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Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-12331

Subject: MHI's Revised Response to US-APWR DCD RAI No. 841-6055 Revision 3 (SRP 03.04.01)

Reference: 1) "Request for Additional Information No. 841-6055 Revision 3, SRP Section 03.04.01 – Internal Flood Protection for Onsite Equipment Failures - Application Section: 3.4.1", dated October 18, 2011 (ML112920578).
2) MHI Letter No. UAP-HF12283, "MHI's Response to US-APWR DCD RAI No. 841-6055 Revision 3 (SRP 03.04.01)", dated October 19, 2012 (ML12296A449)

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Revised Response to Request for Additional Information No. 841-6055 Revision 3."

Enclosure 1 is the revised response to Question 03.04.01-29 contained within Reference 1. This response is being resubmitted to update the impact on Design Certification Document ("DCD") and the markup pages to the DCD. This response supersedes the response to Question 03.04.01-29 previously transmitted in Reference 2. The response to the other question in Reference 2 is not changed by this document.

Please contact Mr. Joseph Tapia, General Manager of Licensing Department, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of this submittal. His contact information is provided below.

Sincerely,

Y. Ogata

Yoshiki Ogata,
Director- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosure:

1. Revised Response to Request for Additional Information No. 841-6055 Revision 3

D081
NRO

CC: J. A. Ciocco
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Enclosure 1

UAP-HF-12331
Docket No. 52-021

Revised Response to Request for Additional Information
No. 841-6055 Revision 3

December 2012

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

12/26/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 841-6055 REVISION 3**
SRP SECTION:	**03.04.01 – INTERNAL FLOOD PROTECTION FOR ONSITE EQUIPMENT FAILURES**
APPLICATION SECTION:	**3.04.01**
DATE OF RAI ISSUE:	**10/18/2011**

QUESTION NO.: 03.04.01-29:

DCD Tier 2, Section 3.4.1.5, "Evaluation of Internal Flooding," outlines the flood evaluation process used in the internal flooding analysis for the US-APWR design. This section identifies the following flooding events that were considered in the analysis:

- Loss of Coolant Accident (LOCA)
- Earthquake
- High-Energy Line Break/Moderate Energy Line Break (HELB\MELB)
- Fire Fighting Operations

While the DCD states that the above events are considered, and identifies the events that were used in determination of the maximum flood height in the various plant areas subject to internal flooding, the DCD did not provide the basis for the assumption used in determining these applicable flood levels. An example would be flooding resulting from fire fighting operations in the reactor building. In the DCD, it is indicated that the quantity of flood water associated with fire-fighting activities is based on operation of two hose stations for two hours, assuming a 125 gpm flow rate per hose station. The basis for the assumption of two hose stations, and the assumption of a flowrate of 125 gpm per hose station for two hours is not provided in the DCD. Another example where the DCD has limited information is on the HELB/MELB evaluations. HELB/MELB is considered in the evaluation, and the HELB contribution to flood levels are shown in some areas but there is no indication on when breaks and cracks in moderate energy lines were considered, or how they were evaluated.

In order for the staff to evaluate if safety-related SSCs are adequately protected form internal flooding, as required by GDCs 2 and 4, the applicant is requested to provide following information:

1. Provide, and include in the DCD, the basis for assumptions made for evaluating flooding due to fire fighting operations, including the bases for the number of hose stations assumed, the flow rates for those stations for all areas where fire fighting operations were assumed, and the 2 hour duration.
2. Discuss how high and moderate energy line breaks and cracks were accounted for in their analsysis. Include information on which breaks were accounted for in each area, and how the release rates and durations were determined for the high and moderate energy line failures.

Additionally, the flooding analysis should be made available for NRC audit.

ANSWER:

[Item No.1]

The water volume discharged during fire fighting operation is evaluated under reasonable assumptions in light of the industrial common knowledge with sufficient conservatism. Two hose stations are not necessarily available in all fire areas, but are assumed for conservatism. The flow rate of 125 gpm per hose station is estimated with a hose station that can be handled by untrained persons. The assumption of a two-hour duration as well as that of two hose stations is extremely conservative for fire fighting in one room, and is consistent with the Section 3.2 of RG 1.189.

Furthermore, the above-mentioned assumptions are in line with the other precedent design certifications.

MHI will provide the basis for the assumptions made for the fire protection activity in the DCD. See the Impact on the DCD.

[Item No.2]

The flooding caused by HELB/MELB is evaluated in accordance with the criteria provided in DCD Tier 2, Section 3.6, "Protection Against Dynamic Effects Associated with Postulated Rupture of Piping." Since a LOCA represents the worst case flooding event in the containment vessel, postulated line breaks in the reactor building (R/B) or power source buildings (PS/Bs) are discussed below.

High energy line breaks

Water-containing high energy lines with nominal diameters of more than 1 inch are evaluated as potential water sources in the flooding evaluation. Such lines belong to chemical and volume control system (CVCS), feedwater system (FWS), or steam generator blowdown system (SGBDS). The volume of water discharged from these lines in the event of HELB is calculated as follows.

CVCS in the R/B RCA west area

Letdown line, charging line, and seal water injection line run through the west radiological controlled area (RCA) of the reactor building (R/B). Flow rate from postulated pipe rupture (Q) is calculated with,

$$Q = \sqrt{\frac{2g\Delta H}{\Sigma K}} \times A \quad \text{(1)}$$

where g is the gravitational acceleration, ΔH is the hydraulic head at the break point, ΣK is loss coefficient, and A is flow area. ΔH and A are assumed to be the design pressure of the line, and internal cross-section of the pipe, respectively. ΣK of 1.5 is conservatively applied.

The discharge from the three lines is assumed to continue until the broken line is automatically isolated in response to low water level alarm of the pressurizer. Therefore, the duration of water release is sum of the time elapsing from initiation of the discharge to activation of the alarm, and from the alarm and closure of an isolation valve. The former is calculated based on the flow rate given above, and the latter is assumed to be 5 minutes for conservatism.

On the basis of the assumptions above, the break in charging line will result in 15,000 ft^3 of flooding water, the largest amount among the three lines. This obtained value is

conservative also in that the design pressure, instead of operating pressure, is chosen as the pipe internal pressure and assumed to remain constant throughout the discharge.

While the above mentioned three lines run between B1F and 2F in west RCA of the R/B, flooding water discharged on between 1F and 2F will immediately flow down to B1MF through grated floor near the pipes, resulting in no accumulation of water on the upper floor. As a consequence, the flooding water released following the charging line break will accumulate on either B1F or B1MF. Since all of the components required to maintain functionality during a flood event are located within water-tight compartment, the event will not jeopardize the plant's safety.

FWS in the R/B NRCA west and east MS/FW area

The high energy piping in the MS/FW piping areas comprises main steam, feedwater, and SG blowdown piping. A rupture of the feedwater piping upstream of the feedwater check valve represents the worst case flooding scenario in this area. The water volume released in this event is broken into the water from the SG, the main feedwater pump, and the main feedwater piping.

1. The volume of water from the SG

   Although it is the most likely that the water retained in the SG below the level of the feedwater nozzle is released, the volume is more conservatively calculated on the assumption that the water between the narrow range level taps is released. As a result, the water volume is estimated to be 95 m^3 (3,355 ft^3).

2. The volume of water from the main feedwater pump

   The volume of water coming from the main feedwater pump is calculated by multiplying the flow rate in feedwater piping under normal plant conditions and time duration. The flow rate assumed in the calculation is 2,850 m^3/h. It is postulated that the main feedwater pump keeps pumping the feedwater until the SG low water level signal automatically trips the pump. This duration is estimated on the basis of

   i) Released water volume required to trigger SG low water level signal

   ii) Release rate of water from the SG

   The water volume i) is 3,355 ft^3. The flow rate of discharge from the SG is calculated with the formula (1).

$$Q = \sqrt{\frac{2g\Delta H}{\Sigma K}} \times A = \sqrt{\frac{2 \cdot 32.2[\mathrm{ft/sec^2}] \cdot 37.346[\mathrm{ft}]}{1.5}} \times 1.0[\mathrm{ft^2}] \cong 40[\mathrm{ft^3/sec}]$$

   The loss coefficient of 1.5 is conservatively applied, and ΔH of 37.346 [ft] is determined on the basis of the level difference between the break point and the upper narrow range level taps. The area of the break is 1.0 ft^2, in accordance with DCD Tier 2, Section 3.6.

   Therefore, the time duration between the break and the SG low water level signal is obtained as,

$$3{,}355\ [\mathrm{ft^3}] / 40\ [\mathrm{ft^3/sec}] \cong 84\ [\mathrm{sec}]$$

   Although this calculated duration is shorter than 1.5 min, time duration of 5 min is applied in the water volume calculation for extensive conservatism. Consequently, the water volume discharged from the main feed water pump before the signal is,

$$2{,}850\ [\mathrm{m^3/hr}] \times 5[\mathrm{min}]/60[\mathrm{min/hr}] \cong 240\ [\mathrm{m^3}]$$

3. The volume of water from the main feedwater pipe

   The water volume from the main feedwater pipe is calculated on the basis of the piping volume from the feedwater nozzle of the SG to the main feedwater control valve, and is 7 m^3. For conservatism, 10 m^3 was applied for the flood evaluation.

In conclusion, the total flood water volume in the west and east MS/FW piping areas at elevation 76 ft, 5 in calculated as follows.

$$95\ m^3 + 240\ m^3 + 10\ m^3 = 345\ m^3 \cong 12{,}180\ ft^3$$

SGBDS in the R/B NRCA west and east MS/FW area

High energy lines of SGBDS subject to flooding evaluation run through the MS/FW areas. Since the HELB of the feedwater piping represents the most severe flooding event in the areas as mentioned above, the HELB of the SGBDS lines are not postulated.

MHI will provide additional description on the postulation of high and moderate energy line break as bases for the flood evaluation. See the attachment for DCD impacts.

Moderate energy line breaks

Moderate energy line breaks (through-wall cracks) in pipes with nominal diameters of more than 1 inch are postulated in the flooding evaluation in accordance with DCD Tier 2, Section 3.6. Discharged water volumes are calculated with the formula (1), assuming the flow area is equal to a rectangle one-half the pipe inside diameter in length and one-half the pipe wall thickness in width.

The water release duration of one hour is applied as the time elapsing from initiation to the end of the discharge, conservatively assuming that operators start required actions 30 minutes after the initiation, and the operators stop water release in 30 minutes after starting taking actions.

Threshold values of allowable discharged water volume are set to 4,000 ft^3 in both the RCA and NRCA. Any line the calculated water volume from which exceeds the threshold is to be designed so that a crack is not required to be postulated in the line by means of route and support design, in accordance with the criteria provided in Section 3.6. Consequently, maximum water volume postulated in the event of MELB on which water level calculation is based is 4,000 ft^3 in both the RCA and NRCA.

Impact on DCD

The DCD Section 3.4 will be revised as shown in the attachment. In addition to the changes to clarify the above-mentioned bases, other changes to reflect the latest design information including those related to seismic closure plan are incorporated in the attachment. DCD markup pages for the impacts on Appendix 3K and Tier 1 are to be submitted in accordance with "Updated Closure Plan for US-APWR Seismic and Structural Analyses" (UAP-HF-12238). Markup pages for the impacts on the following parts of the DCD are to be submitted in a separate document by January 31, 2013.

Tier 1		Section 2.7.6.8.1		
		Table 2.7.6.8-1		
Tier 2	Chapter 3	Table 3.2-2		
		Figure 3E-2,	Figure 3E-3,	Figure 3E-5,
		Figure 3E-6,	Figure 3E-9,	Figure 3E-13
	Chapter 5	Figure 5.1-2		
	Chapter 9	Section 9.2.7,	Section 9.3.3	
		Figure 9.1.3-2,	Figure 9.2.2-1,	Figure 9.2.6-2,
		Figure 9.2.6-3,	Figure 9.2.7-2,	Figure 9.3.2-1,
		Figure 9.3.3-1,	Figure 9.3.4-1	
	Chapter 10	Figure 10.4.8-1,	Figure 10.4.9-2	

Impact on R-COLA

There is no impact on the R-COLA.

Impact on S-COLA

There is no impact on the S-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Topical Report / Technical Report

There is no impact on the Topical Report / Technical Report.

Attachment to RAI 841-6055

3.4.1.3 Flood Protection from Internal Sources

The US-APWR SSCs are designed to accommodate the effects of, and to be compatible with, the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including LOCAs. This subsection addresses the accommodations made for flooding from internal water sources, specifically from the following:

- Earthquakes
- Pipe breaks and cracks
- Fire fighting operations
- Pump mechanical seal failures

The combination of events is not considered. However, an earthquake event followed by fire fighting operations for an earthquake induced fire is considered.

Full-circumferential ruptures of non-seismic piping and failures of non-seismic equipment located in the R/B or power source buildings (PS/Bs) are considered in the evaluation of flooding caused by an earthquake. Non-seismic equipment~~For flood events caused by an earthquake, equipment or pipe (not classified as seismic category I) in the R/B are assumed to be fully compromised and the total volume of the fluid contained within the subject equipment or pipe contributes to the flood volume. Equipment~~ or piping ~~not classified as seismic category I~~ in areas outside of the area of concern is also assumed to be fully compromised, and if the discharge fluids can not be demonstrated to be excluded from the area of concern, their volume is included in the flood volume. The US-APWR is designed for maximum water levels created by internal flooding sources. The internal flood design accommodates the effects of, and is compatible with, environmental conditions associated with normal operations, maintenance, testing, and postulated accidents, including LOCAs. DCD_03.04.01-29

Water-tight doors are used as protective barriers to prevent flood waters from spreading to adjacent divisions in various buildings and elevations. ~~Water-tight doors have remote position indication for closure verification and are periodically inspected and tested to ensure proper functionality.~~Water-tight doors have remote position indication for closure verification and are subject to periodic visual inspection and functional testing to help maintain and demonstrate meeting their design function. Any aging-related degradation or fault is identified and repaired. The COL Applicant is responsible for developing inspection and testing~~are performed in accordance with operating~~ procedures ~~developed as per Subsection 13.5.2.~~in accordance with manufacturer recommendations so that each water-tight door remains capable of performing its intended function. DCD_03.04.01-32 DCD_03.04.01-32 S01

Open pits are isolated within water tight compartments using water tight doors, penetration seals, and normally closed floor drains. In this manner, flooding effects caused by open pit water sloshing are considered.

For flood events caused by the postulated failure of piping, defined in Section 3.6, the rupture of the single worst-case piping in the area of concern is assumed in the flood

Attachment to RAI 841-6055

analysis for each area of concern. The discharge volume is calculated according to "Subcompartment Pressure and Temperature Transient Analysis in Light Water Reactors", American National Standards Institute (ANSI)/American Nuclear Society (ANS) 56.10-1987, Section 3 (Reference 3.4-6), and is included in the pipe break and cracks flood evaluation. The structures adjacent to the postulated pipe rupture locations are also designed for the maximum associated hydrodynamic loads due to a pipe failure as discussed in Section 3.6. The loads and load combinations are addressed in detail in Section 3.8.

In the flooding effects from fire fighting operations, water discharged from only fire hose stations is assumed. The fire fighting operations are assumed to continue for a period of 2 hours from two hose stations, on the basis of the Section 3.2 of RG 1.189. The discharge rate of 125 gpm per hose station is applied, assuming the use of a hose station that can be handled by untrained persons~~In fire fighting operations, a discharge rate of 125 gpm is assumed for a period of 2 hours from two hose stations~~. DCD_03.04.01-29

Pump mechanical seal failures of concern are limited to the active pumps identified in Section 3.9. Seal failure is a low probability event based on the use of robust pump mechanical seals. Additionally, monitoring of mechanical seal water temperature, pressure, and flow rate across the pump mechanical seals provides the means of limiting the effects of pump seal failure through early detection and timely corrective action. As such, pump mechanical seal failure presents a sufficiently low probability of occurrence and flood volume that it can be credibly ignored.

The formulae and methodology of "Design Criteria for Protection against the Effects of Compartment Flooding in Light Water Reactor Plants", ANSI/ANS-56.11-1988 (Reference 3.4-7) are used when analyzing flow rates through unusual features such as stairwells and floor/wall openings.

The areas of concern within the US-APWR are as follows:

- R/B
  - Inside the PCCV

    Systems to be protected within the PCCV are the RCS, the safety injection system (SIS), RHRS, the CSS, and the containment boundary.

    The components to be protected from flooding in the protected systems are the motor operated components, such as valves and electric/instrumentation components.

  - Outside the PCCV

    US-APWR R/B consists of a radiological controlled area (RCA) and a non-radiological controlled area (NRCA) separated physically by concrete barrier walls. These concrete barrier walls are designed to preclude flooding between the RCA and the NRCA. Piping, instrumentation, HVAC duct, conduit, and cable trays installed through a flood barrier wall are routed above the maximum flood level or provided with water-tight seals.

Attachment to RAI 841-6055

- R/B RCA

  Systems to be protected in the RCA of the R/B are the SIS, the RHRS, the CSS, the containment boundary, the safeguard component area HVAC system, and the annulus air clean up system.

  In the systems to be protected, the components to be protected from flooding are the motor driven pumps, the valves, and the HVAC fans and dampers, the electric panels, and the electric/instrumentation components within the relevant system.

  Instrumentation for flood detection is installed in the containment annulus compartment since the compartment houses mechanical penetrations including piping systems containing water. The instrumentation is designed to alarm when the annulus compartment is flooded.

- R/B NRCA

  The NRCA of the R/B adjoins the east and west PS/Bs and the T/B, with personnel access between all three areas.

  The systems to be protected in the NRCA of the R/B are the CCWS, the emergency feedwater system (EFWS), the electrical panels, the Class 1E electric/instrumentation components, and the HVAC fans and dampers for these systems.

- PS/B

  DCD_03.04.01-29

  The east and west PS/Bs adjoin the R/B.

  The equipment to be protected in the east area of PS/B are the A, B, C, and D train Essential Chiller Units, and A, B, C, and D train Class 1E GTG.

- A/B

  The A/B adjoins the R/B. There are no SSCs to be protected from flooding the A/B.

- T/B

  The T/B adjoins the NRCA of the R/B. The T/B is subject to flooding from a variety of potential sources including the circulating water, service water, condensate/feedwater, CCW, demineralized water, and fire protection systems.

  The bounding flooding source for the T/B is a break in the circulating water piping.

  A break in the circulating water system (CWS) piping would result in water flowing into the lower elevation of the T/B, elevation -18 ft, 0 in. When the flood water fills the lower level of the T/B, to prevent the CWS flood volume from affecting R/B equipment, a flood relief panel system is built into the T/B exterior walls. Passive actuation of the flood relief panels allows the CWS flood volume to drain out to the

Attachment to RAI 841-6055

Flood Events are considered as follows;

- Earthquake

Most of the water-containing equipment and piping in the RCA of the R/B are excluded from flooding source because they are designed to withstand Safe Shutdown Earthquake (SSE). The flood water volume is evaluated on the basis of amounts of water contained in or estimated flow rates from other non-seismic equipment and/or piping~~Most of equipments and piping contained water in the RCA of the R/B are excluded from flooding source because these components are designed as seismic category I or II. However, it is assumed that there is other miscellaneous piping designed as non-seismic, and the amount of water contained by this piping is considered as flood water~~. DCD_03.04.01-29

The amount of water released in the seismic event is 260 ft^3 in the east area and 4,400 ft^3 in the west area~~contained by other miscellaneous piping is 1,060 ft^3~~.

- High-energy line break/moderate-energy line break (HELB/MELB)

The high energy line in the RCA of R/B consists of the charging line, letdown line, and seal water injection line of the chemical and volume control system (CVCS). All these lines are not routed within the east side of R/B. Of these lines, the line break in the charging piping in the west side of R/B RCA constitutes the most severe flooding event. In this event, release of water from the charging piping continues until the line is automatically isolated. The time required for automatic closure of an isolation valve after an isolation signal is conservatively estimated to be 5 minutes.~~The high energy piping in the RCA of R/B consists of the charging pipe, letdown pipe, and seal water injection piping of the CVCS. Of this piping, the line break occurs in the charging piping at the charging pump discharge nozzle. The water volume released by this break consists of the following:~~ DCD_03.04.01-29

- ~~The total content of the VCT, 670 ft^3.~~
- ~~The volume of water from the RWSAT, which would be released between the time of the HELB event and the time of the RWSAT isolation from the line break. The gravity flow rate from the RWSAT is 14,400 ft^3/hr. The time duration between HELB and isolation is taken as 45 minutes. Thus, the volume of the RWSAT released is 10,800 ft^3.~~
- ~~The associated pipe, assumed to be 100 ft^3, between the two tanks and the charging pump.~~

The total water volume from this HELB event in the west area is 15,000 ft^3~~This total water volume from the HELB event is 11,570 ft^3~~.

Moderate energy piping whose failure may leads to discharge of more than 4,000 ft^3 of water is designed not to be subject to the pipe break postulation by means of route and support design. Therefore, the most severe postulated flooding event

Attachment to RAI 841-6055

caused by a crack in the rest of the moderate energy piping results in discharged water volume of equal to or less than 4,000 ft^3 in both east and west area~~The flow path from the RWSAT is through a six in. pipe line containing two parallel sets of motor operated valves with two valves in each set. These valves are normally closed but are open upon signal from the reactor make up water system. The HELB is conservatively considered to occur when the valves of the reactor make up water system have been actuated open and remain open until actuated closed by plant personnel. The amount of time allotted to transpire between the HELB event and closure actuation is conservatively assumed to be 45 minutes. Detection of the HELB occurs through multiple paths. The primary path is the charging pump trip logic circuit. The secondary path is the charging pump rooms leak detection system. In addition, the CVCS line from the RWSAT and the charging pumps contains a flow indicating orifice which dually serves as an indicator of excess flow from the RWSAT and also as flow restrictor. Credit for the flow restriction is not taken~~. DCD_03.04.01-29

- Fire Fighting Operations

  Flooding contribution from fire-fighting operations is based on the full operation of two hose stations for 2 hours. The flow rate from 1 hose station is 125 gpm. With two stations operating for 2 hours, the total volume of water is 4,010 ft^3.

Based on the above, the worst case flooding on the west side of the R/B is a HELB at 15,000~~11,570~~ ft^3. On the east side of the plant, the worst case flooding is an earthquake followed by fire fighting operations due to an earthquake induced fire at 4,270~~5,070~~ ft^3. DCD_03.04.01-29

The square footage of floor area subject to flooding at elevation -26 ft, 4 in. is as follows:

- East side: 4,100 ft^2
- West side: 4,200~~5,100~~ ft^2 DCD_03.04.01-29

Based on these values, the maximum water levels are as follows:

- East side: 1.05~~24~~ ft above elevation -26 ft, 4 in. DCD_03.04.01-29
- West side: 3.58~~2.27~~ ft above elevation -26 ft, 4 in.

The SI pump and CS/RHR pump are installed in a room which prevents flow-in water by water-tight door, and floor drains of these rooms are separated by closed valve or check valve for each train. Therefore, the pumps are not flooded. Instrumentation of the SI pump and CS/RHR pump are installed above the flood water level.

Elevation 3 ft, 7 in.

Flood waters occurring above elevation -26 ft, 4 in. drain to floor elevation -26 ft, 4 in. through floor drains, stairwell, elevator shaft and/or equipment hatch. However, the evaluation above elevation -26 ft, 4 in. conservatively assumes that the water drainage will not reduce the flood water level at the floor of origin~~flooding water is not drained~~. DCD_03.04.01-29

The equipment to be protected in the east area of RCA at elevation 3 ft, 7 in. are the A and B train CS/RHR heat exchanger (HX), the A and B train safeguard component area air handling unit, and the A train SFP pump. The equipment to be protected in the west area of RCA at elevation 3 ft, 7 in. are the C and D train CS/RHR HX, the C and D train safeguard component area air handling unit, and B train SFP pump.

The CS/RHR HX and the safeguard component area air handling unit are isolated by concrete walls and water-tight door. Moreover, floor drains of these rooms are separated from floor drains outside of these rooms and are also separated for each train. Therefore, flood water is assumed to run across the area except the CS/RHR HX and the safeguard component area air handling unit rooms.

Flood Events are considered as follows:

- Earthquake

  The flood water volume is estimated on the basis of the amount of water contained in non-seismic equipment or piping. The amount of water discharged in the seismic event is 100 ft^3 in both the east and west area~~The total water volume from the earthquake event is same as that of elevation -26 ft, 4 in~~. DCD_03.04.01-29

- HELB/MELB

  HELB event is not a concern, because the flood water discharged from the postulated pipe break will immediately flow down to the lower floor level through floor opening. DCD_03.04.01-29

  The total water volume from the MELB event is same as that of elevation -26 ft, 4 in~~at the discharge nozzle of the CVCS charging pump occurs at a location on a lower floor level~~.

- Fire Fighting Operations

  The total water volume from the fire fighting operation events is same as that of elevation -26 ft, 4 in.

Based on the flood events described above, the worst case results are from a combination of earthquake and fire fighting operations. The total volume of flood water caused by this combination is 4,110~~5,070~~ ft^3 in both the east and west area. DCD_03.04.01-29

The footage of subject area and the water level are as follows:

- East side: 7,250~~400~~ ft^2 area, 0.57~~69~~ ft water height above elevation 3 ft, 7 in. DCD_03.04.01-29
- West side: 5,200~~750~~ ft^2 area, 0.80~~8~~ ft water height above elevation 3 ft, 7 in.

CS/RHR HX and safeguard component area air handling unit are installed in the room which prevents flow-in water by water-tight door, and floor drains of these rooms are separated from floor drains outside of these rooms and are also separated for each train.

Therefore, components are not flooded. The instrumentation of the CS/RHR HX and safeguard component area air handling unit are installed above the flood water level.

The height (top of concrete) of A and B train SFP pump foundations are 1.0 ft above the floor elevation 3 ft, 7 in. Therefore, the SFP pumps are not flooded.

Elevation 25 ft, 3 in.

The equipment to be protected in the east and west area of RCA elevation 25 ft, 3 in. are the containment isolation valves in piping penetration room.

Flood Events are considered as follows:

- Earthquake

  The amount of water discharged from non-seismic equipment or piping in the seismic event is 100 ft^3 in the east area and 10 ft^3 in the west area~~The total water volume from the earthquake event is same as that of elevation -26 ft, 4 in~~. DCD_03.04.01-29

- HELB/MELB

  HELB event is not a concern, because the flood water discharged from the postulated pipe break will immediately flow to the lower floor level through floor opening. DCD_03.04.01-29

  The total water volume from the MELB event is same as that of elevation -26 ft, 4 in~~postulated pipe break at the discharge nozzle of the CVCS charging pump occurs at a location on a lower floor level~~.

- Fire Fighting Operations

  The total water volume from the fire fighting operation events is same as that of elevation -26 ft, 4 in.

Based on the flood events described above, the worst case results are from a combination of earthquake and fire fighting operations. The total volume of flood water caused by this combination is 4,110~~5,070~~ ft^3 in ~~both~~ the east area, and 4,020 ft^3 in the west area. DCD_03.04.01-29

The both east and west areas are isolated by concrete walls and the fireproof doors and/or air-tight doors which are not water-tight. Therefore, flood water is assumed to run across the each area.

The footage of subject area and the water level are as follows;

- East side: 9,450~~500~~ ft^2 area, 0.44~~53~~ ft water height above elevation 25 ft, 3 in. DCD_03.04.01-29
- West side: 7,200~~350~~ ft^2 area, 0.56~~69~~ ft water height above elevation 25 ft, 3 in.

The containment isolation valve motors are installed above the flood water level.

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Elevation 50 ft, 2 in.

The equipments to be protected in the east and west area of RCA elevation 50 ft, 2 in. are annulus emergency exhaust filtration unit and junction boxes and cables in the electrical penetration rooms.

Flood Events are considered as follows;

- Earthquake

  The amount of water discharged from non-seismic equipment or piping in the seismic event is 10 ft^3 in the west area. There is no non-seismic water-containing equipment or piping in the east area on this floor~~The total water volume from the earthquake event is same as that of elevation -26 ft, 4 in~~. DCD_03.04.01-29

- HELB/MELB

  HELB event is not a concern, because there is no high energy piping on or above this floor. DCD_03.04.01-29

  The total water volume from the MELB event is same as that of elevation -26 ft, 4 in~~the postulated pipe break at the discharge nozzle of the CVCS charging pump occurs at a location on a lower floor level~~.

- Fire Fighting Operations

  The total water volume from the fire fighting operation events is same as that of elevation -26 ft, 4 in.

Based on the flood events described above, the worst case results are from a combination of earthquake and fire fighting operations. The total volume of flood water caused by this combination is 4,010~~5,070~~ ft^3 in ~~both~~ the east area, and 4,020 ft^3 in the west area. DCD_03.04.01-29

The both east and west areas are isolated by concrete walls and the fireproof doors and/or air-tight doors which are not water-tight. Therefore, flood water is assumed to run across the each area.

The footage of subject area and the water level are as follows:

- East side: ~~8,8700~~7,550 ft^2 area, 0.~~4658~~54 ft above elevation 50 ft, 2 in. DCD_03.04.01-29
- West side: 6,650 ft^2 area, 0.61~~76~~ ft above elevation 50 ft, 2 in. DCD_03.04.01-29 S01

The annulus emergency exhaust filtration unit foundations (top of concrete) height is 1.0 ft above floor elevation 50 ft, 2in. As such, the annulus emergency exhaust filtration units are not flooded. The junction boxes and cables in the electrical penetration rooms is designed to be located at heights above the level of flood water.

Elevation 76 ft, 5 in.

Elevation 76 ft, 5 in. of the RCA is divided into two areas, east and west, by concrete wall and water-tight doors and the fuel handling area. The fuel handling area is isolated by installing the water-tight doors to walkway and/or doorways of stairwell to prevent flood water by sloshing of SFP spilling to other area.

The equipment to be protected from internal flooding on elevation 76 ft, 5 in. of the RCA are junction boxes and cables connected to the PCCV penetrations in the east and west electrical penetration areas.

There is no equipment to be protected in the fuel handling area.

Flood Events are considered as follows;

- Earthquake

  The amount of water discharged from non-seismic equipment or piping in the seismic event is 10 ft^3 in the west area. There is no non-seismic water-containing equipment or piping in the east area on this floor~~The total water volume from the earthquake event is same as that of elevation -26 ft, 4 in~~. DCD_03.04.01-29

- HELB/MELB

  HELB event is not a concern, because there is no high energy piping on or above this floor. DCD_03.04.01-29

  The total water volume from the MELB event is same as that of elevation -26 ft, 4 in~~the postulated pipe break at the discharge nozzle of the CVCS charging pump occurs at a location on a lower floor level~~.

- Fire Fighting Operations

  The total water volume from the fire fighting operation events is same as that of elevation -26 ft, 4 in.

Based on the flood events described above, the worst case results are from a combination of earthquake and fire fighting operations. The total volume of flood water caused by this combination is 4,010~~5,070~~ ft^3 in ~~both~~ the east area, and 4,020 ft^3 in the west area. DCD_03.04.01-29

The both east and west areas are isolated by concrete walls and the fireproof doors and/ or air-tight doors which are not water-tight. Therefore, flood water is assumed to run across the each area.

The footage of subject area and the water level are as follows:

- East side: 5,900~~6,050~~ ft^2 area, 0.68~~84~~ ft above elevation 76 ft, 5 in. DCD_03.04.01-29
- West side: ~~5,1~~4,900 ft^2 area, 0.~~7999~~83 ft above elevation 76 ft, 5 in. DCD_03.04.01-29 S01

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The junction boxes and cables in the electrical penetration rooms are~~is~~ designed to be located at heights above the level of flood water. DCD_03.04.01-29

3.4.1.5.2.2 NRCA

The NRCA is arranged into rooms/compartments to provide a physical separation of the water containing components from the electrical components. This separation, along with the associated physical barriers (concrete walls and floors), minimizes the probability of component leaks affecting the electrical components.

All floors in the NRCA of the R/B are divided into the two areas, east and west, by concrete walls and/or water-tight doors. The concrete walls are designed to prevent flood water migration from one safety train to another. This is accomplished by installing piping, electrical conduit, HVAC duct, cable trays, etc., penetrations above the maximum flood level and/or by sealing penetrations.

Two types of drain systems are provided in the NRCA of the R/B - an equipment drain system and a room/compartment floor drain system. The equipment drain system collects water leaking from components and routes the leakage to the non-radioactive drain sump. The floor drain water is also routed to the non-radioactive drain sump at elevation -26 ft, 4 in. The floor drains of the east areas are connected and finally go into the A-R/B non-radioactive sump. The floor drains of west areas are connected and finally go into the B-R/B non-radioactive sump. There is no cross-connection between east area drains and west area drains. Therefore, east and west areas are evaluated as independent areas.

The drains from the NRCA of A/B and the PS/B are also collected in the R/B non-radioactive sumps. The water in the R/B non-radioactive sumps is transferred to the T/B sump by sump pumps. The evaluation of flooding in the NRCA area of the R/B conservatively excludes the use of the sump pump.

The drains from the main steam (MS) / feedwater (FW) piping area is directly collected in the T/B sump. The MS/FW piping area is addressed separately below.

Elevation -26 ft, 4 in.

The systems to be protected at elevation -26 ft, 4 in. of the NRCA of the R/B are the four trains (A, B, C, and D) of the component cooling water (CCW) heat exchanger and pump and four trains (A, B ,C and D) of the emergency feedwater (EFW) pump.

The east side includes the two trains (A and B) of the CCW HX and pump rooms, and two trains (A and B) of the EFW pump room. The west side includes the two trains (C and D) of the CCW HX and pump room, and two trains (C and D) of the EFW pump room.

Equipment rooms are isolated by concrete walls and the fireproof doors which are not water-tight. Therefore, flood water is assumed to run across the area.

In addition, since the doorways to the PS/B which adjoined each east and west area of R/B are not water-tight, flood water of the NRCA of R/B is assumed to flow into the whole area of the PS/B, elevation -26 ft, 4 in.

Therefore, the subject area of east is the east side of R/B and PS/B. Similarly, the subject area of west is the west side of R/B and PS/B.

Flood events are considered as follows:

- Earthquake

  Most of the water-containing equipment and piping in the NRCA of the R/B and PS/B are excluded from flooding source because they are designed to withstand Safe Shutdown Earthquake (SSE). The flood water volume is estimated on the basis of the amount of water contained in other non-seismic equipment or piping. DCD_03.04.01-29

  The amount of water discharged in the seismic event is ~~540~~700 ft^3 in both the east and west areas.~~In the flooding events caused by an earthquake, the following components are assumed to fail and release all of their contents:~~ DCD_03.04.01-29 S01

  - ~~Non-seismic category I piping in the NRCA of the R/B, total volume of water held by these pipe lines is 700 ft^3.~~

  - ~~Non-seismic category I components in the adjacent A/B are considered damaged. Water from these failed components is conservatively assumed to flow to the NRCA portion of the R/B through floor drains. The components in these buildings which are not seismic category I are associated with the demineralized water system, non-safety chilled water. The total volume of water held by these systems is 1,590 ft^3. Since floor drains of the NRCA of the A/B are collected by non-radioactive drain sump, the water of these areas does not flow into the east area. Therefore, the water generated in the NRCA of the A/B is taken into consideration only to evaluation of the west area.~~

- HELB/MELB

  HELB event is not a concern, because ~~there are no piping breaks, which are assumed to occur in the subject area~~break of turbine driven emergency feedwater pump steam piping drain line, which is the only high energy line in these areas, results in less severe flooding event than that caused by earthquake concurrent with fire-fighting operation. DCD_03.04.01-29

  Moderate energy piping whose failure may leads to discharge of more than 4,000 ft^3 of water is designed not to be subject to the pipe break postulation by means of route and support design. Therefore, the most severe postulated flooding event caused by a crack in the rest of the moderate energy piping results in discharged water volume of equal to or less than 4,000 ft^3 in both east and west area.

- Fire Fighting Operations

  The flooding contribution from fire fighting operations is based on the full operation of two hose stations for 2 hours. The flow rate from one hose station is 125 gpm. With two stations operating for 2 hours, the total volume of water is 4,010 ft^3.

Based on the flood events described above, the worst case results are from a combination of earthquake and fire fighting operations. The total volume of flood water caused by this combination is as follows:

- East side: 4,550~~710~~ ft^3 DCD_03.04.01-29
- West side: 4,710~~5506,300~~ ft^3 DCD_03.04.01-29 S01

The square footage of floor area subject to flooding at elevation -26 feet, 4 inches is as follows:

- East side: 11~~0~~,500 ft^2 DCD_03.04.01-29
- West side: 11~~0~~,1~~5~~00 ft^2

Base on these values, the maximum water level is as follows:

- East side: 0.40~~5~~ ft above elevation -26 ft, 4 in. DCD_03.04.01-29
- West side: 0.43~~160~~ ft above elevation -26 ft, 4 in. DCD_03.04.01-29 S01

The pump foundations (top of concrete) height is 1.0 foot above floor elevation -26 ft, 4 in. As such, the pumps are not flooded. The instrumentation of each pump is designed to be located at heights above the level of flood water.

Elevation 3 ft, 7 in.

Flood waters occurring above elevation -26 ft, 4 in. drain to floor elevation -26 ft, 4 in. through floor drains, stairwell, elevator shaft and/or equipment hatch. However, the evaluation above elevation -26 ft, 4 in. conservatively assumes that the water drainage will not reduce the flood water level at the floor of origin~~flooding water is not drained~~. DCD_03.04.01-29

The equipment to be protected in the east area of NRCA at elevation 3 ft, 7 in. are the A and B train Class 1E electrical panels. Similarly, the equipment to be protected in the west area is the C and D train Class 1E electrical panels. The Class 1E electrical panel rooms are isolated from corridor by concrete walls and water-tight door. There are no floor drains in the Class 1E electrical panel rooms.

Since the doorway between the corridor in the east PS/B and east area of the R/B at elevation 3 ft, 7 in. is not water-tight, flood water in the east NRCA of the R/B is assumed to flow into the east PS/B, and vice versa. DCD_03.04.01-29

Flood events are considered as follows:

- Earthquake

  The flood water volume is estimated on the basis of the amount of water contained in non-seismic equipment or piping. The amount of water discharged in the seismic event is 10 ft^3 in both the east and west area~~The total water volume from the earthquake event is same as that of elevation -26 ft, 4 in~~. DCD_03.04.01-29

- HELB/MELB

  HELB event is not a concern, because break of drain piping for turbine driven emergency feedwater pump steam piping results in less severe flooding event than that caused by earthquake concurrent with fire-fighting operation. DCD_03.04.01-29

  The total water volume from the MELB event is same as that of elevation -26 ft, 4 in~~there are no piping breaks, which are assumed to occur in the subject area~~.

- Fire Fighting Operations

  The total water volume from the fire fighting operation events is same as that of elevation -26 ft, 4 in.

Based on the flood events described above, the worst case results are from a combination of earthquake and fire fighting operations. The total volume of flood water caused by this combination is 4,020~~710~~ ft^3 in both the east and west area. DCD_03.04.01-29

The footage of corridor area and the water level are as follows:

- East side: 4,3~~1,5~~00 ft^2 area, 0.94~~3.14~~ ft above elevation 3 ft, 7 in. DCD_03.04.01-29
- West side:1,500 ft^2 area, 2.68~~3.14~~ ft above elevation 3 ft, 7 in.

Class 1E electrical panels are installed in the room which prevents flow-in water by water-tight door. Therefore, panels are not flooded.

Elevation 25 ft, 3 in.

The equipment to be protected in the NRCA portion of elevation 25 ft, 3 in. is the main control panel and Class 1E I&C panels. The main control room and Class 1E I&C rooms are isolated from corridor by concrete walls and water-tight door.

Flood events are considered as follows;

- Earthquake

  The flood water volume is estimated on the basis of the amount of water contained in non-seismic equipment or piping. The amount of water discharged in the seismic event is 10 ft^3 in both the east and west area~~The total water volume from the earthquake event is same as that of elevation -26 ft, 4 in~~. DCD_03.04.01-29

- High-Energy Line Break/Moderate-Energy Line Break (HELB/MELB)

  HELB event is not a concern, because break of drain piping for turbine driven emergency feedwater pump steam piping results in less severe flooding event than that caused by earthquake concurrent with fire-fighting operation. DCD_03.04.01-29

  The total water volume from the MELB event is same as that of elevation -26 ft, 4 in~~there are no piping breaks, which are assumed to occur in the subject area~~.

- Fire Fighting Operations

  The total water volume from the fire fighting operation events is same as that of elevation -26 ft, 4 in.

~~Cracks are not postulated in the sanitary piping located in the MCR since it is 1 inch nominal diameter moderate energy fluid system piping.~~Since the potable and sanitary water system (PSWS) piping within the MCR compartment is moderate-energy fluid system piping which is designed to be excluded from the postulation of leakage crack during normal plant operation, and is designed as seismic category II to ensure its integrity during and after the SSE, the PSWS piping within the MCR compartment is not postulated to crack or break. DCD_03.04.01-31

Based on the flood events described above, the worst case results are from a combination of earthquake and fire fighting operations. The total volume of flood water caused by this combination is 4,020~~710~~ ft^3 in both the east and west area. DCD_03.04.01-29

The footage of corridor area and the water level are as follows;

- East side: 1,500 ft^2 area, 2.68~~3.14~~ ft above elevation 25 ft, 3 in. DCD_03.04.01-29
- West side: 1,700~~650~~ ft^2 area, 2.37~~85~~ ft above elevation 25 ft, 3 in.

The Class 1E I&C panels are installed in the room, which prevents flow-in water by the use of barriers and water-tight doors. Therefore, panels are not flooded. The MCR subject to regular access is protected from flooding by the use of barriers.

The MCR penetrations are designed to prevent water from flowing in by applying appropriate sealing features. The HVAC ducts coming from the MCR air handling units and the filter train units are routed horizontally above the postulated flooding level. The vertical HVAC ducts penetrate the MCR ceiling and are welded to embedded sleeves for penetration. The HVAC duct sections of concern and the embedded sleeves are designed to withstand the hydrostatic load of flooding. The penetrations of sanitary pipes also use the embedded sleeves (southern exterior wall of the R/B). Cables enter the MCR from beneath the raised MCR floor, and the penetrations at the control room envelope boundary may contain a liquid or clay filling and are water sealed. Therefore, flooding of the MCR through those penetrations is precluded through the use of appropriate sealing features.

Elevation 50 ft, 2 in.

The equipment to be protected in the elevation 50 ft, 2 in. of the NRCA is the MCR air handling units, Class 1E electrical room air handling units, and MCR emergency filtration units.

Flood events are considered as follows;

- Earthquake

There is no non-seismic water-containing equipment or piping in both the east and west areas on or above this floor~~The total water volume from the earthquake event is same as that of elevation -26 ft, 4 in~~. DCD_03.04.01-29

- High-Energy Line Break/Moderate-Energy Line Break (HELB/MELB)

  HELB event is not a concern, because there are no piping breaks, which are assumed to occur in the subject area.

  The total water volume from the MELB event is same as that of elevation -26 ft, 4 in. DCD_03.04.01-29

- Fire Fighting Operations

  The total water volume from the fire fighting operation events is same as that of elevation -26 ft, 4 in.

Based on the flood events described above, the worst case results are from ~~a combination of earthquake and~~ fire fighting operations. The total volume of flood water caused by this event ~~combination~~ is 4,0~~7~~10 ft^3 in both the east and west area. DCD_03.04.01-29

The footage of subject area and the water level are as follows;

- East side: 5,150~~400~~ ft^2 area, 0.78~~87~~ ft above elevation 50 ft, 2 in. DCD_03.04.01-29
- West side: 5,250~~500~~ ft^2 area, 0.77~~86~~ ft above elevation 50 ft, 2 in.

The MCR air handling units, Class 1E electrical room air handling units, as well as the MCR emergency filter units have a steel frame base installed on the top of the concrete foundations. The additional height of this base results in a total of 1.5 feet between the floor level and the filtration units. Therefore, when considering the steel frame base units, the current design has sufficient margin (i.e., 0.72~~63~~ feet above the postulated flood level) to protect against the postulated flooding. DCD_03.04.01-29

Elevation 76 ft, 5 in.

Elevation 76 ft, 5 in. of the NRCA is divided into the MS/FW piping area and other areas by concrete walls and water-tight doors. Moreover, the MS/FW piping area is divided into the two areas, east and west, by the concrete wall.

The equipment to be protected in the MS/FW piping area is the MS isolation valve, main feedwater isolation valve (MFIV), and MS depressurization valve.

The equipment to be protected in the subject area, except the MS/FW piping area, is the instrumentation of the EFW pit, and the remote shutdown console within the remote shutdown room.

Flood events in the MS/FW piping area are considered as follows:

- Earthquake

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The amount of water discharged from non-seismic equipment or piping in the seismic event is 2,700 ft^3 in both the east and west areas~~The total water volume from the earthquake event is same as that of elevation -26 ft, 4 in~~. DCD_03.04.01-29

- HELB/MELB

  In the flooding events caused by the postulated failure of piping, the high energy piping consists of main steam, feedwater, and SG blowdown piping, within the MS/FW piping area. A rupture of the feedwater piping in this area represents the worst case flooding scenario for this area. This is based on a 1.0 ft^2 break, as defined in Section 3.6, in the feedwater piping upstream of the feedwater check valve. The rupture at this point results in feedwater from the SG and from within the associated feedwater piping flow back into and flooding the compartment. In addition, the main feedwater pump is assumed to be pumping at the maximum flowrate. As a result of this scenario, the water level in the SG would decline resulting in a low level alarm/signal from the SG water level indication instrumentation. The low water signal initiates the feedwater isolation circuit. Based on actuation of the feedwater isolation circuit, the main feedwater pump is tripped, which stops the main feedwater pump. The volume of water which floods the main steam/feedwater pipe/relief valve compartment, based on the time required to reach the low water level set point, is 12,180 ft^3. The flood water occurring in the main steam/feed water piping room is drained to the T/B sump through the floor drain. Conservatively assuming that the drain line is clogged, the flood water will not be discharged by way of the floor drain.

  Leakage cracks in moderate-energy piping do not result in flooding more severe than the rupture of the feedwater piping. DCD_03.04.01-29

- Fire Fighting Operations

  The total water volume from the fire fighting operation events is same as that of elevation -26 ft, 4 in.

Based on the above, the worst case flooding in the MS/FW piping area is a piping rupture at 12,180 ft^3. The floor area of the MS/FW piping area is 2,640 ft^2; therefore the water level caused by piping rupture area is 4.62 ft above elevation 65 ft, 0 in, the bottom of the MS/FW piping area. The actuators of valve to be protected are designed to be located at heights above the level of flood water. In addition, the bottom of doorways to the MS/FW piping area is at elevation 76 ft, 5 in. This is 11 ft, 5 in. above the floor at elevation 65 ft, 0 in, and the doorways are located at a level that is higher than the level of flood water. Therefore, the flood water flow from the MS/FW piping area to the balance of the NRCA portion of the R/B is not a consideration. DCD_03.04.01-29 S01

Flood events in the subject area except MS/FW piping room are considered as follows;

- Earthquake

  There is no non-seismic water-containing equipment or piping in both the east and west areas on or above this floor~~The total water volume from the earthquake~~ DCD_03.04.01-29

~~event is same as that of elevation -26 ft, 4 in. The EFW pit is isolated by installing the water-tight doors to doorway to prevent flood water by sloshing of EFW pit spilling to other area~~The EFW pit is isolated by installing the water-tight doors to doorway to prevent flood water by sloshing of EFW pit spilling to other area. DCD_03.04.01-29 DCD_03.04.01-29 S01

- HELB/MELB

  HELB event is not a concern, because maximum flood level within the MS/FW piping area is well below the door elevation as described above, and there are no high energy piping breaks which are assumed to occur outside of the MS/FW areas on or above this floor. DCD_03.04.01-29

  The total water volume from the MELB event is same as that of elevation -26 ft, 4 in.

- Fire Fighting Operations

  The total water volume from the fire fighting operation events is same as that of elevation -26 ft, 4 in.

Based on the flood events described above, the worst case results are from ~~a combination of earthquake and~~ fire fighting operations. The total volume of flood water caused by this event~~combination~~ is 4,0~~7~~10 ft^3 in both the east and west area. DCD_03.04.01-29

The footage of subject area and the water level are as follows;

- East side: 3,150 ft^2 area, 1.28~~50~~ ft above elevation 76 ft, 5 in. DCD_03.04.01-29
- West side: 3,550~~800~~ ft^2 area, 1.13~~24~~ ft above elevation 76 ft, 5 in.

The instrumentation of the EFW pit is designed to be located at heights above the level of flood water. The remote shutdown console is installed in the remote shutdown room. There is no piping and therefore no flooding sources inside the remote shutdown room. In addition, the remote shutdown room is protected from in-flow of water from flood sources by a water-tight door.

3.4.1.5.3 R/B Flooding Events Impacting PS/B

The US-APWR PS/B includes an east and west PS/B that are adjoined by the NRCA of R/B.

The doorways provide potential flow paths from the NRCA of R/B to the PS/B. These flooding events are evaluated on a compartment basis.

All floors in the NRCA of the R/B are divided into two areas, east and west, by concrete walls and/or water-tight doors. The floor drain water is also routed to the non-radioactive drain sump at elevation -26 ft, 4 in. The floor drains of the east areas are connected and finally go into the A-R/B non-radioactive sump. The floor drains of west areas are connected and finally go into the B-R/B non-radioactive sump. There is no cross-

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connection between east and west area drains. Therefore, east and west areas are evaluated as independent areas.

Elevation -26 ft, 4 in.

The equipment to be protected in the east area of PS/B at elevation -26 ft, 4 in. are the A and B train Essential Chiller Units. Equipment to be protected in the west area are the C and D train Essential Chiller Units.

In both the east and west area, each room is divided ~~area is isolated~~ by a fire rated door instead of a water-tight door. Therefore, flood water is assumed to run across the entire area. In addition, the door to the adjoined NRCA of R/B is not a water-tight door, and the flood water from NRCA R/B is assumed to run across the PS/B. DCD_03.04.01-29

Flood Events are considered as follows;

- Earthquake

  Most of the water-containing equipment and piping in the NRCA of the R/B and PS/B are excluded from flooding source because they are designed to withstand Safe Shutdown Earthquake (SSE). The flood water volume is estimated on the basis of the amount of water contained in other non-seismic equipment or piping. DCD_03.04.01-29

  The amount of water discharged in the seismic event is ~~540~~700 ft^3 in both the east and west areas~~In the flooding events caused by an earthquake, the following components are assumed to fail and release all of their contents:~~ DCD_03.04.01-29 S01

  - ~~Non-seismic category I piping in the NRCA of the R/B, total volume of water held by these pipe lines is 700 ft^3.~~

  - ~~Non-seismic category I components in the adjacent A/B are considered damaged. Water from these failed components is conservatively assumed to flow to the NRCA portion of the R/B through floor drains. The components in these buildings which are not seismic category I are associated with the demineralized water system, and non-safety chilled water system. The total volume of water held by these systems is 1,590 ft^3. Since floor drains of the NRCA of the A/B are collected by non-radioactive drain sump, the water of these areas does not flow into the east area. Therefore, the water generated in the NRCA of the A/B is taken into consideration in the evaluation of the west area~~.

- HELB/MELB

  HELB event is not a concern, because break of turbine driven emergency feedwater pump steam piping drain line, which is the only high energy line in these areas, results in less severe flooding event than that caused by earthquake concurrent with fire-fighting operation. DCD_03.04.01-29

  Moderate energy piping whose failure may leads to discharge of more than 4,000 ft^3 of water is designed not to be subject to the pipe break postulation by means of

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route and support design. Therefore, the most severe postulated flooding event caused by a crack in the rest of the moderate energy piping results in discharged water volume of equal to or less than 4,000 ft^3 in both east and west area~~there are no piping breaks, which are assumed to occur in the subject area~~. DCD_03.04.01-29

- Fire Fighting Operations

  The flooding contribution from fire fighting operations is based on the full operation of two hose stations for 2 hours. The flow rate from one hose station is 125 gpm. With two stations operating for 2 hours, the total volume of water is 4,010 ft^3.

Based on the flood events described above, the worst case results are from a combination of earthquake and fire fighting operations. The total volume of flood water caused by this combination is as follows:

- East side: 4,550~~710~~ ft^3 DCD_03.04.01-29
- West side: ~~6,300~~4,710~~550~~ ft^3 DCD_03.04.01-29 S01

The square footage of floor area subject to flooding at elevation -26 feet, 4 inches is as follows:

- East side: 11~~0~~,500 ft^2 (this area includes R/B NRCA floor area) DCD_03.04.01-29
- West side: 11~~0~~,1~~5~~00 ft^2 (this area includes R/B NRCA floor area)

Based on these values, the maximum water level is as follows:

- East side: 0.40~~5~~ ft above elevation -26 ft, 4 in. DCD_03.04.01-29
- West side: 0.43~~160~~ ft above elevation -26 ft, 4 in. DCD_03.04.01-29 S01

The pump foundations (top of concrete) height is 1.0 foot above floor elevation -26 ft, 4 in. As such, the pumps are not flooded. The instrumentation of each pump is designed to be located at heights above the level of flood water.

Elevation 3 ft, 7 in.

The equipment to be protected in the east area of PS/B at elevation 3 ft, 7 in. are the A and B train Class 1E GTG. Similarly, the equipment to be protected in the west area is the C and D train Class 1E GTG. Since the doorway between the corridor in the east PS/B and east area of the R/B at elevation 3 ft, 7 in. is not water-tight, flood water in the east NRCA of the R/B is assumed to flow into the east PS/B, and vice versa. The Class 1E GTG rooms are isolated from corridor of R/B NRCA and corridor of east PS/B by concrete walls and water-tight door. There are no floor drains in the Class 1E GTG rooms. DCD_03.04.01-29

Flood events are considered as follows:

- Earthquake

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The flood water volume is estimated on the basis of the amount of water contained in non-seismic equipment or piping. The amount of water discharged in the seismic event is 10 ft^3 in both the east and west area~~The total water volume from the earthquake event is same as that of elevation -26 ft, 4 in~~. DCD_03.04.01-29

- HELB/MELB

  HELB event is not a concern, because break of drain piping for turbine driven emergency feedwater pump steam piping results in less severe flooding event than that caused by earthquake concurrent with fire-fighting operation. DCD_03.04.01-29

  The total water volume from the MELB event is same as that of elevation -26 ft, 4 in~~there are no piping breaks, which are assumed to occur in the subject area~~.

- Fire Fighting Operations

  The total water volume from the fire fighting operation events is same as that of elevation -26 ft, 4 in.

Based on the flood events described above, the worst case results are from a combination of earthquake and fire fighting operations. The total volume of flood water caused by this combination is 4,020~~710~~ ft^3 in both the east and west area. DCD_03.04.01-29 S01

The footage of corridor area and the water level are as follows:

- East side: ~~1,500~~4,300 ft^2 area, 0.94~~3.14~~ ft above elevation 3 ft, 7 in. DCD_03.04.01-29
- West side: The entire floor of the west area of PS/B at elevation 3 ft, 7 in. consists of water tight compartments~~1,500 ft^2 area, 3.14 ft above elevation 3 ft, 7 in~~.

Class 1E GTG are installed in the room which prevents flow-in water by water-tight door.

Therefore, GTG room is not flooded.

3.4.2 Analysis Procedures

The static and dynamic effects of the design-basis flood or groundwater conditions, which are identified in Section 2.4, are applied to seismic category I structures. Section 3.8 specifies the applicable codes, standards, and specifications used in the design of seismic category I structures. The loads and load combination subsections of Section 3.8 take into consideration the static and dynamic loadings on seismic category I structures including hydrostatic loading as the result of the design-basis flood and/or ground conditions identified in Section 2.4. Section 3.8 also provides the design and analysis procedures used to transform the static and dynamic effects of the DBFL and ground water levels applied to seismic category I structures to assure their design meet the applicable acceptance criteria.

The COL Applicant is to identify any site-specific physical models used to predict prototype performance of hydraulic structures and systems involving an unusual design