



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

3.4.2 ANALYSIS PROCEDURES

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of structural engineering.

Secondary - None

I. AREAS OF REVIEW

The following areas are related to the design of seismic Category I structures to withstand the effects of the highest flood and groundwater levels specified for the plant. These areas are reviewed to ensure conformance with 10 CFR 50, Appendix A, General Design Criterion (GDC) 2. The specific areas of review are as follows:

1. The data of the highest flood and groundwater levels are reviewed. Appropriate loading to account for flood and groundwater on seismic Category I structures are established. Further, for plants where the flood level is higher than the proposed grade around the plant structures, the dynamic phenomena associated with flooding such as currents, flood waves, and their hydrodynamic effects are reviewed. The bases for these parameters are reviewed by organization responsible for review of hydrology related issues in conformance with Standard Review Plan (SRP) Section 2.4.3, and Section 2.4.12.
2. The analysis procedures that are utilized to transform the static and dynamic effects of the highest flood and groundwater levels into effective loads applied to seismic Category I structures are reviewed.

Rev. 3 - [Month] 2007

USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

Requests for single copies of SRP sections (which may be reproduced) should be made to the U.S. Nuclear Regulatory Commission, Washington, DC 20555, Attention: Reproduction and Distribution Services Section, or by fax to (301) 415-2289; or by email to DISTRIBUTION@nrc.gov. Electronic copies of this section are available through the NRC's public Web site at <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0800/>, or in the NRC's Agencywide Documents Access and Management System (ADAMS), at <http://www.nrc.gov/reading-rm/adams.html>, under Accession # [MLxxxxxxx](#).

3. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.
4. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

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

Review Interfaces

Other SRP sections interface with this section as follows.

1. The flood related data to determine the design basis flood and the dynamic effects on structures of the flood where it is above the plant grade is reviewed in accordance with SRP Section 2.4.3.
2. The data related to groundwater to determine the highest groundwater level is reviewed in accordance with SRP Section 2.4.12.
3. The coordination and the review of site parameters postulated for design in a standard design certification application are conducted in accordance with SRP Section 2.0.

The specific acceptance criteria and review procedures are contained in the reference SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations.

1. 10 CFR 50, Appendix A, GDC 2 requires that SSCs important to safety shall be designed to withstand the effects of natural phenomena such as tornados, hurricanes,

tsunami without loss of capability to perform their safety functions as it relates to natural phenomena. The design bases for these SSCs shall reflect appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena.

2. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed ITAAC that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations;
3. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

The design of a structure that must withstand the effects of the highest flood and groundwater levels is acceptable if the relevant requirements of GDC 2, "Design Bases for Protection Against Natural Phenomena," are complied with. The criteria necessary to meet the relevant requirements of GDC 2 are as follows:

1. The highest flood and groundwater levels and the associated static and 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. In most situations, the highest flood level is below the proposed plant grade and only its hydrostatic effects need be considered. Unless the hydrostatic head associated with the highest flood and groundwater levels is relieved by utilizing a drainage or a pumping system around the foundations of a structures, hydrostatic pressure has to be considered as a structural load on basement walls and the foundation slab of a structure. In consideration of any uplifting or floating of a structure, the total buoyancy

force may be based on the highest flood level or the highest groundwater level excluding wave action. However, wave action should be included in the calculation for lateral and overturning movements of a structure.

3. 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 equivalent to those delineated in the U.S. Army Coastal Engineering Research Center, "Shore Protection Manual" (Vol. I, June 2002, reprinted from 1973 edition and Vol. II, June 2002, reprinted from 1973 edition) or in EM 1110-2-1100, Coastal Engineering Manual, Part II, Chapter 1, "Water Wave Mechanics," U.S. Army Corps of Engineers, April 30, 2002 as applicable.

Any other methods proposed should be provided with adequate justification and are reviewed on a case by case basis.

Technical Rationale

The technical rationale for application of these acceptance criteria to the review of the analysis procedures for determining structural forces due to flooding phenomena is discussed in the following paragraphs:

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. GDC 2 also requires that the design basis for these SSCs shall reflect appropriate consideration of the most severe of the natural phenomena that has been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy. This includes that the effects of the highest groundwater condition need to be considered.

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 SSCs 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 may experience.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

The site-related and hydrodynamic parameters described in subsection II.1 of this SRP section are reviewed by staff in accordance with SRP Sections 2.4.3 and 2.4.12.

1. After the acceptability of the site-related and hydrodynamic parameters is established, the reviewer proceeds with the review of the structural aspects of the design for flood or groundwater. The procedures used by the applicant to determine effective flood and groundwater loads are reviewed by staff responsible for the review of structures in accordance with subsection II of this SRP section.
2. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided to satisfy the requirements of this SRP section, and concludes that the 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 GDC 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 highest flood and groundwater levels 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 designed the plant structures with sufficient margin to prevent structural damage for the most severe flood and groundwater levels for the site and used appropriate dynamic effects for structural design, in accordance with U.S. Army Coastal Engineering Research Center, "Shore Protection Manual" (Vol. I, June 2002, reprinted from 1973 edition and Vol. II, June 2002, reprinted from 1973 edition) or in EM 1110-2-1100, Coastal Engineering Manual, Part II, Chapter 1, "Water Wave Mechanics," U.S. Army Corps of Engineers, April 30, 2002 as applicable, 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 load combinations of the most severe flood or groundwater-related loads and the loads resulting from normal and accident conditions.

The procedures used to determine the loadings on seismic Category I structures induced by the highest design flood or highest groundwater levels specified for the plant site are acceptable since these procedures have been used in the design of conventional structures and proven to provide an adequate 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, safety related systems and components located within these structures will be adequately protected and may be expected to perform necessary safety functions, as required, thus satisfying the requirement of item 3 listed above.

For an application referencing a certified plant design, the reviewer's finding should include a concluding statement similar to the following:

Historical data for the proposed site are consistent with the flood level identified in the site parameter envelope specified in the certified plant design documents.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate 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, unless superceded by a later revision.

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," Vol. I, June 2002, reprinted from 1973 edition.
3. EM 1110-2-1100, Coastal Engineering Manual, Part II, Chapter 1, "Water Wave Mechanics," U.S. Army Corps of Engineers, April 30, 2002.
4. U.S. Army Coastal Engineering Research Center, "Shore Protection Manual," Vol. II, June 2002, reprinted from 1973 edition.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

DRAFT SRP Section 3.4.2

Description of Changes

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in (Draft) Revision 3, dated April 1996 of this SRP. See ADAMS accession number ML052070306.

In addition this SRP section was administratively updated in accordance with NRR Office Instruction, LIC-200, Revision 1, "Standard Review Plan (SRP) Process." The revision also adds standard paragraphs to extend application of the updated SRP section to prospective submittals by applicants pursuant to 10 CFR Part 52.

The technical changes are incorporated in Revision 3, dated 2007:

1. The names and acronyms for the various branches appearing in (Draft) Revision 3 of this SRP section were updated.
2. More update references were provided.
3. Added statements to reflect the need of considering the consistence of the flood level in the historical data and in referencing a certified plant design.

Review Responsibilities - Reflects changes in review branches resulting from reorganization and branch consolidation. Change is reflected throughout the SRP.

I. AREAS OF REVIEW

- a. Added Areas of Review, subsections 3 and 4 to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.
- b. Updated the branch names and acronyms appearing in (Draft) Revision 2.
- c. The following statement was retained in the end of item 1 to reflect that HEB is responsible for the dynamic phenomena associated parameters.

The bases for these parameters are within the review responsibility of Hydrologic Engineering Branch(HEB) as stated in Standard Review Plan (SRP) Section 2.4.2. and Section 2.4.12.

II. ACCEPTANCE CRITERIA

- a. Added requirements heading, introductory paragraph, and items 2, and 3 to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.
- b. The following statement was added into Technical Rationale section,

GDC 2 also requires that the design basis for these structures, systems, and

components shall reflect appropriate consideration of the most severe of the nature phenomena that has been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy.

- c. Added Coastal Engineering Manual (Ref. 3)/R1 of Army Corps of Engineers into item 3 for dynamics loads analysis assessment.

III. REVIEW PROCEDURES

- a. Modified the introductory paragraphs to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.
- b. Added item 3 to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

IV. EVALUATION FINDINGS

- a. Added the following statements to reflect the need of considering the consistence of the historical data in referencing a certified plant design.

For an application referencing a certified plant design, the reviewer's finding should include a concluding statement similar to the following:

Historical data for the proposed site are consistent with the flood level identified in the site parameter envelope specified in the certified plant design documents.

- b. Added last paragraph to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

V. IMPLEMENTATION

- a. Modified text to reflect LIC 200, Revision 1, Exhibit 2, November 6, 2006 requirements.

VI. REFERENCES

- a. References 3-4 were added into Reference section.
 - 3. EM 1110-2-1100, Coastal Engineering Manual, Part II, Chapter 1, "Water Wave Mechanics," U.S. Army Corps of Engineers, April 30, 2002.
 - 4. U.S. Army Coastal Engineering Research Center, "Shore Protection Manual," Vol. II, June 2002, reprinted from 1973 edition.