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)~~Civil Engineering and Geosciences Branch (ECGB)[1]

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]

2. The analysis[3] 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.

An applicant for a standard design certification may postulate values for site parameters as a basis for plant design.[4]

Review Interfaces

The ECGB performs the following reviews as part of its primary review responsibility under the SRP sections indicated:[5]

a. The design parameters for the design basis flood ~~or highest ground water level,~~[6] 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)~~[7] by ECGB as part of its primary review responsibility for SRP Section 2.4.2.[8]

b. ECGB reviews groundwater data to determine the highest groundwater levels as part of its primary review responsibility for SRP Section 2.4.12.[9]

c. The ECGB coordinates and performs the review of site parameters postulated for design in a standard design certification application as part of its primary review responsibility for SRP Section 2.3.6.[10]

II. ACCEPTANCE CRITERIA

~~SEB accepts t~~[11]The design of a structure that must withstand the effects of the flood or highest groundwater level is acceptable[12] if the relevant requirements of General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena,"~~ concerning natural phenomena~~[13] 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 static and[14] 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 Sections 2.4.2.~~[15]

~~3~~2[16]. 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.

3.[17] Where the flood level is above the proposed plant grade, the dynamic loads of wave action should be considered. Analysis[18] 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[19] ~~(Ref. 2)~~[20], as applicable. Other methods are reviewed on a case-by-case basis.

Technical Rationale

The technical rationale for application of the above acceptance criteria to the review of the analysis procedures for determining structural forces due to flooding phenomena is discussed in the following paragraphs.[21]

GDC 2 requires that structures important to safety shall be designed to withstand the effects of natural phenomena such as floods, tsunamis, and seiches without loss of capability to perform their safety function. This includes the effects of the highest groundwater condition.

This SRP guides the review of analysis procedures for the determination of static and dynamic loadings due to natural flooding phenomena. These loadings are to be used in the design of structures, systems, and components important to safety in order to ensure their capability to withstand flood effects without loss of their safety functions.

Meeting this requirement provides a level of assurance that plant structures are constructed in such a manner as to withstand stresses resulting from the most severe flooding condition they are likely to experience.[22]

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~~ by EGCB in implementing[23] Standard Review Plan Sections 2.4.2 and 2.4.12. The structural reviewer examines the approved values of these parameters to assure that they are consistent with those contained in SRP Sections 2.4.2 and 2.4.12[24].

2. After the acceptability of the site-related and hydrodynamic parameters is established, the reviewer proceeds with ~~his~~the[25] 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.

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.[26]

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~~the[27] 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'[28] 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 I 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.

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.[29]

V. IMPLEMENTATION

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

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.[30] Except in those cases in which the applicant proposed 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.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.[31]

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 Technical Report No. 4[32], "Shore Protection Manual," 3rd Edition, 1977.

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SRP Draft Section 3.4.2
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current PRB name and abbreviation	Editorial change to reflect current PRB name and abbreviation, ECGB.
2.	Editorial revision	The reference to the review by the other branch was deleted because ECGB now also has primary responsibility for SRP Section 2.4.2. Reference to review under SRP Section 2.4.2 has been moved to the Review Interfaces subsection.
3.	Editorial addition	The modifier, analysis, was added to make the intent of this SRP section clearer.
4.	SRP-UPD format item	Added a sentence explaining that the standard design certification applicant may postulate values for the parameters of interest.
5.	SRP-UDP Update item	Added a subsection titled "Review Interfaces" and inserted the standard introductory sentence for other reviews by the primary review branch.
6.	Editorial revision	Deleted the mention of groundwater here since groundwater is not mentioned at all in SRP 2.4.2. The interface for review of groundwater is added below.
7.	Current PRB designation	Changed the PRB designation to EGCB.
8.	Editorial revision	Moved this paragraph here from the Acceptance Criteria section since it describes acceptance criteria for review under a different SRP Section. This is now an interface with another SRP section.
9.	Editorial revision	Made the reference to the review of groundwater a separate review interface since groundwater does not appear to be 2.4.2 but is reviewed in SRP Section 2.4.12.
10.	SRP-UPD format item	Added a review interface for the new SRP Section 2.3.6 review.
11.	Editorial revision	The branch designation, SEB, is outdated. Furthermore, it is NRC accepting the design, not the PRB.
12.	Editorial addition	Rewrote this to say "the design is acceptable" rather than "SEB accepts the design." See the above comment.
13.	Editorial revision	Inserted the title of GDC 2 to replace the characterization of the GDC as concerning natural phenomena.

Item	Source	Description
14.	Editorial revision	Added "static and" for completeness since both static and dynamic loadings are analyzed.
15.	Editorial revision	Moved this paragraph to the subsection on review interfaces since it tells about acceptance criteria for a different SRP Section.
16.	Editorial revision	Renumbered the paragraph because an above item was deleted.
17.	Editorial revision	Renumbered the paragraph because an above item was deleted.
18.	Editorial revision	Added the modifier to keep the focus on analysis procedures.
19.	Integrated Impact Number 1455	There is 1984 Edition of this reference. The staff should evaluate the latest edition and update the citation as appropriate.
20.	Editorial deletion	Deleted the obvious reference to the Coastal Engineering Research Center Report.
21.	SRP-UPD format item	Added a subsection titled "Technical Rationale" and used the standard introductory paragraph.
22.	SRP-UPD format item	Added technical rationale related to GDC 2, Design Bases for Protection Against Natural Phenomena.
23.	Current PRB designation	Changed the PRB designation to EGCB.
24.	Editorial addition	Added reference to the SRP Section 2.4.12 on Groundwater since groundwater is not mentioned in 2.4.2, but is covered under SRP Section 2.4.12.
25.	Editorial revision	Changed "his" to "the" to eliminate gender.
26.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
27.	Editorial revision	Changed "his review" to "the review."
28.	Editorial revision	An apostrophe was added to make the sense "capability of the structures."
29.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items.
30.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.

Item	Source	Description
31.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
32.	Editorial addition	In the text this document was identified as Technical Report No. 4. This information was added to the citation in the References section.

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SRP Draft Section 3.4.2
Attachment B - Cross Reference of Integrated Impacts

Integrated Impact No.	Issue	SRP Subsections Affected
426	Add acceptance criteria and review procedures for review of the combined license applicant's demonstration that site specific structural design criteria comply with the referenced design.	No change to SRP Section 3.4.2 was made in response to this Integrated Impact.
1455	Acceptance criteria are based on an outdated reference. Update reference.	II. Acceptance Criteria.