U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

3.4.2 ANALYSIS PROCEDURES

REVIEW RESPONSIBILITIES

Primary - Structural Engineering Branch (SEB)

Secondary - None

I. AREAS OF REVIEW

The following areas relating to the design of seismic Category I structures to withstand the effects of the flood or highest ground water specified for the plant are reviewed.

1. The design parameters of the flood or highest groundwater are reviewed from the standpoint of use in defining the input parameters for the structural design criteria appropriate to account for flood and groundwater loadings. Further, for plants where the flood level is higher than the proposed grade around the plant structures, the dynamic phenomena associated with such a flooding such as currents, wind waves, and their hydrodynamic effects, are similarly reviewed. The bases for these parameters are within the review responsibility of the Hydrologic & Geotechnical Engineering Branch (HGEB) as stated in Standard Review Plan Section 2.4.2.

2. The procedures that are utilized to transform the static and dynamic effects of the flood and highest groundwater into effective loads applied to seismic Category I structures are reviewed.

II. ACCEPTANCE CRITERIA

SEB accepts the design of structures that must withstand the effects of the flood or highest groundwater level if the relevant requirements of General Design Criterion 2 concerning natural phenomena are complied with. The criteria necessary to meet the relevant requirements of GDC 2 are as follows:

1. The flood or highest groundwater and the associated dynamic effects, if any, used in the design shall be the most severe ones that have been historically

reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

2. The acceptance criteria for the flood or highest ground water level, for establishing the dynamic effects of the flood where it is above the plant grade, and for the bases for determining these site-related and hydrodynamic parameters, are established by the Hydrologic & Geotechnical Engineering Branch (HGEB) as stated in Standard Review Plan Section 2.4.2.

3. In most situations, the flood level is below the proposed plant grade and only its hydrostatic effects need be considered. Unless the hydrostatic head associated with the flood or with the highest groundwater level is relieved by utilizing a drainage and pumping system around the foundations of structures, it has to be considered as a structural load on the basement walls and foundation slab of the building. Another consideration in such a situation is to prevent any uplift or floating of the structure. The total buoyancy force may be based on the flood or highest groundwater head excluding wave action, if applicable. However, the lateral, overturning and upward hydrostatic pressures acting on the side walls and on the foundation slab, respectively, which should be considered in the structural design of these elements, should be based on the total head including wave action, if any.

   Where the flood level is above the proposed plant grade, the dynamic loads of wave action should be considered. Procedures for determining such dynamic loads are acceptable if they are in accordance with or similar to those delineated in the U.S. Army Coastal Engineering Research Center, Technical Report No. 4 (Ref. 2), as applicable. Other methods are reviewed on a case-by-case basis.

III. REVIEW PROCEDURES

The reviewer selects and emphasizes material from the review procedures described below as may be appropriate for a particular case.

1. The site-related and hydrodynamic parameters described in subsection II.1 of this SRP section are reviewed by the Hydrologic & Geotechnical Engineering Branch (HGEB) and are covered in Standard Review Plan Section 2.4.2. The structural reviewer examines the approved values of these parameters to assure that they are consistent with those contained in SRP Section 2.4.2.

2. After the acceptability of the site-related and hydrodynamic parameters is established, the reviewer proceeds with his review of the structural aspects of the design for flood or groundwater. The procedures used by the applicant to determine effective flood loads are reviewed and compared with those procedures delineated in subsection II.2 of this SRP section.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided to satisfy the requirements of this Standard Review Plan section, and concludes that his evaluation is sufficiently complete and adequate to support the following type of conclusive statement to be included in the staff's safety evaluation report:

The staff concludes that the plant design is acceptable and meets the requirements of General Design Criterion 2. This conclusion is based on the following:

The applicant has met the requirements of GDC 2 with respect to the structures capability to withstand the effects of the flood or highest groundwater level so that their design reflects

1. appropriate consideration for the most severe flood recorded for the site with an appropriate margin,

2. appropriate combination of the effects of normal and accident conditions with the effect of the natural phenomena, and

3. the importance of the safety functions to be performed.

The applicant has met these requirements by reference 2 which provides guidance and techniques used in design for hydraulic and hydrodynamic loads.

The applicant has designed the plant structures with sufficient margin to prevent structural damage during the most severe flood or groundwater and the associated dynamic effects that have been determined appropriate for the site so that the requirements of Item 1 listed above are met. In addition, the design of seismic Category 1 structures, as required by Item 2 listed above, has included in an acceptable manner load combinations which occur as a result of the most severe flood or groundwater-related loads and the loads resulting from normal and accident conditions.

The procedures utilized to determine the loadings on seismic Category I structures induced by the design flood or highest groundwater level specified for the plant are acceptable since these procedures have been used in the design of conventional structures and proven to provide a conservative basis which together with other engineering design considerations assures that the structures will withstand such environmental forces.

The use of these procedures provides reasonable assurance that in the event of floods or high groundwater, the structural integrity of the plant seismic Category I structures will not be impaired and, in consequence, seismic Category I systems and components located within these structures will be adequately protected and may be expected to perform necessary safety functions, as required, thus satisfying requirement of item 3 listed above.

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.

VI. REFERENCES

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

2. U.S. Army Coastal Engineering Research Center, "Shore Protection Manual," 3rd Edition, 1977.