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U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

2.5.1 ~~BASIC~~ GEOLOGIC ~~AND SEISMIC~~CHARACTERIZATION INFORMATION

REVIEW RESPONSIBILITIES

Primary—~~-~~ Organization responsible for ~~the~~ review of ~~basic~~information related to geologic characteristics of the site and ~~seismic information~~ environs

Secondary—~~-~~ None

I. AREAS OF REVIEW

Chapter 2 of the Standard Review Plan (SRP ~~discusses~~) addresses the review of 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),~~an early site permit (ESP), ~~or~~ combined license (COL), a construction permit (CP) or an operating license (OL) concerning regional and site geology~~. This~~ in their Final Safety and Analysis Report (FSAR) or SSAR for an ESP. The SRP ~~section~~Section 2.5.1 applies to reviews ~~performed for~~ of each of these types of applications.~

Draft Revision 5 – August 2013

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USNRC STANDARD REVIEW PLAN

This Standard Review Plan (SRP), NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission (NRC) 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 regulations. The SRP is not a substitute for the NRC 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 SRP sections are numbered in accordance with corresponding sections in Regulatory Guide (RG) 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of RG 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 RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC 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 e-mail to NRR_SRP@nrc.gov

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The ~~regional~~applicant investigates geologic characteristics of the site and ~~site geology~~ its environs in sufficient scope and detail to evaluate the suitability of the site for the proposed facility. The geologic information ~~is~~ collected by the applicant ~~during site and regional investigations. The primary purposes for conducting these investigations~~ for this evaluation must consider all natural phenomena 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. Results of these investigations are used to determine geologic ~~and seismic suitability of the site, to provide the bases for plant~~ factors that affect design and operation of the proposed facility, and to ~~determine whether there is significant new tectonic or~~ estimate, in Section 2.5.2, the site-specific ground motion ~~information that could impact seismic design bases as determined by~~ response spectrum (GMRS) and to support the probabilistic seismic hazard analysis~~, or~~ (PSHA~~(~~).

~~References 1 through 4).~~ The objective of this SRP section is to enable the staff's review of the results of ~~these~~the investigations and ~~assessment~~assessments of geologic ~~and seismic~~ characteristics ~~as they~~that affect the site. Review and acceptance of basic data-gathering processes ~~and findings presented by an applicant to support the geologic and seismic assessments~~, investigation results, and completeness of this information~~,~~ as presented by an applicant are integral parts of the review responsibilities defined in this section.~~—~~

The staff's review, described in this SRP section, focuses on determining the acceptability of applicant's characterization of geologic features that might affect site suitability. The review methods and acceptance criteria developed in this SRP section outline an approach to determine if the results of the geologic investigations are acceptable. An applicant may propose other approaches to demonstrate compliance with applicable regulatory requirements and the staff will review those alternatives. The applicant uses this geologic information in its site suitability analyses (FSAR 2.5.2, 2.5.3, 2.5.4 and 2.5.5) and staff reviews those analyses and assessments per SRP 2.5.2, 2.5.3, 2.5.4 and 2.5.5. Because the geologic and tectonic information provided in FSAR Section 2.5.1 directly supports the assessments in FSAR Section 2.5.2 "Vibratory Ground Motion" and Section 2.5.3 "Surface Deformation," the investigations for Section 2.5.1 generally follow the four areas defined in Regulatory Guide (RG) 1.208, using radii of 320 km (200 mi) for

the site region, 40 km (25 mi) for the site vicinity, 8 km (5 mi) for the site area, and 1 km (0.6 mi) for the site location. RG 1.208 indicates the need for increasing levels of detail as the investigations progress closer to the proposed site. In addition, per Title 10 of the *Code of Federal Regulations* (10 CFR) 100.23 (c), "the size of the region to be investigated and the type of data pertinent to the investigations must be determined based on the nature of the region surrounding the proposed site." In some locations, for example, the potential for very large earthquakes or for volcanic activity might require investigations to be performed at greater distances from the site than 320 km (200 mi).

The ~~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~~geological, geophysical, and geotechnical information provided by an applicant in the ~~Safety Analysis Report (SAR) to support the license application~~ FSAR 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):~~ Safety Analysis Report [SAR] Section 2.5.1.1) and local geology (SAR Section 2.5.1.2): geologic setting, tectonic framework , and potential hazardous conditions caused by human activities. Explicit consideration of human activities (e.g., impacts of mining, quarrying, slope instability, fluid injection or withdrawal) is necessary because such human activities have the potential to alter some geologic processes that may influence site suitability and might not be preserved in the geologic record.

As part of the review process the staff evaluates the information provided by the applicant with a focus on Quaternary aged geologic features. The Quaternary is defined as the geologic period that began approximately 2.6 million years ago (Ma) and continues to the present. Geologic or tectonic features with activity in the Quaternary Period might indicate a potential for future tectonic activity, whereas older tectonic features generally lack such potential. As discussed in RG 1.208, a PSHA characterizes seismic potential through consideration of the historic and geologic record from the Quaternary Period.

Thus, the characterization of potential Quaternary-aged tectonic features is an important part of this review. In addition, the reviewer of FSAR Section 2.5.2 would need to confirm that relevant Quaternary-aged features were considered appropriately in the PSHA.

A PSHA often uses seismic source zones, such as those used in the Central and Eastern United States Seismic Source Characterization (CEUS-SSC) model that integrate tectonic and seismic information~~, non-tectonic deformation~~ from a broad range of sources. The U.S. Nuclear Regulatory Commission (NRC) staff will need to determine if new geologic information~~, and conditions caused by human activities. As part of the process for reviewing regional and site geology, the reviewer assesses~~ has been developed that affects the technical basis for a source-zone model. The significance of new information must be determined as part of a coordinated review of information in Section 2.5.2.

1. Geologic Setting

The reviewer ~~provided on regional and site-specific~~ assesses information related to physiography, ~~geomorphology,~~ stratigraphy, lithology, ~~structural geology, seismology, paleoseismology~~and geomorphology, tectonic setting, faulting and folding characteristics of the region encompassing the site, and geologic ~~and tectonic~~ history with ~~an emphasis~~special focus on ~~the~~features of Quaternary ~~Period. The Quaternary is defined as the geologic period running from 1.8 million years ago (mya) to the present (Reference 5).~~age.

~~1~~The reviewer confirms that the application provides adequate information at the site vicinity and area for assessment of local geologic conditions in comparison to the regional geologic topics addressed above as well as potential hazards related to natural phenomena including landslides and other mass-wasting phenomena;; displacement along growth faults; glacially-induced deformation; and potential for collapse or subsidence in areas underlain by limestone or other soluble rock (e.g., salt and gypsum).

2. Tectonic ~~and Seismic Information~~Framework

The reviewer assesses information related to ~~lithologic, stratigraphic, and~~ the tectonic framework of the region including structural geologic characteristics of the site and the region around the site, ~~including~~ geologic and tectonic history; state of stress in the crust; nature and structure of the crust, and tectonic deformation features underlying the site and region, particularly ~~features~~those of Quaternary age, specifically including data on faulting and fault recurrence rates~~; and~~. The reviewer should also assess historical seismicity ~~and vibratory ground motions, including earthquake recurrence rates, correlation of seismic events with tectonic~~as it relates to the identification and characterization of geological structures~~, and characterization of seismic sources.~~. Seismicity and vibratory ground ~~motions~~motion are primary review responsibilities addressed in SRP Section 2.5.2~~.~~, which includes a detailed review of the seismic record and potential seismic source zones. Close coordination between geologists~~, geophysicists,~~ and seismologists~~, and geotechnical specialists~~ is essential ~~for a thorough review.~~
to assure that the tectonic framework developed in FSAR Section 2.5.1
~~The reviewer confirms that sufficient information~~ is ~~provided~~correctly incorporated into the hazards analyses reviewed in SRP Sections 2.5.2 through 2.5.4.

The reviewer confirms that sufficient information is provided by the applicant 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 (i.e., 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~~features indicative of past seismic activity. The reviewer also confirms that the applicant has addressed the relationship between regional-scale and local-scale features of particular interest. In addition, the reviewer confirms that the applicant has evaluated all geologic phenomena that might affect the design and operation of the proposed facility, irrespective of whether such phenomena are explicitly included in this SRP.

For sites adjacent to large bodies of water, information pertinent to assessing hazards from probable maximum tsunami and seiche ~~must~~shall be provided or cross-referenced to SRP Section 2.4.~~12~~6. At such sites, the reviewer also confirms that the applicant has considered the potential for earthquakes and tectonic structures located beneath water.

~~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~~might effect, or be ~~affected~~effected 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~~remote sensing imagery~~.~~ and Light Detection and Radar (LiDAR). Some sites ~~may~~might 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~~

Locations of all proposed facility structures, Seismic Category I facilities ~~to subsurface geology~~, and site boundaries, should be ~~illustrated. Locations of all plant structures,~~included on data maps. Subsurface data locations, such as borings, trenches, test pits, seismic and geophysical data collection profiles, and geologic cross-sections, should ~~also~~ be included on plot plans. ~~All~~The geologic terminology used should conform to that found in standard references ~~(Reference 7).~~.

~~Applying knowledge~~Considering information derived from the application, other published and unpublished scientific literature, and the ~~reviewer's~~reviewer's own ~~academic background and~~ technical knowledge, practical experience ~~in geoscience~~, and professional judgment, the reviewer assesses adequacy of the geologic~~, seismic, geophysical, and geotechnical~~ information ~~cited~~provided in support of the applicant's conclusions concerning site suitability ~~of the plant site.~~. The staff ~~may bring the review~~ might also need to ~~an earlier completion if the application contains sufficient data to enable~~ conduct an independent ~~assessment of the conclusions therein. Depending on completeness of the application, the staff also may conduct a~~ literature ~~search~~review at an appropriate level of detail. The reviewer should evaluate all pertinent data, including information that could support alternative interpretations of data or conclusions presented by the applicant. 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.

Review Interfaces

Other SRP sections interface with this section as follows:

1. SRP Section 2.0, "Site Characteristics and Site Parameters." For COL applications referencing a DC rule, 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.

~~1.~~2. SRP Section 2.4.12, "Groundwater." 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.~~6.

~~1. 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. ~~3.~~ SRP Section 2.5.2, "Vibratory Ground Motion." Review of earthquake sources, wave propagations and site response to determine the GMRS and PSHA is performed under SRP Section 2.5.2 on Vibratory Ground Motion. Information in SRP Section 2.5.1 on the geologic and tectonic setting, including characteristics of Quaternary-aged faults, should be consistent with information used in SRP Section 2.5.2. Particular attention should be given to new information that has the potential to affect seismic source-zones that were developed in prior investigations.

~~2.~~4. SRP Section 2.5.3, "Surface Deformation." 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."~~Surface Deformation. Information in SRP Section 2.5.1 on the geologic and tectonic setting, including characteristics of Quaternary-aged faults, should be consistent with information used in SRP Section 2.5.3.

~~3.~~5. ~~4.~~ SRP Section 2.5.4, "Stability of Subsurface Materials and Foundations." 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.~~ 6. SRP Section 2.5.5, "Stability of Slopes." 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~~

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

~~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:

~~Section 14.3.~~

~~1. 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 2, "Design Bases for Protection Against Natural Phenomena,"~~1. Applicable to COL, ESP, CP, OL: 10 CFR 100.23, "Geologic and Seismic Siting Criteria," subsection (c) of 100.23, requires that the geologic, seismic and engineering 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 Safe Shutdown Earthquake (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, irrespective of whether such factors are explicitly included in 10 CFR 100.23(c) (e.g., volcanic activity).

2. Applicable to a COL, CP: 10 CFR Part 50, Appendix A, General Design Criterion (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 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~~3. Applicable to ~~identify geologic~~an ESP: 10 CFR 52.17(a)(1)(vi) "Contents of Application." A site SAR includes the geological characteristics ~~that consider~~of the proposed site with consideration of the most severe of the natural phenomena that have been historically reported for the site and 10 CFR 52.17(a)(1)(xii) an evaluation of the site against applicable sections of the SRP acceptance criteria.

4. Applicable to a COL: 10 CFR 52.79(a)(iii). A site FSAR includes the geological characteristics of the proposed site with consideration of the most severe of the natural phenomena that have been historically reported for the site and the 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~~SRP Section 2.5.1 provides the specific 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~~An applicant ~~is required to~~ may propose alternative methods that may be deemed acceptable for complying with the intent of 10 CFR

52.47 (a) (9), “Contents of applications; technical information.” In that case, the applicant will identify the differences between ~~the~~ this SRP and the proposed alternative design features, analytical techniques~~,~~ and procedural measures ~~proposed for its facility and the SRP acceptance criteria and evaluate~~ along with a discussion of how the ~~proposed alternatives to the SRP acceptance criteria~~alternative does provide an acceptable ~~methods of compliance~~method to comply with the ~~NRC~~ regulations.~~—~~

Appropriate sections of the following ~~Regulatory Guides~~RGs 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~~RG 1.208, ~~“~~“A Performance-Based Approach to Define Site~~-~~Specific Earthquake Ground Motion~~” (Reference 12),~~,” describes methods acceptable for ~~(1)~~ conducting geologic, geophysical, ~~seismologic~~seismic, 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~~RG 1.206, “Combined License Applications for Nuclear Power Plants - LWR Edition, discusses guidance for combined license applications for nuclear power plants (LWRs)”.

RG 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 applicable requirements of 10 CFR 100.23~~;~~(c); shows that methods described in ~~Regulatory Guide 1.165,~~RG 1.208, or comparable methods, were employed for identifying and characterizing ~~seismic sources and defining the GMRS~~the geologic information as it pertains to consideration of natural hazard phenomena that might affect the site; and conforms to the format suggested in ~~Regulatory Guide~~RG 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 the applicant's investigations ~~described in Regulatory Guides 1.165, 1.132, 1.138, 1.198, 1.208, and 4.7~~ are conducted ~~with~~at 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~~, with an increasing level of ~~320 km (200 mi) for~~ detail progressing from site region~~, 40 km (25 mi) for site vicinity, 8 km (5mi) for site area, and 1 km (0.6 mi) for~~ to site location~~.~~ as indicated in RG 1.208. The reviewer should confirm that sufficient information is presented in the application to ~~enable a comparison between new data derived from~~ support the site suitability analyses reviewed in SRP Sections 2.5.2, 2.5.3, 2.5.4, and 2.5.5 that the technical information used in these analyses is consistent with the geologic information reviewed in SRP Section 2.5.1. Site specific features that may not have been captured in the regional ~~and site investigations and those data used in tectonic and ground motion models for~~ PSHA~~.~~ model, reviewed in SRP 2.5.2, are of particular concern for the review in this section.

1. Regional Geology (SAR Section 2.5.1.1)

~~In meeting requirements~~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.~~ (c) are met and guidance in RGs 1.~~1 will be considered acceptable~~ 206, 1.208 and 4.7 followed for this area of review if a complete and documented discussion is presented for ~~all~~the geologic ~~(including~~setting, tectonic ~~and non-tectonic), geotechnical, seismic, and geophysical characteristics, as well as~~ framework and conditions caused by human activities, ~~deemed important for~~ that have the potential to affect the safe siting and design of the plant. This section should contain a review of regional stratigraphy, lithology, structural geology, geologic and tectonic history, tectonic features (with emphasis on the Quaternary period), ~~structural geology,~~ seismology, geomorphology, paleoseismology, and physiography~~, geomorphology,~~

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

2. ~~Site~~Local Geology (SAR Section 2.5.1.2)

~~In meeting requirements~~Requirements of GDC 2 in Appendix A of 10 CFR Part 50, 10 CFR 52.17~~,~~ and 10 CFR~~–~~ 100.23~~,~~ (c) are met and ~~regulatory positions presented~~guidance in ~~Regulatory Guides~~RGs 1.~~165~~206, 1.~~132, 1.138, 1.198, 1.208, and 4.7, SAR Section 2.5.1.2 will be considered acceptable~~208 and 4.7 followed for this area of review if it contains a description and evaluation of geologic ~~(including tectonic and non-tectonic)~~ features, ~~geotechnical characteristics, seismic conditions~~tectonic features, 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.~~for determining any potential natural hazards that might affect the design and operation of the proposed facility. 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. ~~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. ~~b. Seismicity~~Geologic maps and cross-sections constructed at scales adequate to clearly illustrate pertinent features in the site vicinity, area and location shall be included in the application.

c. Stratigraphy and lithology of rock units and discussion of their relationships to the regional lithostratigraphic framework.

d. Geomorphologic features as tectonic strain markers or indicators of other potentially hazardous natural phenomena (e.g., landslides, karst development and dissolution collapse, growth faults).

e. Geologic and tectonic history, particularly for the Quaternary Period, and discussion of the relationship to regional geologic and tectonic history.

~~b.~~f. Tectonic framework description, including identification of historical and instrumentally-recorded earthquakes; identification and characterization of any local ~~seismic sources; and~~ tectonic features as they might be related to seismicity; discussion of the relationships between local ~~seismicity~~ and regional tectonic structures and ~~seismic sources.~~any relationship to seismicity; and the nature of the crust beneath the site.

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

~~d.~~ Evidence for ~~paleoseismicity, or~~ paleoseismic features, including a ~~lack~~description of ~~it.~~

~~c.~~g. ~~e. Stratigraphy and lithology~~investigations performed by the applicant to verify the presence or absence of ~~rock units and relationships to regional stratigraphic and lithologic characteristics.~~the features.

~~f. Physiography and geomorphology.~~

~~d.~~h. ~~g. Engineering~~Geologic features that have significance ~~of geologic and~~ for geotechnical ~~characteristics of features and materials, including foundation materials, related to~~engineering:

~~(1) Dynamic behavior during prior earthquakes.~~

~~(2~~(1) 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~~(2) Surface and subsurface dissolution features in soluble rock such as limestone ~~terranes.~~

~~(6) Effects of human activities.~~

~~h. Potentially unstable natural or man-made slopes.~~

~~i. Groundwater conditions, including perched aquifers~~, gypsum, or salt.

Technical Rationale

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

Application of GDC ~~–~~ 2 ~~or~~ ,10 CFR 52.17(a)(1)(vi) for ESP applications ~~require consideration of~~ , 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 all geologic and seismic factors that might affect the design and operation of the ~~natural phenomena.~~ proposed facility have been adequately investigated and characterized.

Application of 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. Further, 10 CFR 100.23(c) ~~further~~ specifies that all geologic and seismic factors that ~~may~~might affect design and operation of the proposed nuclear power plant must be investigated.

Application of 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 ESP, CP, OL 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, 'Acceptance Criteria' 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~~that 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~~.~~, 'Acceptance Criteria.'

~~Three Phase~~ Review ~~Procedure~~Process

~~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~~ During the regulatory review process, the reviewer follows specific regulatory requirements promulgated in the *Code of Federal Regulations*, the regulatory guidance and the acceptance criteria in this SRP. The review process, with staff's responsibilities described within each step, is applied for ESP, COL, CP as appropriate.

1. Acceptance Review

The ~~Phase 1~~ acceptance review is a brief, high level 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~~detailed review of application, 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,~~the requirements of GDC 2 in Appendix A of 10 CFR Part 50, 10 CFR 52.17(a)(1)(vi), and 10 CFR 100.23(c) and in RGs 1.206, and 1.208**,** to enable an independent staff review of conclusions presented by the applicant. An application that has sufficient information for staff to begin the review is acceptable for docketing.

~~Phase~~ 2. Detailed Review of Application

~~In this review phase, which begins after~~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~~identifies all potential safety issues. The reviewer ~~examines the application to confirm~~confirms that all interpretations in the application are based on ~~standard~~generally accepted geologic practices and ~~do not exceed validity limits of either the applicant's~~are supported by appropriate data~~, or other~~ and models. The reviewer confirms that alternative data sets ~~from published scientific literature. The application is~~, if available, are appropriately considered in development of the applicant's assessment and conclusions. The reviewer also ~~reviewed for~~considers any significant new information derived from site-specific geologic, seismic, geophysical, and geotechnical investigations that ~~had~~have not been considered or applied to tectonic and ground motion models used in the PSHA. Appendix C of ~~Regulatory Guide~~RG 1.208 ~~and Appendix E of Regulatory Guide 1.165 describe~~describes acceptable methods for addressing significant new information in the PSHA.

~~At the beginning of this review phase, the~~Literature Review

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~~proceeds with a literature search and review of relevant references (e.g., published ~~geological~~geologic 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 constructionexcavation investigations, a reviewer shoulddoes not rely entirely on information submitted by the applicant or that in published literature. The reviewer should identifyidentifies any pertinent studies underway in the site region, site vicinity, site area, or at the site location and obtainobtains information on preliminary results of these studies. Special provisions maycould be required to examine any pertinent data that are of a proprietary naturedata. The applicant may be requested to provide proprietary data to NRC in a non-public electronic reading room or with a paper copy under oath and affirmation that it the information is exempt from public disclosure as a confidential trade secret or commercial or financial information. The reviewer gives particular attention to models or data that have the potential to introduce alternative interpretations to the models or data in the application, which might affect conclusions for safety or suitability of the site.

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).

Development of Requests for Additional Information

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 these 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~~requests for additional information (RAI) 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~~in the application and that might affect 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~~ for safety or suitability of the site. If insufficient data are provided ~~by~~in the ~~applicant~~application to support interpretations and conclusions presented, ~~and more conservative reasonable~~the staff will request the applicant to provide additional clarifying information. Questions might arise from discovery of references not cited by the applicant that suggest alternative interpretations ~~are technically supported in the literature, the staff will request~~ to the information and interpretations provided by the applicant. The RAIs might indicate the need to conduct additional investigations ~~or require the applicant to adopt the more conservative interpretations. This review phase~~. The detailed review schedule will commonly ~~involve~~include public meetings with the applicant to ~~clarify~~ask clarifying questions and allow the applicant to present new data or other information to justify conclusions ~~presented. The~~ in the application. Staff reviews the applicant's responses to questions ~~are reviewed~~ and ~~any~~ remaining issues ~~settled, either by a second round of questions~~may be resolved by supplemental RAIs, public meetings 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~~ adequate under and consistent with ~~requisites~~ the requirements of 10 CFR 100.23.

~~Phase~~ Site Audit and Confirmatory Activities

Staff conducts site audits to examine geologic features revealed by outcrops, trenches, test pits, surface and subsurface geophysical tests, and borehole data. The audit typically covers review topics for both SRP Sections 2.5.1 and 2.5.3, therefore staff will focus on evaluating geologic features within the site vicinity, area and location that may indicate any natural hazard to the site and surface deformation. Staff prepares a site audit report to document observations and to aid in the development of the Safety Evaluation Report (SER). The report is subsequently submitted to NRC Agencywide Documents Access and Management System and retained as a record.

As part of confirmatory activities for the site audit review, staff might conduct an independent geologic reconnaissance of the site region, vicinity, area, and location as necessary to examine soil and rock samples from core borings and test pits and geologic features in trenches and excavations for other facilities.

3. Review of Supplemental Information

~~The Phase 3 review is the~~The final phase for resolving all open safety-related issues~~, an activity commonly~~ is 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~~ If the RAI response does not adequately answer the staff's concern, staff typically will develop supplemental RAIs and request a meeting with the applicant to discuss the technical details of the remaining issues~~, or take a more conservative position if deemed necessary to assure~~ regarding site suitability and the ~~required degree~~safe operation of ~~safety is imposed for~~ the ~~plant.~~proposed facility. 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~~prepares the Final Safety Evaluation Report (FSER).

4. Geologic Mapping License Condition

Under~~staff has prepared~~ the ~~SER~~COL, or ESP approach defined in ~~cases where an applicant is granted a COL under Subpart C of~~ 10 CFR Part 52, ~~subsequent reviews of~~ a license might have already been granted to an applicant before safety-related excavations are opened and geologic ~~data and examination~~mapping of the excavations begun. Thus, new geologic features might be discovered in plant excavations, which have the potential to affect staff's understanding of site safety. To ensure that the safety implications of new information are reviewed, clear statements must be provided in the site-specific portion of the COL application that the applicant commits to:

(1) Perform detailed geologic mapping of the excavations for safety-related structures;

(2) Examine and evaluate geologic features discovered in excavations for safety-related structures; and

(3) Notify the NRC once excavations for ~~Seismic Category I~~safety-related structures are open for inspection by NRC staff.

Staff propose a geologic mapping license condition in the SER for each COL site where plant excavations and geologic mapping have not been completed prior to a license being granted. Likewise, a geologic mapping license condition will be proposed in the SER for each ESP site. For those COL or ESP sites where plant excavations and geologic mapping take place prior to a COL or ESP being granted, staff will ~~be necessary to confirm that site parameters lie within~~evaluate the ~~certified design envelope specified in~~plant excavations and mapping as part of the ~~COL~~ application review.

Review ~~Procedures~~Considerations Specific to ~~10 CFR Part 52 Application Type~~ESPs and COLs

1. ~~a.~~ Early Site Permit Reviews

10 CFR Part 52, Subpart A ~~to 10 CFR Part 52~~ specifies the requirements and procedures applicable to the ~~Commission's~~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~~At the COL stage, in the absence of certain circumstances, such as a compliance or adequate protection issue, 10 CFR 52.39 "Finality of Early Site Permit Determinations" precludes the staff from imposing new site characteristics, design parameters, or terms and conditions on the ~~early site permit at the COL stage.~~ESP. Accordingly, the reviewer for SRP Section 2.5.1 should ensure that all geologic ~~and seismic~~ site characteristics that could affect the design basis of ~~SSCs important to~~ safety-related structures, systems and components are reflected in the site characteristics, design parameters, or terms and conditions of the ~~early site permit.~~ESP. Nevertheless, this requirement does not relieve the applicant or permit holder from the requirements of 10 CFR 52.6(b), which state that the NRC must be notified about any new information having a significant implication for public health and safety or common defense and security that might be developed following issuance of an ESP

~~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.~~ In order to verify that no geologic features or conditions exist beneath the safety-related structures at the site that could compromise plant safety, the staff proposes a permit condition requiring an applicant to: (1) perform detailed geologic mapping of the excavations for nuclear island structures; (2) examine and evaluate geologic features discovered in excavations for safety-related structures other than those for the nuclear island; and (3) notify the NRC once excavations for safety-related structures are open for inspection by NRC staff.

2. Combined License Reviews

~~For~~ NRC staff reviews a COL application referencing a certified standard design~~, NRC staff reviews that application~~ to ~~ensure~~determine that sufficient information ~~was~~is presented to demonstrate that the characteristics of the site fall within the DC 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~~ NRC staff reviews a COL application referencing an ESP~~, NRC staff reviews the~~ application to ~~ensure the applicant provides~~determine that sufficient information is presented 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~~if the design of the facility does 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 "Finality of early site permit determinations" precludes the staff from imposing new site characteristics, design parameters, or terms and conditions on the ~~early site permit~~ ESP 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, long-term environmental changes and changes to the region resulting from human activities or natural causes might introduce changes to the site characteristics that are relevant to the design basis. Therefore, 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~~Final Safety Evaluation Report (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~~staff's evaluation of geologic ~~and seismic~~ site characteristics ~~with respect to~~concerning the relevant regulatory criteria. The evaluation should support the ~~staff's~~staff's conclusions ~~as to~~regarding whether the regulations are met. The reviewer should state what was done to evaluate the ~~applicant's safety analysis report. The staff's~~applicant's SAR. Depending on the content of the application, the staff's evaluation ~~may~~might include verification that the applicant followed applicable regulatory guidance, performance of independent calculations, and~~/or validation~~ confirmation of~~–~~ appropriate assumptions. The reviewer may state that certain information provided by the applicant was not considered ~~essential~~significant to ~~the staff's review~~staff's understanding of safety and, consequently, was not reviewed ~~by the staff. While~~in detail. Although the reviewer may summarize or quote the information offered by the applicant in support of ~~its~~the application, the reviewer should clearly articulate the bases for ~~the staff's~~staff's conclusions regarding compliance with applicable regulatory requirements.

~~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~~ The staff has considered ~~pertinent~~ information ~~gathered~~about the geologic characterization of the site and site suitability provided by the applicant in support of the license application. The information reviewed includes data from ~~site~~regional and ~~near-site~~local investigations~~, as well as a~~; geologic reconnaissance of the site ~~region, site~~ vicinity~~, site area,~~ and ~~site location; an~~area; the staff's independent review of ~~recently~~pertinent published literature; and discussions with knowledgeable scientists ~~with~~at 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.~~. The staff concludes that the applicant has investigated the geological characteristics of the site and its environs in sufficient scope and detail to permit an adequate evaluation of the proposed site, as required by 10 CFR 100.23(c). Staff concludes that the size of the region investigated is appropriate for the geologic setting of the proposed site, and that all geologic factors that might affect the design and operation of the proposed facility have been investigated.

~~(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 regarding 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.~~

Staff concludes that the applicant has acceptably characterized the most severe of the geologic phenomena that have been historically reported for the site and surrounding area, and has provided sufficient margin in this characterization to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, as required by 10 CFR 52.17(a)(1)(vi).

In order to verify that no geologic features or conditions exist beneath the safety-related structures at the site that could affect the design and operation of the facility, the staff proposes a license condition requiring an applicant to: (1) perform detailed geologic mapping of the excavations for nuclear island structures; (2) examine and evaluate geologic features discovered in excavations for safety-related structures other than those for the nuclear island; and (3) notify the NRC once excavations for safety-related structures are open for inspection by NRC staff.

2. Combined License, Construction Permit, Operating License Reviews

A typical staff finding at the conclusion of ~~the review~~a review for a COL that does not reference a previous ESP can be illustrated as follows~~:~~.

The staff ~~evaluation of the geologic and seismic~~has considered information ~~pertaining to this~~ about the geologic characterization of the site~~, as presented~~ and site suitability provided by the applicant~~, is discussed~~ in ~~SER sections 2.5.1, 2.5.2,~~support of the license application. The information reviewed includes data from regional and ~~2.5.3.~~local investigations; geologic reconnaissance of the site vicinity and area; the staff's independent review of pertinent published literature; and discussions with knowledgeable scientists at the USGS, State Geological Surveys, universities, consulting firms, or other non-governmental and professional organizations.

Based on the staff review:

The geologic, geophysical investigations and information provided by the applicant as required by 10 CFR 52.79(a)(iii), 10 CFR Part 50, Appendix A, GDC 2 and 10 CFR 100.23 have been combined with the staff's independent review of the data and other information sources. The staff concludes that the ~~site~~applicant has investigated the geological characteristics of the site and its environs in sufficient scope and detail to permit an adequate evaluation of the proposed site, as required by 10 CFR 100.23(c). Staff concludes that the size of the region investigated is appropriate for the geologic setting of the proposed site, and that all geologic factors that might affect the design and operation of the proposed facility have been investigated.

Staff concludes that the applicant has acceptably characterized the most severe of the geologic phenomena that have been historically reported for the site and surrounding area, and has provided sufficient margin in this characterization to account for the limited

accuracy, quantity, and period of time in which the historical data have been accumulated, as required by 10 CFR 52.79(a)(iii). This characterization 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:~~as a design basis for protection against natural phenomena, as required by 10 CFR Part 50, Appendix A, GDC 2(1).

~~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").~~

In order to verify that no geologic features or conditions exist beneath the safety-related structures at the site that could affect the design and operation of the facility, the staff proposes a license condition requiring an applicant to: (1) perform detailed geologic mapping of the excavations for safety-related structures; (2) examine and evaluate geologic features discovered in excavations for safety-related structures; and (3) notify the NRC once excavations for safety-related structures are open for inspection by NRC staff.

For COL applications that do not reference a previous ESP, staff evaluation findings will include the evaluation findings identified above for ESP reviews. For a COL referencing a previous ESP, staff should refer to the previous ESP and include an evaluation of any new pertinent information that might have been discovered after the ESP was issued that affects the design and operability of the proposed facility. For a CP application, findings will be similar to the ESP findings. For an OL application, findings will include evaluation of excavations for safety-related structures.

For 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.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of ~~DC applications and license~~ESP, COL, CP, applications submitted by applicants pursuant to 10 CFR 100.23, 10 CFR Part ~~50~~52 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~~ 50, Appendix A, and GDC 2, as applicable. The staff will use the method described herein to evaluate conformance with Commission regulations. If the applicant proposes an alternative method for complying with specified portions of the Commission's regulations, the applicant must demonstrate the acceptability of its alternate method in meeting those 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.~~
The guidance of this SRP section has been accepted as an alternative method for complying with 10 CFR 52.47(a)(9), "Contents of applications; technical information," which states, in part, that the application must contain an evaluation of the standard plant design against the SRP revision in effect six months before the docket date of the application, FSAR does not deviate from the design assumptions made by the NRC staff while preparing this SRP section. If the design assumptions deviate from the SRP, the staff will use the SRP consistent with 10 CFR 52.47(a)(9). Alternatively, the SRP section might be revised consistent with NRC procedures in order to address new design assumptions.

VI. REFERENCES

1. ~~1. J.B. Savy et al., "Eastern Seismic Hazard Characterization Update," Lawrence Livermore National Laboratory,~~ 10 CFR 100.23, "Geologic and Seismic," of 10 CFR Part 100, "Reactor Site Criteria."

~~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.~~

1.2. 6. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants.".”

3. 7. K.K.E. Neuendorf, J.P. Mehl, Jr,Divisions of Geologic Time-Major Chronostratigraphic and Geochronologic Units, U.S. Department of the Interior, U.S. Geological Survey, Fact Sheet 2010-3059, July 2010.

4. EPRI, “Central and Eastern United States Seismic Source Characterization for Nuclear Facilities,” EPRI, Palo Alto, CA, U.S DOE and U.S. NRC NUREG-2115, 2012.

GDC and J. A. Jackson, Editors, "Glossary of Geology," Fifth Edition, American Geological Institute, Alexandria, Virginia, 2005.

2.5. 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.”.”

K.K.E. Neuendorf, J.P. Mehl, Jr., and J. A. 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."

6. 11. Regulatory GuideJackson, Editors, "Glossary of Geology," Fifth Edition (revised), American Geosciences Institute, Alexandria, Virginia, 2011.

3.7. RG 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."

4.8. 16. Regulatory GuideRG 1.206, U.S. NRC, “"Combined License Applications for Nuclear Power Plants (LWR Edition).”).”

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9. RG 4.7, U.S. NRC, "General Site Suitability Criteria for Nuclear Power Stations."

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.

SRP Section 2.5.1
Description of Changes

Section 2.5.1 "GEOLOGIC CHARACTERIZATION INFORMATION"

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in Revision 4 March 2007 of this SRP (Accession No. ML070730464). Changes include consideration of the geologic characteristics of the site and region including consideration of the most severe of natural phenomena that have been historically reported for the site and region in order to evaluate the suitability of the site for the proposed facility. The technical changes incorporated in current revision include the following:

In general and throughout; updated text with editorial and clarifying statements and changed the title of the SRP as shown above.

Otherwise:

I. Areas of Review

a. Clarified the link to 10 CFR 100.23(c) and removed Appendix A language

b. Clarified and strengthened review interfaces especially with respect to SRP 2.5.2 and 2.5.3

c. Clarified the emphasis on Quaternary aged features

d. Removed outdated EPRI references, added NUREG 2115

e. Removed review of PSHA assessment, inserted review emphasis on geologic information in support of SRP 2.5.2 and 2.5.3 hazard assessments.

II. Acceptance Criteria

a. Enhanced and clarified the link to 10 CFR 100.23 (c), 10 CFR 52.17, 10 CFR 52.79, and GDC 2.

b. Removed RG 1.132, 1.138, 1.165, 1.198

III. Review Procedures

a. Modified the review process steps based on lessons learned from recent reviews

b. Added information regarding Site Safety Audits and RAI development based on lessons learned from recent reviews.

c. Added specific detail concerning the Geologic Mapping License Condition

IV. Evaluation Findings

Clarified and updated findings based on applicable regulations 10 CFR 100.23(c), 52.17, 52.79 and Part 50 GDC 2

V. Implementation

Clarified and updated text according to recommendation by Division of Advanced Reactors and Rulemaking

VI. References

a. Removed the following references:

i. RG 1.165
ii. TR-102293 R.G. 1.132
iii. RG 1.138
iv. RG 1.198
v. UCRL-ID-115111
vi. NUREG-1488
vii. NP-4726A
viii. EPRI Report

b. Added the following documents:

NUREG-2115

c. Updated the following references:

Geologic Time Scale, US Geological Survey, Fact Sheet 2010-3059
Glossary of Geology