but an area of over 300 square meters is available, so that a depth of less than 8 inches is maintained. No water will damage safety-related equipment.

insert d

Maximum leakage is that postulated for a 10 inch RHR pressure line failure in rooms that are connected to rooms below on floor 100 (B3F). Hence, leakage from these breaks accumalates on floor 100 (B3F).

insert e

These rooms are connected to floor 100 (B3F) by pipe chases. No accumalation expected on this floor.

insert f

raising the equipment 8 inches off the floor.

insert g

Flooding may occur from the failure of 8 inch fuel pool cooling lines at a maximum rate of .9 cubic meters/minute (240 gpm), which will fill the floor area. The water will escape down stairwells or flow down the drain system to floor 100 (B3F). Due to limited inventory, water is limited to a few millimeters in depth. Safety-related equipment sensitive to water (i.e., electrical, control, and instrumentation) will be protected by raising them at least 8 inches above the floor.

Flooding may also occur inside the steam tunnel. This water volume will be kept inside the tunnel until the operators are ready to pump it to radwaste for treatment. No safety-related equipment will be effected by this break. All valve operators are well off the floor. They are expected to act prior to their emersion by any flood.

insert h

damaging safety-related equipment by raising water sensitive equipment at least 8 inches above the floor.

insert i

will be raised at least 8 inches off the floor to minimize flooding impact on all safety-related equipment.

insert j

Only limited water depth can occur; therefore, safety-related equipment are raised at least 8 inches off the floor for their protection.

insert k

Flooding events that may result from the failure of the fire fighting systems within the control building are directed to the basement by the floor drain system.

On all floors, water sensitive equipment will be raised at least 8 inches off the floor to protect them in case of water intrusion due to manual firefighting or other flooding event on their floor.