U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

2.5.1 BASIC GEOLOGIC AND SEISMIC INFORMATION

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of basic geologic and seismic information

Secondary - None

I. AREAS OF REVIEW

Chapter 2 of the SRP discusses the site characteristics that could affect the safe design and siting of the plant. The staff reviews information presented by the applicant for a construction permit (CP), operating license (OL), design certification (DC), early site permit (ESP), or combined license (COL) concerning regional and site geology. This SRP section applies to reviews performed for each of these types of applications.

The regional and site geology information is collected by the applicant during site and regional investigations. The primary purposes for conducting these investigations are to determine geologic and seismic suitability of the site, to provide the bases for plant design, and to determine whether there is significant new tectonic or ground motion information that could impact seismic design bases as determined by probabilistic seismic hazard analysis, or PSHA (References 1 through 4). The objective of this SRP section is to enable review of the results of these investigations and assessment of geologic and seismic characteristics as they affect the site. Review and acceptance of basic data-gathering processes and findings presented by an applicant to support the geologic and seismic assessments, and completeness of this information, are integral parts of the review responsibilities defined in this section.

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NRC staff reviews the geologic, seismic, geophysical, and geotechnical information submitted by an applicant. This technical information results primarily from surface and subsurface geologic, seismic, geophysical, and geotechnical investigations, performed in progressively greater detail closer to the site, within each of four areas defined by circles drawn around the site using radii of 320 km (200 mi), 40 km (25 mi), 8 km (5 mi), and 1 km (0.6 mi). These four circumscribed areas correspond, respectively, to site region, site vicinity, site area, and site location.

The geologic, seismic, geophysical, and geotechnical information provided by an applicant in the Safety Analysis Report (SAR) to support the license application addresses the following three specific topics necessary for review of regional geology (SAR Section 2.5.1.1) and site geology (SAR Section 2.5.1.2): tectonic and seismic information, non-tectonic deformation information, and conditions caused by human activities. As part of the process for reviewing regional and site geology, the reviewer assesses information provided on regional and site-specific physiography, geomorphology, stratigraphy, lithology, structural geology, seismology, paleoseismology, and geologic and tectonic history with an emphasis on the Quaternary Period. The Quaternary is defined as the geologic period running from 1.8 million years ago (mya) to the present (Reference 5).

1. Tectonic and Seismic Information

The reviewer assesses information related to lithologic, stratigraphic, and structural geologic characteristics of the site and the region around the site, including geologic and tectonic history; tectonic deformation features underlying the site and region, particularly features of Quaternary age, including faulting and fault recurrence rates; and seismicity and vibratory ground motions, including earthquake recurrence rates, correlation of seismic events with tectonic structures, and characterization of seismic sources. Seismicity and vibratory ground motions are primary review responsibilities addressed in SRP Section 2.5.2. Close coordination between geologists, geophysicists, seismologists, and geotechnical specialists is essential for a thorough review.

The reviewer confirms that sufficient information is provided to estimate the potential for strong earthquake ground motions and surface tectonic deformation at the site and to enable assessment of the Ground Motion Response Spectrum (GMRS) proposed for the site. This information includes proximity and character of potential seismic sources, geologic evidence for Quaternary deformation (faulting or folding), evidence of prehistoric earthquakes (i.e., paleoliquefaction features), and other seismically-induced features. Adequate information on characteristics of subsurface materials beneath the site, including basic data addressing soil and rock stability (e.g., rock quality designations) and liquefaction potential, must be provided or cross-referenced with SRP Section 2.5.4. These data must be reviewed by the staff so potential for amplification of vibratory ground motion or ground failure under dynamic loading conditions can be assessed. Potential ground failure modes include liquefaction, collapse of unstable slopes, excessive settlement, differential settlement, and failure induced by high tectonic stresses. In addition, for sites adjacent to large bodies of water, information pertinent to assessing hazards from probable maximum tsunami and seiche must be provided or cross-referenced to SRP Section 2.4.12.

2. Non-Tectonic Deformation Information

The reviewer confirms that the application provides adequate information for assessment of potential for non-tectonic deformation, including landslides and other mass-wasting phenomena; subsidence, to include differential subsidence; slip along

growth faults; glacially-induced deformation; and potential for collapse or subsidence in areas underlain by carbonate rocks. Chemical weathering zones and evidence for pre-consolidation may also be factors to consider in relation to characteristics of subsurface materials beneath the site.

3. Conditions Caused by Human Activities

The reviewer assesses information regarding topography, slope stability, fluid injection or withdrawal, mineral extraction, jointing and faulting, solution effects, and seismicity at the site as they may affect, or be affected by, conditions resulting from human activities.

The reviewer confirms that the application includes information on potential for changes in groundwater conditions caused by withdrawal or injection of fluids; subsidence or collapse caused by withdrawal of fluids; issues related to mineral extraction; and induced seismicity and fault movement caused by reservoir impoundment and fluid injection or withdrawal.

4. Additional Information for 10 CFR Part 52 Applications

Additional information will be presented dependent on the type of application. For a COL application, the additional information is dependent on whether the application references an ESP, a DC, both or neither. Information requirements are prescribed within the “Contents of Application” sections of the applicable Subparts to 10 CFR Part 52.

The reviewer confirms that information provided by the applicant is documented through appropriate references to all relevant published and unpublished materials. Illustrative materials provided to document site characteristics should include, but are not necessarily limited to, structural, tectonic, physiographic, topographic, geologic, gravity, and magnetic maps; geologic cross-sections showing soil horizons, stratigraphy, lithology, and structure; geologic maps of trenches and test pits; seismic reflection or refraction and other geophysical survey profiles; soil and core boring logs; geophysical borehole logs; aerial photographs; and satellite imagery. Some sites may require maps illustrating areas of subsidence, karst features, mechanically weak zones of soil and rock, paleoliquefaction features, irregular weathering conditions and weathering depths, landslide potential, locations of oil and gas wells, faults and joints. Maps should include superimposed plot plans of plant facilities and the relationship of all Seismic Category I facilities to subsurface geology should be illustrated. Locations of all plant structures, borings, trenches, test pits, seismic and geophysical data collection profiles, and geologic cross-sections should also be included on plot plans. All geologic terminology used should conform to that found in standard references (Reference 7).

Applying knowledge derived from the application, other published and unpublished scientific literature, and the reviewer’s own academic background and practical experience in geoscience, the reviewer assesses adequacy of the geologic, seismic, geophysical, and geotechnical information cited in support of the applicant's conclusions concerning suitability of the plant site. The staff may bring the review to an earlier completion if the application contains sufficient data to enable an independent assessment of the conclusions therein. Depending on completeness of the application, the staff also may conduct a literature search at an appropriate level of detail. However, the application and its supporting information should enable the staff to logically progress from data and assumptions to conclusions drawn without the need for an extensive independent literature search. The staff should present and evaluate all pertinent data, including information which is potentially controversial.

Review Interfaces

Other SRP sections interface with this section as follows:

1. Review of information pertaining to local and regional groundwater is performed under SRP Section 2.4.12 on "Groundwater." For sites adjacent to large bodies of water, information pertinent to assessing potential hazards from probable maximum tsunami and seiche must be provided in this SRP section or cross-referenced to SRP Section 2.4.12.

2. Review of information from geologic, geotechnical, geophysical, and seismic investigations performed to determine the GRMS is performed under SRP Section 2.5.2 on "Vibratory Ground Motion."

3. Review of information that addresses existence of the potential for surface deformation that could affect the site is performed under SRP Section 2.5.3 on "Surface Faulting."

4. Review of information concerning properties and stability of all soils and rock that may affect plant facilities under both static and dynamic loading conditions, including vibratory ground motions associated with the GRMS, is performed under SRP Section 2.5.4 on "Stability of Subsurface Materials and Foundations."

5. Review of information related to stability of all earth and rock slopes, both natural and man-made, and cuts, fills, embankments, and dams, the failure of which could adversely affect safety of the plant, is performed under SRP Section 2.5.5 on "Stability of Slopes."

6. For DC applications and COL applications referencing a DC rule or DC application, review of the site parameters in the Design Control Document (DCD) Tier 1 and Chapter 2 of the DCD Tier 2[1] submitted by the applicant is performed under SRP Section 2.0, "Site Characteristics and Site Parameters." Review of site characteristics and site-related design parameters in ESP applications or in COL applications referencing an ESP is also performed under Section 2.0.

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

II. ACCEPTANCE CRITERIA

Requirements

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

1. 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 2, "Design Bases for Protection Against Natural Phenomena," as it relates to consideration of the most severe of the natural phenomena that have been historically reported for the site and

[1] Additional supporting information of prior DC rules may be found in DCD Tier 2 Section 14.3.

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

2. For ESP applications, GDC are not applicable. However, the GDC 2 requirement to identify geologic site characteristics that consider the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated is specifically identified in 10 CFR 52.17(a)(1)(vi).

3. 10 CFR Part 100, Section 100.23, "Geologic and Seismic Siting Criteria" (Reference 3), for evaluating suitability of a proposed site based on consideration of geologic, geotechnical, geophysical, and seismic characteristics of the proposed site. Geologic and seismic siting factors must include the Safe Shutdown Earthquake (SSE) for the site; and the potential for surface tectonic and non-tectonic deformation. The site-specific GMRS satisfies requirements of 10 CFR 100.23 with respect to the development of the SSE.

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.

Appropriate sections of the following Regulatory Guides are used by the staff for the identified acceptance criteria:

Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion" (Reference 11), describes acceptable methods for (1) conducting geologic, seismic, and geophysical investigations of the site and site region; (2) identifying and characterizing seismic sources; (3) performing PSHA; and (4) determining the GMRS for the site (see SRP Section 2.5.2 and Reference 3).

Regulatory Guide 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion" (Reference 12), describes methods acceptable for (1) conducting geologic, geophysical, seismologic, and geotechnical investigations; (2) identifying and characterizing seismic sources; (3) performing PSHA; (4) determining seismic wave transmission characteristics of soil and rock sites; and (5) determining site-specific, performance-based earthquake ground motion leading to establishing an GMRS. This regulatory guide offers an alternative to Regulatory Guide 1.165 for satisfying requirements of 10 CFR 100.23.

Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants" (Reference 13), describes geotechnical site investigations that enable evaluation of site safety in relation to performance of foundations and earthworks under anticipated loading conditions, including earthquakes. This regulatory guide provides general guidance and recommendations for developing site-specific investigative programs as well as specific guidance for conducting subsurface investigations.

Regulatory Guide 1.138, “Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants “ (Reference 14), describes laboratory investigations and testing practices acceptable for determining soil and rock properties and characteristics necessary for engineering analysis and design of foundations and earthworks for nuclear power plants.

Regulatory Guide 1.198, “Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites” (Reference 15), describes acceptable methods for evaluating potential for earthquake-induced instability of soils resulting from liquefaction and consequent strength degradation.

Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations" (Reference 16), discusses major site characteristics related to public health and safety which are considered by a reviewer for determining suitability of sites for nuclear power facilities.

Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants - LWR Edition” (Reference 17), discusses guidance for combined license applications for nuclear power plants (LWRs).

The reviewer should confirm that information provided in the application is complete; properly documented; consistent with requirements of 10 CFR 100.23; shows that methods described in Regulatory Guide 1.165, 1.208, or comparable methods, were employed for identifying and characterizing seismic sources and defining the GMRS; and conforms to the format suggested in Regulatory Guide 1.206. For evaluating completeness and acceptability of the application, the reviewer should use published and unpublished scientific information derived from various sources that present geologic, geotechnical, seismic, geophysical, and related data for the region in which the site is located. These sources include the United States Geological Survey (USGS); other Federal and State agencies; and academia, industry, and other non-governmental and professional organizations. It is the responsibility of the reviewer to remain up-to-date on geologic, geotechnical, geophysical, and seismic information about a site or site region by regularly reviewing current scientific literature deemed pertinent and participating professional meetings at which this information is presented.

The reviewer must ensure that investigations described in Regulatory Guides 1.165, 1.132, 1.138, 1.198, 1.208, and 4.7 are conducted with an appropriate level of thoroughness by the applicant within the four areas designated in Regulatory Guide 1.165 and 1.208. These four areas are defined by circles drawn around the site using radii of 320 km (200 mi) for site region, 40 km (25 mi) for site vicinity, 8 km (5mi) for site area, and 1 km (0.6 mi) for site location. The reviewer should confirm that sufficient information is presented in the application to enable a comparison between new data derived from regional and site investigations and those data used in tectonic and ground motion models for PSHA.

1. Regional Geology (SAR Section 2.5.1.1)

In meeting requirements of GDC 2 in Appendix A of 10 CFR Part 50, 10 CFR 52.17, and 10 CFR 100.23, SAR Section 2.5.1.1 will be considered acceptable if a complete and documented discussion is presented for all geologic (including tectonic and non-tectonic), geotechnical, seismic, and geophysical characteristics, as well as conditions caused by human activities, deemed important for safe siting and design of the plant. This section should contain a review of regional geologic and tectonic history, tectonic features (with emphasis on the Quaternary period), structural geology, seismology,

paleoseismology, physiography, geomorphology, stratigraphy, and lithology within a distance of 320 km (200 mi) from the site (i.e., the “site region”) to provide a framework within which significance to safety can be evaluated in regard to geology, seismology, and conditions caused by human activities. Geologic maps and cross-sections constructed at scales adequate to illustrate pertinent regional features should be included in the application.

2. Site Geology (SAR Section 2.5.1.2)

In meeting requirements of GDC 2 in Appendix A of 10 CFR Part 50,10 CFR 52.17, 10 CFR 100.23, and regulatory positions presented in Regulatory Guides 1.165, 1.132, 1.138, 1.198, 1.208**,** and 4.7, SAR Section 2.5.1.2 will be considered acceptable if it contains a description and evaluation of geologic (including tectonic and non-tectonic) features, geotechnical characteristics, seismic conditions, and conditions caused by human activities at appropriate levels of detail within areas defined by circles drawn around the site using radii of 40 km (25 mi) for site vicinity, 8 km (5mi) for site area, and 1 km (0.6 mi) for site location. This subsection should contain the following information, and geologic maps and cross-sections constructed at scales adequate to clearly illustrate pertinent features in the site vicinity and site area and at the site location should be included in the application.

a. Structural geology, including identification and characterization of faults, joints, and other tectonic deformation features; and discussion of the relationships between these features and regional tectonic structures.

b. Seismicity, including identification of historical and instrumentally-recorded earthquakes; identification and characterization of any local seismic sources; and discussion of the relationships between local seismicity and regional tectonic structures and seismic sources.

c. Geologic and tectonic history, particularly for the Quaternary Period, and its relationships to regional geologic and tectonic history.

d. Evidence for paleoseismicity, or a lack of it.

e. Stratigraphy and lithology of rock units and relationships to regional stratigraphic and lithologic characteristics.

f. Physiography and geomorphology.

g. Engineering significance of geologic and geotechnical characteristics of features and materials, including foundation materials, related to:

(1) Dynamic behavior during prior earthquakes.

(2) Zones of mineralization, alteration, irregular or deep weathering, or structural weakness in surface or subsurface materials.

(3) Unrelieved residual stresses in bedrock.

(4) Subsurface materials that could be weak or unstable due to mineralogy or physical properties.

(5) Karst features in limestone terranes.

(6) Effects of human activities.

h. Potentially unstable natural or man-made slopes.

i. Groundwater conditions, including perched aquifers.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

GDC 2 or 10 CFR 52.17(a)(1)(vi) for ESP applications require consideration of the most severe of the natural phenomena. 10 CFR 100.23(c) requires that the geologic and seismic characteristics of the site and its environs be investigated in sufficient scope and detail to permit an adequate evaluation of the proposed site; provide sufficient information to support estimates of the SSE ground motion; and permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site. 10 CFR 100.23(c) further specifies that all geologic and seismic factors that may affect design and operation of the proposed nuclear power plant must be investigated. 10 CFR 100.23(d) requires that the geologic and seismic siting factors considered for design include a determination of the potential for surface tectonic and non-tectonic deformations. Application of GDC 2 or 10 CFR 52.17(a)(1)(vi) for ESP applications, and 10 CFR 100.23 provides assurance that the most severe geologic and seismic conditions at the chosen plant site have been identified, and that geologic and seismic elements of the site have been adequately investigated and characterized.

III. REVIEW PROCEDURES

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

The procedures outlined below are used to review CP applications, ESP applications, and COL applications that do not reference an ESP to determine whether geologic and seismic information for the proposed site meets the acceptance criteria given in Subsection II of this SRP section. For reviews of OL applications, these procedures are used to verify that the geologic and seismic information remains valid and that the facility's design specifications are consistent with this information. As applicable, reviews of OLs and COLs include a determination on whether the content of technical specifications related to continued seismic surveillance is acceptable and whether the technical specifications reflect consideration of any unique geologic and seismic conditions which have been identified.

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.

Three Phase Review Procedure

Three review phases are conducted by the staff: (1) an acceptance review of the application; (2) a thorough, detailed technical review of the application; and (3) a review of supplemental

information provided by the applicant in response to questions from the staff. All three review phases may be applied for reviews of a CP, OL, ESP, or COL application.

Phase 1. Acceptance Review

The Phase 1 acceptance review is a brief review of the application to evaluate its completeness and identify safety issues that could cause delays in subsequent phases of the review process. Acceptance or rejection of the application for Phase 2 review is governed by two criteria: (1) adherence to standard format for identifying and describing geologic, seismic, geophysical, and geotechnical characteristics and features, as well as conditions resulting from human activities, that may affect safety of the site; and (2) provision of adequate information and documentation, as described in Regulatory Guides 1.165, 1.206, and 1.208**,** to enable an independent staff review of conclusions presented by the applicant.

Phase 2. Review of Application

In this review phase, which begins after the application is docketed, the staff conducts a thorough, detailed technical review of material in the application and an effort is made to identify all safety issues. The reviewer examines the application to confirm that all interpretations are based on standard geologic practices and do not exceed validity limits of either the applicant's data, or other data sets from published scientific literature. The application is also reviewed for any significant new information derived from site-specific geologic, seismic, geophysical, and geotechnical investigations that had not been applied to tectonic and ground motion models used in the PSHA. Appendix C of Regulatory Guide 1.208 and Appendix E of Regulatory Guide 1.165 describe acceptable methods for addressing significant new information in the PSHA.

At the beginning of this review phase, the staff decides how consultants and advisors who are geoscience experts should be involved. Consultants and advisors may include geoscientists at the U.S. Geological Survey (USGS), State Geological Surveys, universities, and private industry who are able to provide first-hand knowledge of the site region, site vicinity, site area, and site location in relation to geologic and seismic characteristics. Necessary information is made available to any consultants and advisors that are selected by the staff, and they may be asked to perform such tasks as reviewing the tectonic setting of plants in regions of complex geology, evaluating potential for surface deformation, verifying an applicant's geochronology for stratigraphic units and fault displacement, and providing advice on levels of earthquake ground motion for seismic evaluation of selected sites

A literature search and review of relevant references (e.g., published geological reports, USGS professional papers and open-file reports, university theses, physiographic and geologic maps, and aeromagnetic and gravity maps) is conducted by NRC staff and its advisors and consultants to acquire additional pertinent information on regional and local geology and seismology

However, as publication of data and results commonly lags behind completion of research projects and construction investigations, a reviewer should not rely entirely on information submitted by the applicant or that in published literature. The reviewer should identify any pertinent studies underway in the site region, site vicinity, site area, or at the site location and obtain information on preliminary results of these studies.

Special provisions may be required to examine any pertinent data that are of a proprietary nature.

As part of the Phase 2 review, the staff will conduct geologic reconnaissance of the site region, site vicinity, site area, and site location as necessary to examine soil and rock samples from core borings and test pits and geologic features in trenches and excavations for plant facilities, if these information sources exist. Since geologic features (e.g., faults, paleoliquefaction features indicative of seismically-induced ground motions, and solution cavities) or geologic materials (e.g., soil or rock zones that may result in unanticipated engineering concerns due to liquefaction, heave, excessive settlement, or groundwater flow during or after construction) which have the potential to adversely impact site safety may be discovered in plant excavations or during other field investigations, this reconnaissance is deemed necessary in light of requirements and procedures specified in Subpart C of 10 CFR Part 52 which allows for a COL (i.e., a combined CP and OL) as an alternative to the two-step licensing process previously defined in 10 CFR Part 50 which includes a CP (Step 1) separate from an OL (Step 2).

Under the COL approach defined in 10 CFR Part 52, the Safety Evaluation Report (SER) will have been written by the staff and a license granted to the applicant before plant construction excavations and geologic mapping of the excavations begin. Therefore, the geologic reconnaissance performed by the staff notwithstanding, geologic features and potential engineering concerns discovered in plant excavations of applicants granted a COL may not have been evaluated by the staff. To alleviate potential problems, clear statements must be provided in the site-specific portion of the COL application that the applicant commits to (1) notifying the staff immediately if previously unknown geologic features that could represent a safety hazard to the plant are discovered in the excavations; (2) at a minimum, undertaking detailed geologic mapping of walls and floors of all excavations for Seismic Category I facilities; and (3) notifying NRC staff when the excavations and geologic maps of those excavations are available for examination and evaluation.

The two-step licensing process defined in 10 CFR Part 50 requires applicants to obtain a CP (Step 1), followed by an OL (Step 2) after construction excavations and required geologic mapping of all Seismic Category I excavations have been completed and plant design bases have been approved by the staff. Seismic Category I excavations and the associated geologic maps are to be examined by the staff prior to placement of backfill or concrete and before the SER is completed. This procedure should continue for future sites licensed under the two-step process of 10 CFR Part 50.

During the Phase 2 detailed technical review, the staff develops questions and comments related to issues considered to be inadequately addressed by the applicant which may either be revealed during this review phase or developed based on additional information provided by the applicant as a result of the acceptance review. Questions may also result from discovery of references not cited by the applicant that contain conclusions conflicting with those of the applicant. These first-round questions usually require the applicant to conduct additional investigations or supply clarifying information and are referred to as Requests for Additional Information (RAIs). When insufficient data are provided by the applicant to support interpretations and conclusions presented, and more conservative reasonable alternative interpretations are technically supported in the literature, the staff will request additional investigations or require the applicant to adopt the more conservative interpretations. This review phase will commonly involve public meetings with the applicant to clarify questions and allow the applicant to present

new data to justify conclusions presented. The applicant's responses to questions are reviewed and any remaining issues settled, either by a second round of questions or by staff positions. A staff position is usually in the form of a requirement for the applicant to provide confirmatory information or to design for a specific condition in a manner deemed to be sufficiently conservative and consistent with requisites of 10 CFR 100.23.

Phase 3. Review of Supplemental Information

The Phase 3 review is the final phase for resolving all open safety-related issues, an activity commonly associated with the staff review of the applicant's responses to RAIs. The staff may either concur with decisions of the applicant on safety-related issues, or take a more conservative position if deemed necessary to assure the required degree of safety is imposed for the plant. When safety-related issues have been resolved, the staff then provides input for its SER. Because plant construction excavations will not be completed until after the staff has prepared the SER in cases where an applicant is granted a COL under Subpart C of 10 CFR Part 52, subsequent reviews of geologic data and examination of excavations for Seismic Category I structures will be necessary to confirm that site parameters lie within the certified design envelope specified in the COL application.

Review Procedures Specific to 10 CFR Part 52 Application Type

a. Early Site Permit Reviews

Subpart A to 10 CFR Part 52 specifies the requirements and procedures applicable to the Commission's review of an ESP application for approval of a proposed site. Information required in an ESP application includes number, type, and thermal power level of the facilities for which the site may be used; types of cooling systems used; and a description of geologic, seismic, geophysical, geotechnical, and hydrologic characteristics of the proposed site. The scope and level of detail of review of data parallel that used for a CP review. The applicant should propose geologic and seismic site characteristics that will form a set of minimum values for design and construction of a new plant to be built at the site.

In the absence of certain circumstances, such as a compliance or adequate protection issue, 10 CFR 52.39 precludes the staff from imposing new site characteristics, design parameters, or terms and conditions on the early site permit at the COL stage. Accordingly, the reviewer should ensure that all geologic and seismic site characteristics that could affect the design basis of SSCs important to safety are reflected in the site characteristics, design parameters, or terms and conditions of the early site permit.

b. Standard Design Certification Reviews

DC applications do not contain general descriptions of site characteristics because this information is site-specific and will be addressed by the COL applicant. However, pursuant to 10 CFR 52.47(a)(1), a DC applicant must provide site parameters postulated for the design.

There are no postulated site parameters for a DC related to this SRP section.

c. Combined License Reviews

For a COL application referencing a certified standard design, NRC staff reviews that application to ensure sufficient information was presented to demonstrate that the characteristics of the site fall within the site parameters specified in the DC rule. Since there are no applicable site parameters included in the DC, this demonstration is not applicable for this SRP section.

For a COL application referencing an ESP, NRC staff reviews the application to ensure the applicant provides sufficient information to demonstrate that the design of the facility falls within the site characteristics and design parameters specified in the early site permit as applicable to this SRP section. In accordance with 10 CFR 52.79(b)(2), should the design of the facility not fall within the site characteristics and design parameters, the application shall include a request for a variance from the ESP that complies with the requirements of 10 CFR 52.39 and 10 CFR 52.93.

In addition, long-term environmental changes and changes to the region resulting from human activities or natural causes may have introduced changes to the site characteristics that could be relevant to the design basis. In the absence of certain circumstances, such as a compliance or adequate protection issue, 10 CFR 52.39 precludes the staff from imposing new site characteristics, design parameters, or terms and conditions on the early site permit at the COL stage. Consequently, a COL application referencing an ESP need not include a re-investigation of the site characteristics that have previously been accepted in the referenced ESP. However, in accordance with 10 CFR 52.6, "Completeness and Accuracy of Information," the applicant or licensee is responsible for identifying changes of which it is aware, that would satisfy the criteria specified in 10 CFR 52.39. Information provided by the applicant in accordance with 10 CFR 52.6(b) will be addressed by the staff during the review of a COL application referencing an ESP or a DC.

For a COL application referencing either an ESP or DC or both, the staff should review the corresponding sections of the ESP and DC FSER to ensure that any early site permit conditions, restrictions to the DC, or COL action items identified in the FSERs are appropriately handled in the COL application.

IV. EVALUATION FINDINGS

The review should document the staff's evaluation of geologic and seismic site characteristics with respect to the relevant regulatory criteria. The evaluation should support the staff's conclusions as to whether the regulations are met. The reviewer should state what was done to evaluate the applicant's safety analysis report. The staff's evaluation may include verification that the applicant followed applicable regulatory guidance, performance of independent calculations, and/or validation of appropriate assumptions. The reviewer may state that certain information provided by the applicant was not considered essential to the staff's review and was not reviewed by the staff. While the reviewer may summarize or quote the information offered by the applicant in support of its application, the reviewer should clearly articulate the bases for the staff's conclusions.

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

1. Early Site Permit Reviews

A typical staff finding at the conclusion of the review can be illustrated as follows.

> In its review of the geologic and seismic aspects of the plant, the staff has considered pertinent information gathered by the applicant in support of the license application. The information reviewed includes data from site and near-site investigations, as well as a geologic reconnaissance of the site region, site vicinity, site area, and site location; an independent review of recently published literature; and discussions with knowledgeable scientists with the USGS, State Geological Surveys, local universities, consulting firms, or other non-governmental and professional organizations.

Based on the staff review:

(1) The geologic, seismic, geophysical, and geotechnical investigations and other information provided by the applicant as required by 10 CFR 52.17 and 10 CFR 100.23 have been combined with the staff's independent review of the data and other information sources, including information from geologic reconnaissance of the site and region. These results provide an adequate basis to establish that no capable tectonic features or seismogenic sources exist in the plant site area that have a potential for causing surface or near-surface displacements or earthquakes to be centered at the site location.

(2) Based on the results of the applicant's regional and site geologic, seismic, geophysical, and geotechnical investigations and the staff's independent evaluation, the staff concludes that all seismic sources significant to determining the Ground Motion Response Spectrum (GRMS) for the site have been identified and appropriately characterized by the applicant in accordance with Regulatory Guide 1.165 and 1.208 and Standard Review Plan (SRP) Section 2.5.2.

(3) Based on the applicant's geologic, geophysical, and geotechnical investigations of the site vicinity and site area, the staff concludes that site lithology, stratigraphy, geologic history, structural geology, and characteristics of subsurface soils and rocks have been properly characterized.

(4) There is no potential for occurrence of other non-tectonic geologic events (e.g., landsliding, collapse or subsidence related to occurrence of karst features in limestone terranes, differential settlement) that could compromise the safety of the site, or the applicant has mitigated such occurrences and adequately supported acceptable engineering solutions in the application.

(5) There is no potential for effects of human activity, such as subsidence caused by withdrawal or injection of fluids or collapse due to mineral extraction, that compromise safety of the site, or the applicant has taken steps to prevent such occurrences and has adequately supported these actions in the application.

2. Design Certification Reviews

There are no postulated site parameters for a DC related to this SRP section. Geologic and seismic information is site-specific and will be addressed by the COL applicant.

3. Construction Permit, Operating License, and Combined License Reviews

If the staff completes review of geologic and seismic aspects of the plant site and confirms that the applicant has met all applicable requirements (i.e., appropriate portions of GDC 2 in 10 CFR Part 50, Appendix A; and 10 CFR 100.23) and guidelines (i.e., Regulatory Guides 1.165, 1.132, 1.138, 1.198, and 1.208), the conclusion in the SER should state that investigations and analyses performed and information provided support the applicant's conclusions regarding geologic and seismic suitability of the proposed nuclear power plant site. Licensing conditions established by the staff to resolve any significant deficiency identified in the application should be stated in sufficient detail to make clear the precise nature of the concerns and the required resolution. The application is also reviewed for any significant new information derived from site vicinity, site area, or site location geologic, seismic, geophysical, and geotechnical investigations that had not been previously applied to tectonic and ground motion models used in the PSHA.

Determinations reqarding geologic and seismic suitability of the site are made by the staff after CP, OL, or COL application reviews. Conclusions regarding an OL application will include evaluation of excavations for Seismic Category I structures. For COL applications that do not reference a previous ESP, the staff evaluation findings will include the evaluation findings identified above for ESP reviews. Otherwise, conclusions relating to geologic and seismic suitability of a site following a COL application review will be made when the applicant has committed to (1) notifying the staff immediately if previously unknown geologic features that could represent a hazard to the plant are discovered in the construction excavations; (2) at a minimum, undertaking detailed geologic mapping of walls and floors of all excavations for Seismic Category I facilities; and (3) notifying the staff when the excavations and associated geologic maps are available for examination and evaluation. The staff will visit the COL application site to examine walls and floors of excavations at an appropriate time after licensing to confirm that no evidence exists in the excavations for previously unknown geologic features (e.g., faults, paleoliquefaction features indicative of seismically-induced ground motions, solution cavities) or potentially problematical geologic materials (e.g., soil or rock zones that may result in unanticipated engineering concerns due to liquefaction, heave, excessive settlement, or groundwater flow during or after construction). This staff site visit, in addition to determining whether there is new information of significance for site suitability and safety that was revealed after review of the COL application was completed, will ensure that recommendations or conditions formulated by the staff during the COL application review have been implemented. The site visit will also include an appraisal by the staff of the applicant’s engineering solutions for mitigating any potential non-tectonic geologic hazards.

A typical staff finding at the conclusion of the review can be illustrated as follows:

> The staff evaluation of the geologic and seismic information pertaining to this site, as presented by the applicant, is discussed in SER sections 2.5.1, 2.5.2, and 2.5.3. The staff concludes that the site is acceptable from geologic and seismic standpoints and meets the requirements of 10 CFR Part 50, Appendix A, General Design Criterion 2 (GDC 2); and 10 CFR 100.23. This conclusion is based on the applicant having met the requirements and guidelines of:

a. General Design Criterion 2 (“Design Bases for Protection Against Natural Phenomena”) of Appendix A (“General Design Criteria for Nuclear Power Plants”) to 10 CFR Part 50 (“Domestic Licensing of Production and Utilization Facilities”) with respect to protection against natural phenomena such as earthquakes, surface deformation, and seismically-induced floods and water waves.

b. 10 CFR 100.23 ("Geologic and Seismic Siting Criteria”) with respect to obtaining geologic and seismic information necessary to determine site suitability and appropriate plant design, and ascertain that any new information derived from site-specific investigations does not impact the GRMS derived by a probabilistic seismic hazard analysis. In complying with this regulation, the applicant also meets guidance in Regulatory Guides 1.132 ("Site Investigations for Foundations of Nuclear Power Plants”); 1.138 (“Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants”); 1.165 ("Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion”); 1.208 (“A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion”); 1.198 (“Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites”); 4.7 ("General Site Suitability Criteria for Nuclear Power Stations”); and 1.206 (“Combined License Applications for Nuclear Power Plants - LWR Edition”).

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 submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. J.B. Savy et al., "Eastern Seismic Hazard Characterization Update," Lawrence Livermore National Laboratory, UCRL-ID-115111, 1993.

2. P.Sobel, "Revised Livermore Seismic Hazard Estimates for Sixty-Nine Nuclear Power Plant Sites East of the Rocky Mountains," US NRC, NUREG-1488, 1994.

3. Electric Power Research Institute, "Probabilistic Seismic Hazard Evaluation of Nuclear Power Plant Sites inthe Central and Eastern United States," Volumes I through 10, NP-4726A, 1989.

4. Electric Power Research Institute, "Guidelines for Determining Design Basis Ground Motions," EPRI Report TR-102293, Vols. 1-4, 1993.

5. Geological Society of America (GSA Website), Geologic Time Scale, 1999.

6. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

7. K.K.E. Neuendorf, J.P. Mehl, Jr, and J. A. Jackson, Editors, "Glossary of Geology," Fifth Edition, American Geological Institute, Alexandria, Virginia, 2005.

8. General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," in Appendix A ("General Design Criteria for Nuclear Power Plants") to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

9. Section 100.23, "Geologic and Seismic Siting Criteria," of 10 CFR Part 100, "Reactor Site Criteria."

10. Regulatory Guide 1.165, U.S. NRC, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion."

11. Regulatory Guide 1.208, U.S. NRC, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion."

12. Regulatory Guide 1.132, U.S. NRC, "Site Investigations for Foundations of Nuclear Power Plants."

13. Regulatory Guide 1.138, U.S. NRC, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants ."

14. Regulatory Guide 1.198, U.S. NRC, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites."

15. Regulatory Guide 4.7, U.S. NRC, "General Site Suitability Criteria for Nuclear Power Stations."

16. Regulatory Guide 1.206, U.S. NRC, "Combined License Applications for Nuclear Power Plants (LWR 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.
