U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

2.4.10 FLOODING PROTECTION REQUIREMENTS

REVIEW RESPONSIBILITY

Primary - Hydrologic and Geotechnical Engineering Branch (HGEB)

Secondary - None

I. AREAS OF REVIEW

The locations and elevations of safety-related facilities and of structures and components required for protection of safety-related facilities are compared with the estimated static and dynamic effects of design basis flood conditions identified in safety analysis report (SAR) Section 2.4.2.2, to determine whether flood effects need be considered in plant design or emergency procedures.

If flood protection is required, the type of flood protection ("hardened facilities", sandbags, flood doors, bulkheads, etc.) is reviewed. Any emergency procedures required to implement flood protection and warning times available for implementation thereof are reviewed, based on the flood conditions identified in other sections.

If there is evidence of potential structural effects, the Structural Engineering Branch (SEB) will be requested by HGEB to ascertain whether these effects are properly considered in the structural design bases for the plant; similarly, Auxiliary Systems Branch (ASB) will be requested by HGEB to ascertain whether these effects are properly considered in the systems design bases for the plant. Guidance for determining whether these potential effects are considered properly is outlined in the appropriate SEB and ASB SRP sections.

II. ACCEPTANCE CRITERIA

HGEB acceptance criteria for this SRP section relate to the following regulations:

1. 10 CFR Part 50, §50.55a requires structures, systems, and components to be designed and constructed to quality standards commensurate with the importance of the safety function to be performed.

2. General Design Criterion 2 (GDC 2) requires structures, systems, and components important to safety to be designed to withstand the effects of floods.

3. 10 CFR Part 100 requires that hydrologic characteristics be considered in the evaluation of the site.

Specific criteria necessary to meet the relevant flood protection requirements of 10 CFR Part 50, §50.55a, GDC 2, and 10 CFR Part 100 are as follows:

1. The flood design basis for each facility must be comparable with the positions in Regulatory Guide 1.59. For construction permit (CP) reviews, the types of flood protection (discussed in Regulatory Guide 1.102) proposed must be capable of protecting those safety-related structures, systems, and components identified in Regulatory Guides 1.59 and 1.29.

2. For operating license (OL) reviews the specific designs of flood protection measures are reviewed to assure the protection levels are adequate (including static and dynamic effects) for the controlling flood conditions and that any necessary technical specifications are considered.

3. Standard engineering practice in positive flood control and shore protection, such as that developed by the Corps of Engineers, provides the basis for acceptance of methods to be employed for protection. Where sites are "hardened", that is, where emergency action is required, the time available to implement emergency procedures must be estimated by analysis of the hydrologic design event. The environmental conditions likely to prevail during all potential flooding events up to and including events of the severity of the controlling event are compared with the requirements for implementing flood emergency procedures. If the environmental conditions likely are such that the procedures can be carried out, they will be considered acceptable. An appropriate item in the plant Technical Specifications will be required in cases where emergency procedures are required to assure adequate flood protection.

4. "Hardened" flood protection (as discussed in Regulatory Guide 1.59, for facilities identified in Regulatory Guide 1.29) will be interpreted to mean "almost always in place."

III. REVIEW PROCEDURES

The estimated design basis flood level is compared with the locations and elevations of safety-related components. The staff will independently determine from analyses of postulated individual hydrologic events whether flood protection is required, and if so, what protective levels (including static and dynamic effects) are applicable. These data are transmitted to Structural Engineering Branch (SEB) for determination of structural design criteria adequacy and to Auxiliary Systems Branch (ASB) and Equipment Qualification Branch (EQB) for determination of safety system adequacy. For flood protection requiring emergency action, the design basis flood conditions, and other less severe events, are reviewed to establish the minimum time available for implementation of emergency procedures. Physical parameters such as rate-of-rise (of river or lake levels), as well as evaluation (based on experience and engineering judgment) of flood warning networks, provide the staff with an independent estimate of available time. These data are provided to ASB and EQB for their independent evaluation of the time required to implement shutdown and flood protective measures.

For OL reviews, the design of flood protection measures is reviewed to assure compatibility with the original design basis. For those plants for which shutdown (if required under Regulatory Guide 1.59, Position 2) and installation of protective measures is required in the event of a major flood, the procedures for carrying out these measures are reviewed for compatibility of available and required times as established above. The Technical Specifications must reference an emergency plan which allows for the orderly installation of required flood protection.

The above reviews are performed only when applicable to the site or site region. Some items of review may be done on a generic basis.

IV. EVALUATION FINDINGS

For CP reviews, the findings will consist of statements of flood design bases for safety-related facilities. If emergency procedures are required, the findings will indicate staff conclusions that time for implementation and methods of providing flood protection provide the necessary protection.

For OL reviews the findings will indicate the flood protection measures provided for safety-related facilities, and will indicate the type of technical specifications required to assure that the protection will be in place.

If Regulatory Guide 1.59, Position 2, is elected by the applicant, a statement describing lesser design bases will be included in the findings with the staff's conclusion of adequacy.

A sample CP-stage statement follows:

> The staff concludes that the flood protection design of the plant is acceptable and meets the requirements of 10 CFR Part 50, §50.55a, GDC 2, and 10 CFR Part 100. This conclusion is based upon the following evaluation:
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> The probable maximum surge produces a maximum calculated stillwater level that is 3.9 feet above the plant grade elevation (583.0 feet). Wave runup associated with the coincident wind wave activity results in calculated flooding levels at safety-related structures that are higher than the stillwater level. Subsequent to our review of the Preliminary Safety Analysis Report, the applicant proposed a breakwater fronting the plant to attenuate the effects of the probable maximum meteorological event on plant structures. The breakwater will be a rubble mound structure using an armor cover of stone. The toe of the structure will be at 572.0 feet and the crest will be at 583.0 feet. The front (lakeward) slope will be 2 horizontal to 1 vertical. To determine the design wave for the breakwater, the toe was conservatively assumed to scour 3 feet to elevation 569.0 feet. The maximum significant breaking wave was estimated to be 12.2 feet during the probable maximum surge. Based on these conditions, the armor layer was designed to be 7.5 feet thick using 3.3-ton to 5-ton stone. Underlayers were specified as follows: the secondary layer will be 3.5 feet thick with 600-pound to 1000-pound stone; and the filter layer will be 1.5 feet thick with 30-pound to 50-pound stone. The staff independently evaluated the proposed design using the Coastal Engineering Research Center's "Shore Protection Manual" and

concluded that the proposed breakwater design was conserative and therefore meets the criteria of 10 CFR Part 50, §50.55a.

During the probable maximum surge, the breakwater will be submerged by up to 3.9 feet of water (maximum stillwater elevation is 586.9 feet). Waves that would impinge on safety-related structures are limited by this maximum depth of water, and the maximum breaking wave that can be supported in this depth of water is approximately 3 feet. Waves that are transmitted over the breakwater will approach the service building and radwaste building which are nearest to the lake. These buildings are not seismic Category I structures, but do afford some protection for seismic Category I structures from direct wave attack. Waves travelling around the ends of the breakwater, however, can reach and runup on seismic Category I structures, and the applicant used the resulting wave forces in the design of the structures. Seismic Category I structures considered in these analyses were the reactor building, the auxiliary building, and the residual heat removal building. In addition to considering the wave forces under the above postulated conditions, the applicant also provided airlocked and waterproofed doors that are normally closed for all openings in seismic Category I structures that are below the level of the maximum wave runup. We therefore conclude that the design of these structures meets the requirements of 10 CFR Part 50, §50.55a with respect to wave forces.

We have independently evaluated the effects of the probable maximum surge stillwater elevation plus wind-generated waves on all seismic Category I structures and have concluded that the wave forces and wave runup estimates used by the applicant are conservative and therefore meet the requirements of 10 CFR Part 50, §50.55a, GDC 2, and 10 CFR Part 100.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC 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

Other SRP sections in the 2.4 series provide hydrologic design basis flood levels and environmental condition descriptions. Reports of the Corps of Engineers, United States Geologic Survey, Bureau of Reclamation, National Oceanic and Atmospheric Administration, and others will be used on an "as available" basis to evaluate flood warning systems, if applicable. The references for acceptability of protection will be completed projects of the Corps of Engineers and other Federal, State, and local agencies, and similar types of protection previously reviewed and found acceptable for other nuclear plants.

1. 10 CFR Part 50, §50.55a, "Codes and Standards."

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

3. 10 CFR Part 100, "Reactor Site Criteria."

4. Regulatory Guide 1.70, "Standard Format and Contents of Safety Analysis Reports for Nuclear Power Plants."

5. Regulatory Guide 1.59, "Design Basis Flood for Nuclear Power Plants."

6. Regulatory Guide 1.29, "Seismic Design Classification."

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

8. ANSI N170, "Standards for Determining Design Basis Flooding at Power Reactor Sites."

9. Regulatory Guide 1.125, "Physical Models for Design and Operation of Hydraulic Structures and Systems for Nuclear Power Plants."