U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

3.4.1 FLOOD PROTECTION

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - None

I. AREAS OF REVIEW

The ASB review of the plant flood protection includes all structures, systems and components (SSC) whose failure could prevent safe shutdown of the plant or result in uncontrolled release of significant radioactivity to assure conformance with the requirements of General Design Criterion 2. The facility design and equipment arrangements presented in the applicant's safety analysis report (SAR) are reviewed with respect to the following considerations: to identify the safety-related SSC that must be protected against flooding from both external and internal causes; to determine the capabilities of structures housing safety-related systems or equipment to withstand flood conditions, i.e., the relationship between structure elevation and flood elevation including waves and wind effects as determined in the review described in SRP Sections 2.4.1 through 2.4.14; to determine the adequacy of the isolation of redundant safety-related systems or equipment subject to flooding; to identify possible inleakage sources, such as cracks in structures not designed to withstand seismic events and exterior or access openings or penetrations in structures located at a lower elevation than the flood level and associated wave activity. The ASB review also includes consideration of flooding from internal sources of SSC important to safety from failure of tanks, vessels, and piping. The effects of piping failures are considered in SRP Section 3.6.1. The effects of flooding due to failure of tanks and vessels are reviewed within the context of this SRP section.

The ASB review for the underground drainage system and for flood protection uses information provided by HGEB reviews, as indicated below, to assure that the integrated design of the underground drainage system is capable of performing its safety function and that the flood protection utilized is compatible with the maximum flood elevation established for the plant site.

Coordinated reviews are performed by other branches and the results used by the ASB to complete the overall evaluation of the flood protection. The coordinated reviews are as follows:

The Hydrologic and Geotechnical Engineering Branch (HGEB) reviews the underground drainage system as part of its primary review responsibility for SRP Section 2.4.13. The HGEB also verifies the elevations and coincident conditions determined for the various conditions of site flooding, including the adequacy of the type of flood protection utilized as part of its primary review responsibility for SRP Sections 2.4.1 through 2.4.14. The Structural Engineering Branch (SEB) determines the acceptability of the design analyses, procedures, and criteria used for structures that must withstand the effects of the design basis flood as part of its primary review responsibility for SRP Section 3.4.2. The Instrumentation and Control Systems Branch (ICSB) and the Power Systems Branch (PSB) will, upon request, verify the adequacy of instrumentation needed for flood protection, including adequacy of detectors and alarms necessary to detect rising water levels within structures, and will evaluate the consequences of flooding on other safety-related instrumentation and electrical equipment in affected areas. The review of Technical Specifications is coordinated and performed by the Licensing Guidance Branch as part of its primary review responsibility for SRP Section 16.0.

For those areas of review identified above as being reviewed as part of the primary review responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.

II. ACCEPTANCE CRITERIA

Acceptability of the flood protection measures described in the SAR is based on meeting specific general design criteria and regulatory guides. The plant design for protection of SSC from the effects of flooding is acceptable if it meets the relevant requirements of General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," and 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," Section IV.C as related to protecting SSC important to safety from the effects of floods, tsunamis and seiches. Acceptance is based on the design meeting the guidelines of Regulatory Guide 1.59 with regard to the methods utilized for establishing the probable maximum flood (PMF), probable maximum precipitation (PMP), seiche and other pertinent hydrologic considerations; and the guidelines of Regulatory Guide 1.102 regarding the means utilized for protection of SSC important to safety from the effects of the PMF and PMP. If safety-related structures are protected from below-grade groundwater seepage by means of a permanent dewatering system, then the system should be designed as a safety-related system and meet the single failure criterion requirements.

III. REVIEW PROCEDURE

The review procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report (PSAR) meet the acceptance criteria given in subsection II of this SRP section. For the review of operating license (OL) applications the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design

as set forth in the final safety analysis report (FSAR). The reviewer will select and emphasize material from the paragraphs below as may be appropriate for a particular case.

The reviews of flood elevations and other hydrologic considerations pertinent to protection of SSC important to safety, including the underground drainage system, are performed by HGEB as part of its primary responsibility for SRP Sections 2.4.1 through 2.4.14.

Upon request from the primary reviewer, the coordinating review branches will provide input for the areas of review stated in subsection I of this SRP section. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

The review procedure consists of:

1. A determination from the SAR as to which SSC are safety-related and should be protected against floods or flooded conditions.

2. An evaluation using the plant arrangement and layout drawings as to the various means to prevent flooding of safety-related systems or components, such as external barriers, enclosures, pumping systems, and watertight doors. The measures utilized are reviewed and coordinated with HGEB to determine their ability to cope with the design basis flood conditions, as established in SRP Sections 2.4.1 through 2.4.14.

3. An assessment of leakage, a determination if liquid-carrying systems could produce flooding, and an evaluation of the measures taken to protect safety-related equipment. The effects of piping failures are considered in SRP Section 3.6. The effects of potential flooding of SSC due to postulated failure of nonseismic Category I and nontornado protected tanks, vessels, and other process equipment is considered in this SRP section. A failure modes and effects analysis may be performed to determine that the flooding consequences resulting from failures of such liquid-carrying systems close to essential equipment will not preclude required functions of safety systems.

4. A review of the SAR to ascertain if safety-related systems or components are capable of normal function while completely or partially flooded.

5. A review of plant arrangement and layout drawings to determine if safety-related equipment or components are located within individual compartments or cubicles which act as positive barriers against possible means of flooding, and if barriers or other means of physical separation are utilized between redundant safety-related trains.

6. Review plant structure design drawings to determine if any safety-related structures have been provided with a safety-related permanent dewatering system for control of ground water seepage. The dewatering system should be designed to safety grade requirements. In addition, see SRP Section 2.4.13.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that his evaluation supports conclusions of the following type, to be included in the staff's safety evaluation report:

The flood protection review included all systems and components whose failure could prevent safe shutdown of the plant and maintenance thereof or result in significant uncontrolled release of radioactivity. Based on the review of the applicant's proposed design criteria, design bases, and safety classification for safety-related SSC necessary for a safe plant shutdown during and following the flood condition from either external or internal causes, the staff concludes that the design of the facility for flood protection conforms to the Commission's regulations as set forth in General Design Criterion 2 and 10 CFR Part 100 Appendix A. This conclusion is based on the applicant having met the requirements of General Design Criterion 2 and Appendix A to 10 CFR Part 100 with respect to protection of SSC important to safety from the effects of floods, tsunamis, and seiches by:

(a) Meeting Regulatory Guide 1.59 positions C.1 regarding the conditions utilized for design of SSC important to safety for the worst site-related flood probable at a nuclear power plant (e.g., PMF, seismically induced flood, hurricane, seiche, surge, PMP) and C.2 regarding alternatives to hardened protection of SSC important to safety.

(b) Meeting Regulatory Guide 1.102 positions C.1 regarding the type of flood protection provided and C.2 regarding provision of guidance in establishing shutdown technical specifications and emergency operating procedures related to flooding.

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

(d) Protecting essential SSC from external and internal flooding by locating the systems and components in individual flood-proof enclosures, providing exterior barriers (levees, seawalls, floodwalls, revetments or breakwaters), or design of individual systems to maintain their safety function if they are flooded.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants."

3. Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants."

4. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."