INTERNAL FLOOD PROTECTION AS PART OF THE APR1400 DESIGN CONTROL DOCUMENT AUDIT REPORT

Korea Hydro and Nuclear Power Co., Ltd. (KHNP) and Korea Electric Power Corporation (KEPCO)

APR1400 DESIGN CERTIFICATION
Docket No. 52-046

NRC Audit Team:

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1.0 Summary:

To facilitate the U.S. Nuclear Regulatory Commission (NRC) staff's review of internal flood protection of the Advanced Power Reactor (APR) 1400 DCD Revision 0 (Accession Number ML15006A042) Section 3.4.1, "Flood Protection and Evaluation," the NRC staff conducted a regulatory audit of KHNP document(s) on internal flood protection analysis. The NRC staff audited the applicant's electronic reading room (ERR) between May 27, 2015, and June 11, 2015. The purpose of this audit was to: (1) gain an understanding on the basis of APR1400 internal flood protection to reach a reasonable assurance finding, and (2) review related documentation and non-docketed information to evaluate conformance with Standard Review Plan (SRP) Section 3.4.1, "Internal Flood Protection for Onsite Equipment Failures."

2.0 Observations and Results:

Based on the initial review of the information provided in design control document (DCD) Tier 2 Section 3.4.1 Revision 0, the NRC staff found that the description of the internal flood protection was generally incomplete and did not adequately explain what were the structure, systems, and components (SSCs) subject to flood protection, how the flood protection analyses were performed based on the proposed design, what assumptions were used for the calculation and could be justified according to the DCD design features, how the limiting case was determined with sufficient technical bases. To supplement the DCD information, the NRC staff audited the applicant's calculations in its electronic reading room. The NRC staff found in the audit that non-safety components were used for the flood protection, but the requirements of the functional capability and qualification of those components were not discussed in the DCD. Also, the assumptions and bases of the calculation methods were not adequately described in the DCD.

During the audit, the NRC staff discussed with the applicant in a teleconference meeting on June 4, 2015 the questions being identified during the initial review of the DCD and audit of the calculations. These questions are shown in Attachment 1. Some of the clarification questions were resolved in the meeting. Additional clarification questions were responded by the applicant in a letter, dated June 22, 2015 (Accession Number ML15174A408). The remaining questions were developed as request for additional information (RAIs) by the staff as shown in Attachment 2.

3.0 Conclusions:

The NRC staff has determined that the DCD should be revised to provide a comprehensive explanation of the internal flood protection. The NRC staff will review the applicant's letter, dated June 22, 2015 and RAI responses during the Phase 2 review.

4.0 References:

1. 10 CFR Parts 50, "Domestic Licensing of Production and Utilization Facilities," and 52 "Licenses, Certifications, and Approvals for Nuclear Power Plants."

2. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition", Chapter 3, "Design of Structures, Components, Equipment, and Systems."

3. KHNP APR1400 Design Control Document – Tier 2 Chapter 03 – Design of Structures, Systems, Components, and Equipment (ML15006A059).

Attachment 1

Questions Discussed in the Teleconference Meeting on June 4, 2015

1. Identification of SSCs Subject to Flood Protection: SRP Section 3.4.1 states that safety-related SSCs should be protected against flooding. DCD Tier 2 Section 3.4.1.5 refers to Section 7.4 for scoping the systems subject to flood protection. Section 7.4 describes the systems required for safe shutdown, which is a subset of the safety-related systems. Clarify whether all safety-related SSCs are in the scope for the flood protection and revise DCD accordingly. DCD Table 3.2-1 lists all the safety-related SSCs. Clarify the differences for the systems and components being identified for the flood protection and referenced in Section 7.4 and Table 3.2-1, and provide justification for using Section 7.4 instead of Table 3.2-1 to identify the SSCs subject to flood protection.

2. CCW and ESW SSCs Subject to Flood Protection: COL 3.4(2) states that the COL applicant is to provide flooding analysis with flood protection and mitigation features for internal flooding for the CCW Heat Exchanger Building (CCWHXB) and the essential service water building (ESWB).

   a) Clarify in the DCD where these two buildings are located.

   b) In addition to the buildings, identify in the DCD the safety-related portions of the systems and components being subject to flood protection in the ESWB and the CCWHXB, because these components are part of the standard plant design rather than COL applicant's design.

3. Identification of SSCs Subject to Flood Protection: DCD Tier 2, Section 3.4.1 states the following:

   The reactor containment building systems to be protected from flooding are the reactor coolant system (RCS), safety injection system (SIS), reactor coolant gas vent system (RCGVS), and main steam system (MSS). The components to be protected from flooding are the valves and electric instrumentation of these systems.

   a) It is not clear whether all the systems and components in the reactor containment building subject to flood protection are identified in the DCD. For example, feedwater system, auxiliary feedwater system, shutdown cooling system, Class 1E power system, and component cooling water system are not identified in the above system list. Justify the exclusion, or revise the list in the DCD.

   b) It is not clear why pumps in the containment are not identified in the above component list for flood protection. Justify the exclusion, or revise the DCD.

   c) Are the instrumentation and valves to the in-containment refueling water storage tank (IRWST) subject to the flood protection or are they above the flood level in the containment? Justify the exclusion.

4. <u>Watertight Door Seals</u>: SPR Section 3.4.1, Subsection III.2 provides guidance for the staff to evaluate the adequacy of flood protection features including watertight doors. The penetration seals are periodically inspected to ensure their functionality. The applicant is requested to provide a COL information item addressing the seal maintenance to ensure the water tight doors and sealed penetrations serve their intended flood protection function.

5. <u>Clarification of Layout in Containment</u>: DCD Tier 2, Section 3.4.1.5.1 states that the flood protection in the reactor containment building is to allow flooding sources to flow to the lowest level of the building through the floor openings and stairwells. Section 3.4.1.5.1 also states that water at El.136 ft 6 in., El. 114 ft, and El. 100 ft flows to the containment annulus area. The flood water level is determined as 2 ft above El. 100 ft.

    a) Why is the upper level water flowing to the containment annulus area instead of to the bottom of the containment? Where is the lowest level of the containment building, the bottom of containment or the annulus?

    b) Clarify the relationship between the bottom of containment and the annulus with respect to collecting the flood water. Which area does the 2 ft containment flood level apply and why?

6. <u>Flood Areas and Flood Heights in Containment</u>: DCD Tier 2 Table 6.2.1-1 identifies potential pipe breaks in the steam generator subcompartment, pressurizer subcompartment, pressurizer spray valve room, regenerative heat exchanger room, letdown heat exchanger room, and letdown heat exchanger valve room. These subcompartments are confined inside containment. Explain why there are no flood analyses for these subcompartments. Are there any other subcompartments being missed for flood protection?

    The staff's audit of Calculation No. 1-035-N385-001, Sheet 4 of 41 found flood areas including Valve Rooms, Regenerative HX Rm, Pressurizer Cavity, Refueling Pool Area, Operating Areas with different flood height for each area. There are areas (e.g., Room Nos. 116-C03, 116-C04, 130-C01, 136-C01A, and 136-C01B) where flood heights are higher than 2 ft. Why those areas are not discussed in the DCD? Explain the difference between the flood level and flood heights. Why is the flood level not bounding all the flood heights in the calculation?

7. <u>Worst Case Internal Flooding Determination</u>: In DCD Tier 2, Sections 3.4.1.3 and 3.4.1.5, the applicant identified the flooding sources from LOCA and operation of fire protection system. The applicant stated that the worst-case flooding event is a double-ended discharge leg LOCA with the minimum SIP because it results in maximum break to the reactor containment building as a flooding source. The following information is requested relating to the determination of the worst case.

    a) Explain the basis to use "maximum break", instead of "maximum break flow volume" to determine the worst case flooding event. The flood level should be determined by the water volume.

b) Explain the basis for the determination of the worst case being LOCA. It should be noted that LOCA has higher peak flow but drops quickly, and fire protection water could last for a long duration.

c) How were the other water sources such as main feedwater line, main steam line, auxiliary feedwater system, shutdown cooling system, component cooling system, safety injection tank (SIT), in-containment refueling water storage tank (IRWST), and other water carrying lines in the containment considered, evaluated, and compared to the worst case LOCA?

8. Worst Case Determination: In DCD Tier 2, Section 3.4.1.5, the applicant stated that for flooding analysis, the single worst-case piping rupture for non-seismically analyzed piping is assumed for each analyzed area.

a) Clarify which non-seismically pipes were considered in containment.

b) Explain how the case of non-seismically analyzed piping, which could have a long lasting flood source, is evaluated for the flood protection analysis, and why this case is less severe than the worst case LOCA in containment.

9. Flood Height Determination: In DCD Tier 2, Section 3.4.1.5, the applicant stated that the flood level of the reactor containment building is determined by dividing the accumulated volume of discharged water for 50 seconds by the total floodable area at El. 100 ft. The flood level in containment is determined to be 2 ft.

a) Explain how the “50 seconds” limit was determined and justify its adequacy.

b) What is the floodable area at EL. 100 ft?

c) Explain how the “2 ft” is determined. Is it applicable to all containment areas including annulus and areas outside annulus at El. 100 ft.

10. Flood Height Determination: In DCD Section 3.4.1.5, the applicant stated that the fluid flow rate through a stairwell or a floor opening is calculated using equation 5.2-1, and the flow rate under a door is calculated using equation 5.2-3 in Reference 5 (ANSI 56.11-1988). Reference 5 has not been endorsed or reviewed by the NRC. Provide sufficient information to demonstrate the acceptability and applicability of the above two equations.

11. Fire Water Flooding: In DCD Tier 2, Section 3.4.1.5, the applicant stated that indoor hydrants that could reach the area or zone where a fire occurs are contributed to internal flooding sources when a fire occurs. The discharge flow rate from indoor hydrants is assumed to be 0.044 m^3/s (700 gpm).

a) Why is the assumption of 700 gpm adequate? Could the fire water last very long? In DCD Section 19.1.5.3.1.5, page 19.1-157 stated that the fire protection system is assumed to have infinite volume of water.

b) What is the total discharge water volume from the indoor hydrants? Is this the limiting volume for the potential flood resulting from all fire protection system failures (e.g., pipe breaks, sprinkle failures)?

c) Why is it bounded by the worst case LOCA as far as flooding is concerned? What is the flood height in containment resulting from fire protection water, which may last for long time?

12. Flood Level Determination: In the audit review of the calculations, the staff found in Table 2 (Sheet 9 of 41) that the non-safety drainage system appears to be taken credit for determining flood levels. Please clarify it in the DCD. SRP Section 3.4.1, Subsection III.7 provides guidance for using the non-safety system for flood protection. The following are the concerns relating to the use of drainage system in the internal flood protection:

    a) Table 2 listed drain discharge (gpm) vs. depth of water (in.) up to six inches. What is the discharge flow for the flood level of 2 ft?

    b) How many drains are required to perform the function in each flood areas?

    c) The required functional capability should be specified and justified in the DCD.

    d) A failure of the drainage system may prevent a safety-related system to perform its safety function. A failure modes and effects analysis should be provided in accordance with SRP Section 3.4.1, Subsection III.4.

    e) The drainage system, as described in DCD Section 9.3.3, does not appear to recognize this safety function. Clarify this safety function in the DCD.

    f) This functional capability should be tested, maintained throughout the life of the plant. There is no initial testing, ITAAC, programmatic control on this system function.

    g) The applicant has not addressed the potential clogging of drain path in an accident (similar to GSI 191).

13. Clarification: In DCD Tier 2, Section 3.4.1.5 (page 3.4-7), the applicant stated that for each storage tank, it is assumed that the total inventory of the tank is spilled out.

    What are the tanks being referred in this statement? Is IRWST included? Is safety injection tank included? If not, why?

14. Proper Reference: In DCD Tier 2, Section 3.4.1.5.1, the applicant stated that the total discharged volume of double-ended discharge leg break of a LOCA is 425.7 m^3 (15,036 ft^3).

    Provide the proper referenced data in the DCD for the determination of this volume.

15. Additional Information on the Configuration: In DCD Section 3.4.1.5.2, the applicant stated that the worst case of flooding in the auxiliary building El. 55 ft, the lowest elevation being analyzed, is the water source in the IRWST. The maximum water level is 2.74 m (9 ft) with some margin. The released water volume is contained within the affected quadrant.

    Provide the information of the height of the divisional walls in the DCD to demonstrate that walls are sufficiently high to contain the released water within the affected quadrant.

16. Clarification: As stated in DCD Section 3.4 (page 3.4-1), the failures of non-seismic and "non-tornado" protected tanks are analyzed for flood protection.

    a) Expand tornado-protected tank to high-wind (including tornado and hurricane) protected tanks being subject to flood protection. Revise DCD accordingly.

    b) Identify the external tanks, vessels, and piping being referenced above in DCD Section 3.4. Are the service water piping, circulating water piping, raw water tank considered?

17. ITAAC: DCD Tier 1, Section 2.2.5.1.2, "Internal Flooding," states that the inspection, tests, analyses, and associated acceptance criteria for protection against hazards are specified in Item 2 of Table 2.2.5-1, "Protection against Hazards ITAAC." It states that the inspection of the as-built protective provisions against internal flooding hazard will be conducted. The provisions include divisional flood barriers, watertight doors, penetrations in the flood barrier, and safety-related electrical, instrumentation, and control equipment in nuclear island are located above the internal design flood level.

    The staff reviewed the above information and found that it is not clear whether the safety-related SSCs other than instrument and control (such as valves and pumps) are properly confirmed in this ITAAC to be located above the internal flood level. The applicant is request to verify the scope of this ITAAC and revise it accordingly.

18. Clarification: On page 3.4-7, second paragraph mentions "Indoor hydrants." There is no mention of "indoor hydrants," in Section 9.5.1, "Fire Protection Program," or Appendix 9.5A, "Fire hazard Analysis." Please describe what an indoor hydrant is.

19. Inconsistency: On page 3.4-11 the applicant stated that:

    "However, a malfunction of the fire protection system is not considered in this area because it has a CO2 suppression system."

    Section 9.5.1, "Fire Protection Program," page 9.5-17 states that there are no CO_2 systems used in the APR1400. Clarify the inconsistency.

20. Clarification: Confirm that the main control room (MCR) does not have an automatic sprinkler system so that the possibility of flooding from fire protection system inside MCR is eliminated. The fire protection system line failure is postulated in the corridor outside the MCR. How is the MCR protected such that water will not enter into the room?

21. Editorial Comment: On page 3.4-4, edit in third paragraph, need a space between the following words:

    Sensorsignals of sensors to indicate

22. Emergency Overflow Lines:

    In the audit of the calculations to support DCD Section 3.4.1, the staff found that emergency overflow lines are used for flood protection in the Auxiliary Building quadrants A, B, C, and D at El. 55 ft. It is not clear why this is not discussed in the DCD.

    The applicant is requested to provide in the DCD the following information relating to emergency overflow lines:

    a) Describe how the emergency overflow lines are used for flood protection.

    b) Specify the functional requirements and seismic classification of these lines.

Attachment 2

Request for Additional Information on Internal Flood Protection
RAI 8041

03.04.01-27208 Identification of SSCs Subject to Flood Protection:

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

SRP Section 3.4.1 states that safety-related SSCs should be protected against flooding. DCD Tier 2 Section 3.4.1.5 refers to Section 7.4 for scoping the systems subject to flood protection. Section 7.4 describes the systems required for safe shutdown, which is a subset of the safety-related systems.

The staff noted that DCD Table 3.2-1 lists all the safety-related SSCs, but Section 7.4 does not include the complete list of safety-related SSCs. This is an inconsistency in the application.

The applicant is requested to use Table 3.2-1 or justify the use of Section 7.4 to identify the SSCs subject to flood protection.

03.04.01-27209 Identification of SSCs Subject to Flood Protection:

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

DCD Tier 2, Section 3.4.1 states that "the reactor containment building systems to be protected from flooding are the reactor coolant system (RCS), safety injection system (SIS), reactor coolant gas vent system (RCGVS), and main steam system (MSS). The components to be protected from flooding are the valves and electric instrumentation of these systems."

The applicant is requested to clarify in the DCD whether the instrumentation and valves in the in-containment refueling water storage tank (IRWST) are subject to flood protection or are above the flood level in the containment.

03.04.01-27210 Determination of the Limiting Case Internal Flooding

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the structures, systems, and components (SSCs) of the

facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

DCD Tier 2, Sections 3.4.1.3 and 3.4.1.5 identify the in-containment flooding sources as coming from a loss of coolant accident (LOCA) or from a break in the fire protection system. The applicant states that the worst-case flooding event is a double-ended discharge leg LOCA with the minimum safety injection because it results in the most limiting flooding source for the reactor containment building.

The applicant is requested to provide the following information relating to the determination of the worst case:

a) Provide a comprehensive explanation of the calculation method for using “maximum break,” instead of ”maximum flood water volume” to determine the worst case flooding event. In general, flood level is determined by the water volume. Provide design requirements (such as the drain capability) and the basis to support the method being used by APR1400.

b) Explain the basis for the determination of the worst case being LOCA with duration of 50 second. It should be noted that LOCA has higher peak flow but drops quickly lasting much longer than 50 second, while fire protection water could leak indefinitely without isolation resulting in larger volume of flood water. If isolation is used, provide the design basis and justifications.

c) Explain how other in-containment water sources (such as main feedwater line, main steam line, auxiliary feedwater system, shutdown cooling system, component cooling system, safety injection tank (SIT), and other water carrying piping) compare against the worst case LOCA?

03.04.01-27211 Determination of the Flood Level:

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

DCD Section 3.4.1.5 states that the fluid flow rate through a stairwell or a floor opening is calculated using equation 5.2-1, and the flow rate under a door is calculated using equation 5.2-3. Both these equations are to be found in Reference 5 (ANSI 56.11-1988). The staff found that Reference 5 has not been endorsed or reviewed by NRC and has been withdrawn by ANS.

The applicant is requested to provide sufficient information to demonstrate the acceptability and applicability of the above two equations.

03.04.01-27212 Fire Water Flooding:

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the structures, systems, and components (SSCs) of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

DCD Tier 2, Section 3.4.1.5 states that indoor hydrants that could reach the area or zone where a fire occurs are considered as internal flooding sources when a fire occurs. The discharge flow rate from these indoor hydrants is assumed to be 0.044 m^3/s (700 gpm).

The applicant is requested to provide the following information:

a) Why is the assumption of 700 gpm adequate for flood protection? How long is it assumed for the fire water? The staff noted that in DCD Section 19.1.5.3.1.5, page 19.1-157, the fire protection system is assumed to have infinite volume of water.

b) What is the total discharge water volume from the indoor hydrants? Is this the limiting volume for the potential flood resulting from all the possible fire protection system failures?

c) Why is it bounded by the worst case LOCA as far as flooding is concerned? What is the flood height in containment resulting from the fire protection water, which may last for long time?

d) GDC 3 states, in part, that "fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on structures, systems, and components important to safety. Firefighting systems shall be designed to assure that their rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components."

Section 3.4 of the DCD, third paragraph, only mentions "operation of fire protection systems." It does not mention the inadvertent rupture of a fire protection system. In the Fire Hazard Analysis, Appendix 9.5A of the DCD, only the inadvertent operation of the automatic sprinkler systems is considered.

The applicant is requested to also address the possibility of rupture/cracks in the fire protection system piping including standpipe system piping.

03.04.01-27213 Flood Level Determination:

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the SSCs of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these

requirements have been established, and the evaluations required to show that safety functions will be accomplished.

During the audit review of the calculations, the staff found in Containment Flooding Analysis (1-035-N385-001), Table 2 (Sheet 9 of 41) that the non-safety drainage system appears to be taking credit for the determination of flood levels.

The applicant is requested to address the following concerns relating to the use of non-safety drainage system in the internal flood protection:

a) Table 2 lists drain discharge (gpm) vs. depth of water (in.) up to six inches. What is the drain discharge flow for the flood level of 2 ft? Provide the basis for the determination.

b) How many drains are required to perform the function in each of the flood areas?

c) Specify and justify the required functional capability of the drainage system in the DCD.

d) A failure of the drainage system may prevent a safety-related system to perform its safety function. A failure modes and effects analysis should be provided in the DCD, in accordance with SRP Section 3.4.1, Subsection III.4.

e) The drainage system, as described in DCD Section 9.3.3, does not appear to recognize this safety function. Clarify this safety function and seismic classification in the DCD, including Section 9.3.3 and Table 3.2-1.

f) This functional capability should be tested and maintained throughout the life of the plant. The DCD should include information on initial testing, ITAAC, programmatic control for this system function.

g) The potential clogging of the drain path due to debris (resulting from dynamic forces or left behind in the building due to previous activities) is a plausible event and needs to be addressed in the DCD.

03.04.01-27214 <u>ITAAC</u>:

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the SSCs of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

DCD Tier 1, Section 2.2.5.1.2, “Internal Flooding,” states that the inspection, tests, analyses, and associated acceptance criteria (ITAAC) for protection against hazards are specified in Item 2 of Table 2.2.5-1, “Protection against Hazards ITAAC.” It also states that the inspection of the as-built protective provisions against internal flooding hazard will be conducted. These provisions include divisional flood barriers, watertight doors, penetrations in the flood barrier, and safety-related electrical, instrumentation, and control (I&C) equipment in nuclear island are located above the internal design flood level.

The staff finds that the ITAAC includes only I&C equipment to be located above the flood level but not all the other safety-related SSCs (such as valves and pumps). The staff also finds that in the ITAAC "Acceptance Criteria" only the nuclear island and EDG structures are included but not ESWB or CCWHXB.

The applicant is requested to verify the scope of this ITAAC as well as its acceptance criteria. The DCD should be revised accordingly.

03.04.01-27215 Inconsistency

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the SSCs of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

On page 3.4-11 of DCD Tier 2, the applicant states that "however, a malfunction of the fire protection system is not considered in this area because it has a CO2 suppression system;" while on page 9.5-17 the applicant states that there are no CO_2 systems used in the APR1400.

The applicant is requested to clarify this inconsistency.

03.04.01-27216 Emergency Overflow Lines

10 CFR 52.47(a)(2) requires that a standard design certification applicant provide a description and analysis of the SSCs of the facility, with emphasis upon performance requirements, the bases, with technical justification therefor, upon which these requirements have been established, and the evaluations required to show that safety functions will be accomplished.

In the audit of the calculations to support DCD Section 3.4.1 the staff found that emergency overflow lines are used for flood protection in the Auxiliary Building quadrants A, B, C, and D at elevation 55'. It is not clear why this is not discussed in the DCD.

The applicant is requested to provide in the DCD the following information relating to emergency overflow lines:

a) Describe how the emergency overflow lines are used for flood protection.

b) Specify the functional requirements and seismic classification of these lines.