



U.S. NUCLEAR REGULATORY COMMISSION

~~STANDARD REVIEW PLAN~~

2.5.3 SURFACE ~~FAULTING~~ ~~DEFORMATION~~

REVIEW RESPONSIBILITIES

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

Secondary - None

I. AREAS OF REVIEW

Chapter 2 of the ~~Standard Review Plan (SRP discusses)~~ addresses the review of site characteristics that could affect the safe design and siting of the plant. ~~U.S. The Nuclear Regulatory (NRC) staff reviews information presented by the applicant for a construction permit (CP), operating license (OL), design certification (DC), an early site permit (ESP), or a combined license (COL), an operating license (OL) or construction permit (CP) concerning the potential for tectonic and non-tectonic surface deformation due to faulting. This. The SRP section~~ Section 2.5.3 applies to the reviews performed for each of these types of applications.

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~~The information related to surface deformation due to faulting is collected by the applicant during site~~ Requirements in the *Code of Federal Regulations* and guidance in NRC regulatory guides (RGs) specify the importance of geologic data in siting new nuclear power facilities.
During site

characterization investigations- for this section of the Final Safety Analysis Report (FSAR), the applicant collects information related to surface deformation or subsidence due to faulting, dissolution of carbonate rock or salt, and diapirism. The primary ~~purposes~~purpose for conducting these investigations ~~are~~is to determine site suitability in regard to whether there is a possibility of significant ground motion that could impact seismic design bases as determined by probabilistic seismic hazard analysis, or PSHA (potential for future ~~References 1 through 4~~), and to provide the bases for plant design. The objective of this SRP section is to enable review of results of the investigations and assessment of surface deformation due to faulting as it that may affect the site. Review design and operation of the proposed nuclear power plant. This SRP section provides criteria for the review and acceptance of the basic data-gathering ~~processes~~process and findings ~~presented by the applicant and~~ to support the staff's assessment of surface faulting, and the completeness of this information, ~~are integral parts of the review responsibilities defined in this section~~ and the final safety decision to clearly establish whether there is a potential for surface deformation.

NRC staff reviews the geologic, seismic, geophysical, and geotechnical information submitted by an applicant. ~~This technical information results primarily from detailed-~~ with respect to surface and subsurface geologic, seismic, geophysical, and geotechnical investigations, ~~performed in progressively greater detail closer to the site, within each of three areas defined by circles drawn around the site using deformation (tectonic and non-tectonic) potential.~~ The technical information derives from various investigations: work that the applicant initiates and completes for the preparation of the application and information from the published findings in peer reviewed scientific literature; information acquired from interviews with knowledgeable experts. The applicant reports this information in its application in each of three areas defined by radii of 40 km (25 mi), 8 km (5 mi), and 1 km (0.6 mi). ~~These-~~ around the site. The three ~~circumscribed~~ areas correspond to, respectively, ~~to~~ the site vicinity, site area, and site location. However, applicants need to report any significant neotectonic features found beyond these distance ranges, which have a potential to impact the site safety.

~~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 specific topics related to surface faulting (SAR Section 2.5.3): geologic, seismic, and geophysical investigations; geologic evidence, or absence of evidence, for tectonic surface deformation; correlation of earthquakes with capable tectonic sources; ages of most recent deformation; relationship of tectonic structures in the site area to regional tectonic structures; characterization of capable tectonic sources; designation of zones of Quaternary deformation in~~

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~~the site region; and potential for surface tectonic deformation at the site.~~ As part of the process for review of potential surface ~~faulting~~deformation issues, ~~the reviewer~~staff evaluates the technical information provided by the applicant, with ~~an emphasis~~a focus on the Quaternary Period. The Quaternary ~~Period~~ is defined as the geologic period ~~running from 1.8~~that began approximately 2.6 million years ago (mya) ~~to the Present (Reference 5).~~Ma) and continues to the present. Emphasis is placed on Quaternary-age features because evidence of surface deformation during the last approximately 2.6 million years generally indicates a potential for future surface deformation to occur.

The applicant provides geologic, seismic, geophysical, and geotechnical information in SAR Section 2.5.3 addressing the following specific topics that are the basis for the assessment of the potential for tectonic and non-tectonic surface deformation at the site:

1. Geologic, Seismic, and Geophysical Investigations ~~(SAR Section 2.5.3.1).~~ The reviewer assesses information provided by an applicant related to Quaternary tectonics, structural geology, stratigraphy, paleoseismology, geochronological methods used for age dating, ~~paleoseismology~~, and the geologic history of the site vicinity, ~~site~~area, and ~~site~~location. ~~Staff reviews to ensure it that the information is complete; compares well with data from acceptably considers~~ other studies carried out in the same areas; and is supported by detailed investigations conducted by the applicant. For coastal and inland sites near large bodies of water, similar detailed investigations are to be conducted by the applicant for onshore and offshore geology and seismology. ~~The reviewer also assesses results of these detailed investigations.~~The applicant shall determine if surface deformation features are located beneath bodies of water and need to be considered in the assessment.
2. Geologic Evidence, or Absence of Evidence, for Tectonic Surface Deformation ~~(SAR Section 2.5.3.2).~~ The reviewer assesses ~~surface and subsurface~~information provided by an applicant for the site vicinity, ~~site~~area, and ~~site~~location to confirm presence or absence of ~~surface~~ tectonic ~~surface deformation~~ (i.e., ~~faulting~~) and, if present, to ~~demonstrate age of most recent fault displacement and chronology of previous displacements.~~ If surface faulting is present, information provided must also include data on fault geometry (i.e., fault orientation, length, and width), amount and sense of displacement, and recurrence rate. Information provided by the applicant should enable the reviewer to determine that undetected fault offsets (e.g., blind faults) or other types of and non-tectonic ~~surface~~ (e.g., growth faults; subsidence and collapse due to dissolution of limestone, salt or gypsum deposits, or salt diapirism) deformation.
3. Timing of Deformation. If deformation (e.g., folding, uplift, or subsidence which may indicate a blind fault) features are not likely to exist.
3. ~~Correlation of Earthquakes with Capable Tectonic Sources (SAR Section 2.5.3.3).~~ The reviewer evaluates information on all historically reported earthquakes within 40 km (25 mi) of the site (i.e., present in the site vicinity) in regard to hypocenter, area, or location ~~accuracy and origin of source.~~ To determine, the reviewer evaluates the information used to constrain the age of the ~~potential for induced surface~~ most recent deformation, ~~the reviewer also assesses information pertaining to capable tectonic sources that could, based on fault geometry (including fault orientation, length, and~~

- width), extend into the site area or to the site location. event, and, if applicable, the ages of preceding events.
4. ~~Ages of Most Recent Deformations (SAR Section 2.5.3.4).~~ The reviewer determines whether ~~age of most recent fault displacement~~the timing of deformation has been acceptably demonstrated, or ~~acceptably~~ estimated, by ~~an applicant for each significant fault or fold associated with a blind fault, any part of which lies within 8 km (5 mi) of the site (i.e., in the applicant's information. Further, the reviewer assesses the site area).~~ The reviewer also determines whether ~~geologic evidence for previous displacements has been identified, and assesses~~ sensitivity and resolution of the investigative methods applied by the applicant for acquiring the information.
 4. Correlation of Earthquakes with Tectonic Features. The reviewer evaluates information on all historically-reported earthquakes within the site vicinity in regard to hypocenter location accuracy and origin of source. The reviewer evaluates the proposed correlations between earthquake hypocenter locations and tectonic features in the site vicinity, to determine if these features have evidence of historical activity.
 5. Relationship of ~~Tectonic Structures~~Geologic features in the Site AreaVicinity to Regional ~~Tectonic Structures (SAR Section 2.5.3.5).~~Geologic Features. The reviewer examines information presented by an applicant on ~~structural and genetic~~ relationships between ~~site area faulting~~faults or other ~~tectonic~~ deformation features ~~and in the site vicinity to the regional tectonic framework to determine, if such relationships exist, that theyinterrelationships~~ are adequately described in regard to potential for inducing ~~tectonic~~future surface deformation at the site ~~location~~.
 6. Characterization of Capable Tectonic Sources (SAR Section 2.5.3.6).~~Potential for Surface Deformation at the Site.~~ The reviewer evaluates the ~~application to determine whether a sufficiently detailed investigation has been conducted~~assessment provided by the applicant ~~to define specific characteristics of all for potential capable tectonic sources, any part of which is located within 8 km (5 mi) of the site (i.e., in the site area).~~ This review should demonstrate that there is little likelihood of near-future surface

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deformation hazard associated with capable tectonic sources existing, but undetected, at or near the site location.

- ~~7. Designation of Zones of Quaternary Deformation in the Site Region (SAR Section 2.5.3.7):~~ at the site. The reviewer evaluates the application to determine whether the zone (or zones) designated by the applicant as requiring detailed fault investigations is of determines that sufficient length geological, seismological, and width to include all Quaternary deformation features potentially significant for the site.
- ~~8. Potential for Surface Tectonic Deformation at the Site (SAR Section 2.5.3.8):~~ If investigations reveal that tectonically-induced surface displacement must be taken into account for the site, this section provides staff recommendations regarding re-location of the plant site.
- ~~9. Additional Information for 10-CFR Part 52 Applications:~~ Additional geophysical information will be presented dependent on the type of application. For a COL application, the additional has been provided to clearly establish whether there is a potential for future surface deformation at the site. If the potential for future surface deformation exists, the reviewer evaluates the information is dependent on whether in the application references an ESP, a DC, both or neither. Information requirements that demonstrates the potential effects of surface deformation are prescribed within the "Contents of Application" sections design basis of the applicable Subparts to 10-CFR Part 52 facility.

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; **Light Detection And Ranging (LiDAR)** and satellite imagery. Some sites ~~may~~ might require maps illustrating areas of subsidence, karst ~~or other dissolution~~ 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 ~~plantsite~~ facilities, ~~site boundaries~~, and the relationship of all Seismic Category I facilities to subsurface ~~geology should be illustrated~~ geologic features. Locations of all ~~plantsite~~ structures, borings, trenches, test pits, seismic ~~and reflection and refraction and other~~ 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~~ information derived from the application, other published and unpublished scientific literature, and the ~~reviewer's own academic background~~ reviewer's technical knowledge and ~~practical experience in geoscience~~ professional judgment, the reviewer assesses the adequacy of the geologic, seismic, geophysical, and geotechnical information cited in support of the applicant's conclusions concerning suitability of the ~~plant~~ proposed site. ~~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, staff also ~~may~~ might need to conduct a literature ~~search~~ review at an appropriate level of detail. However, the application and its supporting information should enable staff to logically progress from data and assumptions to conclusions drawn without the need for an extensive independent literature ~~search~~ review. Staff should ~~present and~~ evaluate that an applicant has provided all pertinent data, including information ~~which is potentially controversial~~ that may support alternative interpretations to data or conclusions formed by the applicant.

Review Interfaces

Other SRP sections interface with this section as follows:

- ~~1. Review and acceptance of the applicant's basic data-gathering processes and findings that are presented in support of the geologic and seismic assessments, and completeness of this information, is performed under SRP Section 2.5.1 on "Basic Geologic and Seismic Information."~~
- ~~2. Review of historical earthquake data to determine the Ground Motion Response Spectrum (GRMS) is performed under SRP 2.5.2 on "Vibratory Ground Motion."~~
- ~~3. 0, "Site Characteristics and Site Parameters." For DC applications and COL applications referencing a DC rule or DC application, review of the site parameters in the Design Control Document design control document (DCD) Tier 1 and Chapter 2 of the DCD Tier 2¹ 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.
2. SRP Section 2.5.1, "Geologic Characterization Information." Review and acceptance of the applicant's basic data-gathering processes and findings that are presented in support of the geologic and seismic assessments, and completeness of this information, is performed under SRP Section 2.5.1 on "Geologic Characterization Information." Information in SRP Section 2.5.3 on the potential for surface deformation, including characteristics of Quaternary-aged faults, should be consistent with information reviewed in SRP Section 2.5.1.
3. SRP Section 2.5.2, "Vibratory Ground Motion." Review of historical earthquake data to determine the (GMRS) and probabilistic seismic hazard assessment (PSHA) is performed under SRP Section 2.5.2 on "Vibratory Ground Motion." Information in SRP Section 2.5.3 on the potential for surface deformation, 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.
- ~~4. The specific acceptance criteria and review procedures are contained in the referenced SRP sections.~~

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

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 DSRS Section 2.5.4 on "Stability of Subsurface Materials and Foundations."

II. ACCEPTANCE CRITERIA

Requirements

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

1. ~~4.~~—Applicable to COL, ESP, CP, OL: Title 10 of the *Code of Federal Regulations* (10 CFR) 100.23, "Geologic and Seismic Siting Criteria." Subpart (c) of 10 CFR 100.23, 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 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). Most importantly, 10 CFR 100.23(d)(2) requires that the geologic and seismic siting factors considered for design include a determination of the potential for surface tectonic and non-tectonic deformations. Sufficient geological, seismological and geophysical data must be provided to clearly establish whether there is a potential for surface deformation.
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~~
3. ~~Applicable to an ESP applications, GDC are not applicable. However,:~~ 10 CFR 52.17(a)(1), "Contents of Application; technical information." A Site Safety Analysis Report (SSAR) includes (vi) the ~~GDC-2 requirement to identify geologic site 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 (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 Standard Safety Analysis Report (SSAR) is required that 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 100.23, "Geologic and Seismic Siting Criteria," as it relates to determining the potential for surface tectonic and non-tectonic deformations at and in the region surrounding the site.~~

SRP Acceptance Criteria

~~Specific SRP~~ Section 2.5.3 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 applicant is required to~~ An applicant 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 (RG) 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 Motions," describes acceptable methods to: (1) conduct geological, seismological, and geophysical investigations of the site and region around the site; (2) identify and characterize seismic sources; (3) perform probabilistic seismic hazard analysis (PSHA); and (4) determine the GMRS for the site (see SRP Section 2.5.2.6 and Reference 3).~~

~~Regulatory Guide~~ RG 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion," 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 and and guidance on assessing surface-fault rupture and associated deformation at the site (Appendix S to 10 CFR Part 50.C.2.4).~~

~~Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants," describes programs of site investigations related to geotechnical aspects that would normally meet the needs for evaluating the safety of the site from the standpoint of the performance of foundations and earthworks under anticipated loading conditions, including earthquakes. This regulatory guide provides general guidance and~~

~~recommendations for developing site-specific investigation programs as well as specific guidance for conducting subsurface investigations, such as borings and sampling.~~

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

~~Regulatory Guide~~ RG 4.7, "General Site Suitability Criteria for Nuclear Power Stations," discusses the major site characteristics related to public health and safety that the reviewer considers in determining the suitability of sites for nuclear power stations.

~~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).

The reviewer should confirm that information provided in the application is complete, properly documented, and consistent with applicable requirements of 10 CFR 100.23; ~~shows. The reviewer confirms~~ that methods described in ~~Regulatory Guide 1.165,~~ RG 1.208, or comparable methods, ~~were~~are employed for identifying and characterizing ~~seismic sources and defining the GMR~~surface deformation features; and that the material conforms to 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 pertinent data for the site vicinity and site area in which the site is located. These sources include the United States Geological Survey (USGS); other Federal and State agencies; and academia, industry, and non-governmental and professional organizations. ~~It is the responsibility of the reviewer to remain up-to-date on geologic, geotechnical, geophysical, and seismic information for the site vicinity, site area, and site location by regularly reviewing current scientific literature deemed pertinent and participating in professional meetings at which this information is presented.~~

The reviewer ~~must~~shall ensure that investigations described in ~~Regulatory Guides 1.165, 1.132, 1.198,~~ RG 1.208, and 4.7 are conducted with an appropriate level of thoroughness ~~by the applicant within each of the three areas designated in Regulatory Guide 1.165 and 1.208.~~ These three areas are defined by circles drawn around for 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. ~~The site area and site location must be investigated by a combination of exploratory methods that include borings, trenching, geologic mapping, and geophysical, seismic, and geotechnical field investigations. Exploration results must be compared with other available data and evaluated by staff.~~ The reviewer should confirm that ~~sufficient information is presented in the application to enable a comparison between new data derived from~~ the results of investigations in the site vicinity, site area, and site location ~~and those data~~are consistent with the information used ~~into develop~~ tectonic and ground-motion models ~~for~~in the probabilistic seismic hazard analysis (PSHA) in Section 2.5.2.

1. Geologic, Seismic, and Geophysical Investigations. Requirements of GDC 2 in Appendix- A of 10 CFR Part 50, 10 CFR 52.17,(a)(1)(vi), or 10 CFR 52.79(a)(1)(iii) and 10 CFR 100.23(c) and 10 CFR 100.23(d)(2), are met and guidance in ~~Regulatory Guides 1.165, 1.132, 1.198,~~ RG 1.208, and 4.7 followed for this area of review if discussions of

Quaternary tectonics, structural geology, stratigraphy, geochronologic methods used for age dating, paleoseismology, and geologic history of the site vicinity, site area, and site location are complete, compare ~~well~~reasonably with studies conducted by others in the same area, and are supported by detailed investigations performed by the applicant. Site vicinity, site area, and site location-specific geologic maps and cross-sections constructed at scales adequate to clearly illustrate surficial and bedrock geology, structural geology, topography, and relationship of power plant foundations and site boundaries to these features should be included in the application. For sites located near bodies of water, the application should address how investigations have been conducted to detect possible surface deformation features that might be located beneath water.

~~For coastal and inland sites near large bodies of water, similar detailed investigations are to be conducted and the application should include information regarding onshore and offshore geology and seismicity. In some cases, it may be possible to identify onshore expression of an offshore tectonic structure (i.e., a fault or fold) of potential concern. As expressed in Regulatory Guide 1.165, Appendix D, and RG 1.208, Appendix C, under this condition it is acceptable for the applicant to investigate expression of the offshore structure in the onshore environment, along with other investigations of the offshore feature when possible, to better evaluate characteristics of the tectonic structure in the site vicinity and site area and at the site location.~~

2. Geologic Evidence, or Absence of Evidence, for Surface Tectonic Deformation. Requirements of GDC 2 in Appendix A of 10 CFR Part 50, 10 CFR 52.17;(a)(1)(vi) or 10 CFR 52.79(a)(1)(iii), and 10 CFR- 100.23(c) and 10 CFR 100.23(d)(2), are met and guidance in ~~Regulatory Guides 1.165, 1.132, 1.198,~~RG 1.208, and 4.7 followed for this area of review if the applicant provides sufficient surface and subsurface information ~~is provided by the applicant~~ for the site vicinity, ~~site~~ area, and ~~site~~ location to confirm and characterize presence or absence of surface ~~tectonic~~ deformation (i.e.g., faulting) and, if present, to demonstrate age of most recent fault displacement and ages of previous displacements. ~~If surface-, growth faulting is present, the faults must be characterized in regard to fault geometry (i.e., fault orientation, length, and width), amount and sense of displacement, and recurrence rate.~~

, subsidence or collapse

~~In addition to geologic~~ field evidence that may indicate faulting, linear features interpreted from topographic maps, low and high altitude aerial photographs, satellite imagery, and other types of imagery should be examined and their use documented. To expedite the review process, an identification index and duplicates of remote sensing data used in the linear features study should be provided to staff for review. Data to assess presence or absence of tectonic deformation at or near the site is obtained by an applicant through conduct of surface (e.g., imagery analysis, geologic reconnaissance, and geologic mapping to define fault traces) and subsurface (e.g., using seismic instrumentation, geophysical surveys at the ground surface and in boreholes, geologic and geotechnical logging of soil materials and rock core in boreholes, and geologic mapping of trenches and test pits to define paleoseismic features and fault surfaces) investigations.

~~Nature of geologic, seismic and paleoseismic, geophysical, and geotechnical investigations to determine whether or not undetected fault displacements or other tectonic deformation features (e.g., folds related to blind faults) are likely to exist will vary in degree of detail~~

~~and extent required based on geologic complexity of the specific site. In the Central and Eastern United States (CEUS) region, defined as that part of the United States east of the Rocky Mountain Front, with the exception of the New Madrid Seismic Zone of the Central Mississippi Valley (extending from northeast Arkansas, southeast Missouri, western Tennessee, and western Kentucky to southern Illinois), the Meers Fault in southwestern Oklahoma, and the Cheraw fault in eastern Colorado, earthquake-generating faults either do not extend to the ground surface or there is insufficient overlying soil or rock for reliable age dating. In the Western United States, many capable faults are exposed at the ground surface and can be more readily characterized with respect to seismic hazard potential. In the Western region, capable tectonic sources (including faults related to subduction zones) dissolution of limestone, salt or gypsum deposits, or salt diapirism and paleoliquefaction) features. The applicant should also exist as blind faults which may be expressed at the surface or near surface only by folding, uplift, or subsidence, and these phenomena should be taken into account by an applicant for a site located in that region the potential for blind faults.~~

3. ~~Correlation of Earthquakes with Capable Tectonic Sources.—Timing of Deformation.~~ Requirements of GDC 2 in Appendix A of 10 CFR Part 50, 10 CFR 52.17, ~~and 10 CFR 100.23~~ are met for this area of review if all reported historical earthquakes within the site vicinity are evaluated with respect to accuracy of hypocenter location and source of origin, and if all capable tectonic sources that could, based on fault orientation and length, extend into the site area or site location are evaluated with respect to potential for causing surface deformation. The application should include a plot of earthquake epicenters superimposed on a map showing local capable tectonic sources.
4. ~~Ages of Most Recent Deformation.~~ Requirements of GDC 2 in Appendix A of 10 CFR Part 50, (a)(1)(vi) or 10 CFR 52.17, 79(a)(1)(iii), and 10 CFR 100.23(c) and 10 CFR 100.23(d)(2), are met for this area of review if ~~every significant~~ recognized surface ~~fault and feature~~ deformation features (e.g., tectonic faults and non-tectonic features including growth faults) and features associated with a blind fault, ~~any part of which lies within the site area, is~~ are investigated in sufficient detail to ~~demonstrate, or allow relatively accurate estimates of, age of most recent fault displacement and enable identification of geologic evidence for previous displacements (if such evidence exists) constrain the age of the most recent surface deformation event, and, if applicable, the ages of preceding deformation events.~~ The application ~~should~~ shall also provide an ~~acceptable~~ evaluation of sensitivity and resolution of the exploratory geologic and geophysical techniques used ~~that is adequate for staff~~ to determine whether or not appropriate techniques were applied to assess ~~the~~ age of the most recent displacement.

5. ~~Relationship of~~
4. ~~Correlation of Earthquakes with Tectonic Structures in the Site Area to Regional Tectonic Structures, Features.~~ Requirements of GDC 2 in Appendix A of 10 CFR Part 50, 10 CFR 52.17, (a)(1)(vi) or 10 CFR 52.79(a)(1)(iii), and 10 CFR 100.23 ~~are satisfied for this area of review by discussion of structural~~(c) and genetic relationships between site area faulting or other tectonic deformation and the regional tectonic framework. In regions of active tectonism, it may be necessary to conduct detailed geological and geophysical investigations for assessing possible

~~relationships of site area faults to regional faults which are known to be seismically active.~~

- ~~6. Characterization of Capable Tectonic Sources. Requirements of GDC-10 CFR 100.23(d)(2) in Appendix A of 10 CFR Part 50, 10 CFR 52.17, and 10 CFR 100.23), are met for this area of review ~~when it has been demonstrated that investigative techniques employed by the~~ if the applicant are sufficiently sensitive to identify/evaluates all potential capable tectonic sources, such as faults or structures associated with blind faults, reported historical earthquakes within the site area; and when fault geometry, length, sense of movement, amount of total displacement and displacement per faulting event, age of latest and any previous displacements, recurrence rate, and limits of the fault zone are provided for each capable tectonic source. Investigations must extend to at least 8 km (5 mi) beyond all plant site boundaries to encompass the site area, including for those sites adjacent to large bodies of water such as oceans, rivers, and lakes. vicinity with respect to accuracy of hypocenter location and source of origin, and with respect to correlation to tectonic features. The applicant shall evaluate the potential for historical activity on tectonic features in the site vicinity. The application should include a plot of earthquake epicenters superimposed on a map showing tectonic features in the site vicinity.~~

5.

- ~~7. Designation Relationship of Zones of Quaternary Deformation Geologic Features in the Site Region Vicinity to Regional Geologic Features. Requirements of GDC 2 in Appendix A of 10 CFR Part 50, 10 CFR 52.17;(a)(1)(vi) or 52.79(a)(1)(iii), and 10- CFR 100.23 regarding designation of zones of Quaternary deformation in the site region (c) and 10 CFR 100.23(d)(2), are met/satisfied for this area of review if the ~~zone (or zones) designated by the applicant as requiring detailed faulting investigations is of sufficient length and width to include all Quaternary~~evaluates the relationships between faults or other deformation features in the site vicinity and the regional framework. The application should provide an acceptable evaluation of the relationships between the regional (tectonic and non-tectonic) framework and deformation features ~~potentially significant to in the site as described in Regulatory Guides 1.165 and 1.208~~ vicinity, including growths faults and growth fault systems. The applicant should show how this information is used in the evaluation of potential for future surface deformation at the site.~~

86. Potential for Surface Tectonic Deformation at the Site Location. To meet requirements of GDC 2 -in Appendix A of 10 CFR Part 50, 10 CFR 52.17;(a)(1)(vi) or 52.79(a)(1)(iii), and 10 CFR 100.23(c) and 10 CFR 100.23(d)(2), for this area of review, ~~information must be presented by the applicant in this subsection if field investigations reveal that surface or near-surfaces~~ shall assess the potential future tectonic and nontectonic surface deformation ~~along a known capable tectonic structure (i.e., a known capable tectonic feature related to a fault or blind fault) must be taken into account~~at the site. The applicant should provide sufficient geological, seismological, and geophysical information to clearly establish whether there is a potential for future surface deformation ~~at the site location~~. If the potential for future surface deformation exists at the site, the application must provide information that demonstrates the potential effects of surface deformation are within the design basis of the proposed facility.

It is important to note that no commercial nuclear power plant has ever been constructed on a ~~known capable tectonic deformation feature, and it~~ tectonic feature with the potential for future surface deformation. NRC regulations do not restrict building in an area with surface faulting potential, but if that potential exists, the regulations require that surface deformation must be taken into account in the design and operation of the proposed nuclear power plant. It is questionable whether it ~~may~~ might be feasible to design for surface ~~or near-surface tectonic displacements~~ deformation with any degree of confidence that safety-related ~~plant features~~ structures, systems, and components would ~~remain intact and functional~~ maintain their safety functions if surface displacements ~~were to occur,~~ in the future. New designs under review do not consider fault related surface deformation beneath proposed sites.

Consequently, it is NRC policy (e.g., RG 1.208) to recommend that any site ~~determined, based on results of detailed fault investigations, to lie~~ located on a surface or near-surface ~~tectonic structure capable of~~ feature with a potential for future displacement be ~~prudently re-~~ located to an alternate site ~~by the applicant. If it becomes feasible in the future to design for surface or near-surface faulting with confidence that safety-related plant features would remain intact and functional should displacements occur, it would be necessary for an applicant to present the design basis for faulting and all supporting data in a high degree of detail.~~

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 all geologic and seismic factors that might affect the most severe design and operation of the natural phenomena.~~ proposed facility have been identified and 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 Safe Shutdown Earthquake (SSE) ground motion; and permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site. The site-specific GMRS satisfies the requirements of 10 CFR 100.23 with respect to the development of the SSE. Further, 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 proposed plant site have been identified, and that geologic and seismic elements of the site have been adequately investigated and characterized.~~

Application of 10 CFR 100.23(d)(2) requires that the geologic and seismic siting factors considered for design include a determination of the potential for surface tectonic and non-tectonic deformations.

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 “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 are 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.”

Procedures for staff review ~~enable evaluation~~provide a process to determine that an applicant has adequately performed investigations appropriate for fulfilling ~~general~~applicable requirements of 10 CFR ~~Part 100, Section 100.23-(c) and 10 CFR 100.23(d)(2).~~ Based on 10 CFR 100.23, ~~applicants are (d)(2), applicant is required to investigate provide an assessment of the potential for surface and near-surface deformation at the site related to both tectonic and non-tectonic phenomena. Guidelines~~General guidelines an applicant may follow to determine presence and extent of surface ~~and near-surface tectonic deformation features~~ in the site vicinity ~~or site, area and at the site location and whether this deformation, if present, poses a potential seismic hazard at the site or location are found in Appendices D and E of Regulatory Guide 1.165 and Appendix C.2.4 of Regulatory Guide~~RG 1.208.

Three Phase Review Process

~~Three~~During the regulatory review ~~phases are conducted by staff: (1) a process, the reviewer follows specific regulatory requirements promulgated in the Code of Federal Regulations, the regulatory guidelines and the acceptance criteria in this SRP. The 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 staff. All three review phases may be process, with staff’s responsibilities described within each step, is applied for reviews of a CP, OL, ESP, or COL application.~~applications.

~~Phase 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 delay in subsequent phases of the review process. Acceptance or rejection of the application for **Phase 2 detailed** review is governed by two criteria: (1) adherence to standard format for identifying and describing characteristics and features that ~~may~~**might** indicate **a potential for** surface deformation ~~due to faulting and may~~**which might** adversely affect ~~safety~~**suitability** of the site; and (2) provision of adequate information and documentation as described in ~~Regulatory Guides the requirements of GDC 2 in Appendix A of 10 CFR Part 50, 10 CFR 52.17(a)(1.165,)(vi), and 10 CFR 100.23(c) and 10 CFR 100.23(d)(2), RG 1.206, and 1.208 to enable an independent staff review of conclusions presented by the applicant. By acceptable, the application is deemed acceptable for docketing.~~

4.2. ~~Phase 2. —~~ Detailed Review of Application

~~In this review phase, which begins after~~After the application is docketed, staff conducts a thorough, detailed technical review of material submitted in the application and ~~an effort is made to identify~~**identifies** all potential safety issues ~~related to surface deformation.~~ The reviewer ~~examines the application to confirm~~**confirms** that all interpretations in the application are based on ~~standard~~**generally accepted** geologic ~~practices~~**practice** 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 1.208 and Appendix E of Regulatory Guide 1.165 describe acceptable methods for addressing significant new information in the PSHA. (Section 2.5.2).~~

~~At the beginning of this review phase, staff decides how consultants and advisors who are geoscience experts should be involved. Consultants and advisors may include geoscientists at the~~ Literature Review

The staff proceeds with a ~~U.S. Geological Survey (USGS), State Geological Surveys, universities, and private industry who are able to provide first-hand knowledge of the site location, site area, and site vicinity in relation to Quaternary tectonics. Necessary information is made available to any consultants and advisors that are selected by 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 due to faulting, verifying an applicant's geochronology for 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 at the site vicinity, area and location with**

respect to surface deformation potential. However, as publication of data and results commonly lags behind completion of research projects ~~and construction investigations~~, a reviewer ~~should~~**does** not rely entirely on information submitted by the applicant or ~~that in~~ published literature. The reviewer ~~should identify any pertinent~~**identifies** studies underway in the site ~~vicinity, site area, or at the site location and obtain~~**region and obtains** information on preliminary results of these studies. Special provisions ~~may~~**might** be required to examine ~~any pertinent data that are of a proprietary nature~~**data**. 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 that might affect conclusions for safety or suitability of the site.

~~As part of the Phase 2 review, staff will conduct geologic reconnaissance of the 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., deformation due to faulting) 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 Information

~~Under the COL approach defined in 10 CFR Part 52, the Safety Evaluation Report (SER) will have been written by 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 staff notwithstanding, geologic features discovered in plant excavations of applicants granted a COL may not have been evaluated by 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 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. Furthermore, staff should also be contacted if a fault not previously identified in the application is found within 8 km (5 mi) of the site (i.e., in site area). Staff may collect samples from fault zones or other parts of an excavation for age dating and analysis. Previous applicants have often excavated trenches in areas where major facilities were to be located to reduce the chance of surprises when excavations were started for plant construction.~~

~~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 staff. Seismic Category I excavations and the associated geologic maps are to be examined by 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.~~

~~If faults are identified in the site vicinity, site area, or at the site location, including construction excavations, it must be demonstrated that they do not have a potential for causing surface or near-surface ground displacement and acting as a capable tectonic source at the site location. This demonstration is accomplished by determining ages of latest fault displacements. Stratigraphic methods may be employed to determine age of faulting by identifying datable soil horizons or a stratigraphic unit overlying the fault that is not offset to bound the age of faulting. Other methods include correlating the latest faulting event with regional tectonic activity of known age, providing geomorphologic indications of age, and determining the relationship between time of fault displacement and ages of marine or fluvial terraces. Viable age dating methods that can be used to assess chronology of faulting are referred to in Appendix C of Regulatory Guide 1.208 and described in Appendix D of Regulatory Guide 1.165 and NUREG/CR-5562 (Reference 17).~~

During the ~~Phase 2~~ detailed technical review, staff develops ~~questions and comments~~ requests for 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, staff will request additional investigations or require the applicant to adopt the more conservative to the information and interpretations. This review phase provided by the applicant. The RAIs might indicate the need to conduct additional investigations. 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 and consistent with requisites requirements of 10 CFR 100.23.~~

Phase Site Audit and Confirmatory Activities

Staff will conduct a site audit to examine geologic features revealed by outcrops, trenches, test pits, surface and subsurface geophysical tests, and borehole data. For Section 2.5.3, staff will focus on geologic features within the site vicinity, area and location that may indicate surface deformation. Staff prepares a site audit report to document what staff did at the site and to aid in the development of the staff's Safety

Evaluation Report (SER). The report is subsequently submitted to Agencywide Documents Access and Management System (ADAMS) 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 vicinity and area as necessary to examine soil and rock samples from core borings and test pits and geologic features in trenches and excavations for other site facilities.

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 staff review of the ~~applicant's responses to RAIs. 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, staff then provides input for its SER. Because plant construction excavations will not be completed until after 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.~~ applicant's responses to RAIs. .

4. Geologic Mapping License Condition

Under the COL or ESP approach defined in 10 CFR Part 52, the SER might have been written by staff and a license may have been granted to the applicant before site excavations and geologic mapping of the excavations begin. Thus, new geologic features might be discovered in plant excavations, which have the potential to affect 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 safety-related structures are open for inspection by NRC staff.

A geologic mapping license condition will be proposed in the staff 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 staff 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 evaluate the plant excavations and mapping as part of the application review.

Procedures for Staff Evaluation of Specific Areas of Review

~~Procedures for~~ The staff ~~evaluation of the~~ follows procedures for review based on the six specific 'Areas of ~~Review~~ Review' defined in Subsection I of this SRP section to determine that an applicant has ~~adequately~~ acceptably performed appropriate investigations for fulfilling ~~general~~ applicable requirements of 10 CFR ~~Part~~ 100, Section.23(c) and 10 CFR 100.23 ~~are as follows:~~(d)(2). While ~~performing the task of~~ evaluating all the six Areas of Review for this section, it is important that reviewers of ~~seismic and tectonic~~, will note all significant new information provided by an applicant ~~identify all significant new~~ regarding seismic and tectonic information (e.g., a seismic source or new tectonic model that was not included in the site PSHA) and coordinate closely with the PSHA reviewer of Section 2.5.2 to ensure consistency for information used in the hazard analyses.

1. Geologic, Seismic, and Geophysical Investigations. The reviewer evaluates results of the ~~applicant's~~ applicant's geologic, seismic, and geophysical investigations by conducting ~~an independent~~ literature search and ~~comparing results~~ review on topics that affect staff's understanding of the ~~literature search with information provided in the application.~~ applicant's safety analysis. The ~~comparison~~ review should ~~show~~ allow staff to determine that conclusions presented by the applicant are based on ~~sound~~ appropriate data for this review area and are consistent with both reports published by area experts and conclusions of staff ~~and its advisors and consultants.~~. If conclusions and ~~assumptions~~ interpretations presented by the applicant conflict with the available literature and staff ~~disagrees~~ disagree with the applicant's analysis and assumptions, the reviewer ~~should~~ will require the applicant to submit additional information to further support the conclusions in question. For coastal and inland sites near large bodies of water, similar detailed investigations should include information regarding onshore and offshore deformation features. In some cases, it might be possible to identify onshore expression of an offshore tectonic structure (i.e., a fault or fold) of potential concern. ~~investigative results supporting the conclusions in question~~As expressed in RG 1.208, Appendix C, under this condition it is acceptable for the applicant to investigate expression of the offshore feature in the onshore environment, along with other investigations of the offshore feature when possible, to better evaluate characteristics of the deformation feature in the site vicinity, area and location.

- ~~2.~~
2. Geologic Evidence, or Absence of Evidence, for Surface Deformation. The reviewer evaluates ~~geologic evidence, or~~ that the ~~lack thereof,~~ applicant provides sufficient surface and subsurface information for the site vicinity, area, and location to confirm presence or absence of surface deformation ~~by first determining, through~~ features. This includes the reviewer conducting a literature search and ~~comparison~~ comparing that body of knowledge with the applicant's data, to ensure that all evidence of ~~tectonic~~ surface deformation (e.g., ~~fault offset~~ growth faulting, subsidence or collapse related to dissolution of limestone, salt or gypsum deposits, or salt diapirism) identified in the literature has been considered by the applicant. ~~The reviewer analyzes results of the applicant's site investigations and compares them to results derived from the literature search to determine if there is evidence for existing or possible faulting.~~ If evidence of ~~faulting~~ surface deformation is found, additional field investigations (e.g., geologic mapping, surface and borehole geophysical investigations, borings, or trenching) ~~must~~ shall be carried out to ~~completely define fault characteristics.~~ adequately

characterize the deformation features. The distinction should be made between tectonically-induced surface ~~or near-surface~~ deformation and non-tectonic surface deformation resulting from ~~non-tectonic phenomena (e.g.,~~ growth faulting or collapse due to limestone or salt dissolution ~~in karst terrane or salt diapirism).~~

In addition to geologic evidence that might indicate deformation, topographic and geomorphic evidence should be examined and their use documented (e.g. linear features interpreted from topographic maps, low and high altitude aerial photographs, satellite imagery, LiDAR). Data to assess presence of surface deformation is obtained by an applicant from surface methods such as: imagery analysis, geologic reconnaissance and mapping and subsurface methods such as geophysical surveys at ground surface as well as in boreholes; geologic and geotechnical logging of soil materials and rock core in boreholes, and geologic mapping of trenches and test pits to define paleoseismic features and fault surfaces (including growth faults) or collapse features. The nature and extent of investigations to determine whether or not shallow subsurface deformation features exist (e.g., blind faults, folds related to blind faults, growth faults, dissolution caverns, salt diapirism) are likely to exist will vary in degree of detail and extent required based on geologic context of the specific site.

In the central and eastern United States (CEUS) region, defined in NUREG-2115, earthquake-generating faults typically do not extend to the ground surface or there is insufficient overlying Quaternary soil or rock to constrain the timing of deformation. In the Western United States, many Quaternary faults are exposed at the ground surface and might be more readily characterized with respect to surface deformation potential if appropriately aged geologic formations or units exist at the site of deformation. Tectonic deformation features (including faults related to subduction zones) can exist as blind faults that might be expressed on the surface or near-surface by actively growing folds or areas of uplift and subsidence.

3. Timing of Deformation. The reviewer evaluates the applicant's assessment for the ages of past deformation events to determine if a sufficient technical basis has been established for the age estimates. The reviewer determines whether geochronological methods used by the applicant are based on generally acceptable procedures, such as those described in NUREG/CR-5562 or 'Paleoseismology'. In cases for which the applicant employs unusual or untested age determination techniques, staff will require documentation of the techniques including verification of the precision and accuracy of associated ages. Accuracy and precision of all age-dating techniques used in the applicant's analysis should be carefully documented and considered in the analysis of deformation potential. In general, multiple samples should be analyzed, and more than one dating method applied to each geologic element that is significant in estimating age of a paleodeformation event.

4.
3. Correlation of Earthquakes with Capable Tectonic Sources/Features. The reviewer assesses ~~how the applicant has investigated~~ correlation of earthquakes with ~~capable~~ potential tectonic sources in conjunction with consideration of SRP Section 2.5.2. Historical earthquake data derived from review of SRP Section 2.5.2 are compared with known ~~local~~ tectonic features ~~in the site vicinity~~ and a determination is made regarding whether any earthquakes can reasonably be associated with ~~local~~ these

tectonic structures. This determination includes an evaluation of the hypocentral error estimates of the earthquakes. When available, earthquake source mechanisms should be evaluated with respect to fault ~~geometry. Applicant~~ type (reverse, normal, strike-slip) and ~~licensees are encouraged to~~ characteristics such as orientation and slip history. The applicant shall evaluate the relationship of fault parameters to earthquake magnitude. ~~These parameters~~ This type of assessment will likely provide insights on the potential for future surface displacements. In addition, small earthquakes correlated to growth fault movements or fluid injection or withdrawal ~~should include fault geometry (including~~ be considered in appropriate areas to discern between tectonic activity and man induced events or to determine potential future movements on growth ~~fault orientation, length, and width), fault type, slip rate, recurrence intervals, and rupture areas~~ systems.

- ~~4. Ages of Most Recent Deformation. The reviewer evaluates ages of most recent deformation to determine if times of most recent activity have been reasonably estimated for tectonic features identified, and if there a sufficient technical basis exists for the age estimates. The reviewer determines whether geochronological methods used by the applicant are based on accepted procedures. In cases for which the applicant employs unusual or untested age dating techniques, staff will require documentation of the techniques. Accuracy of all age dating techniques used in the applicant's analysis should be carefully documented. Multiple samples should be tested, and more than one dating method applied to each horizon that is significant in estimating age of a paleoseismic event. To evaluate ages of most recent deformation, staff may require assistance of consultants or advisors with expertise in the specific age dating methods used by the applicant.~~
5. Relationship of Tectonic Structures Geological Features in the Site Area Vicinity to Regional Tectonic Structures Geological Features. The reviewer evaluates relationships of tectonic structures ~~within 8 km (5 mi) of~~ in the site (i.e., the site area) vicinity with regional tectonic structures by using a literature ~~search~~ review to determine that the applicant's evaluation of the regional tectonic framework is ~~consistent with that of recognized experts who have published technical reports on this topic in peer reviewed literature.~~ reasonable. The reviewer confirms that conclusions reached by the applicant are based on ~~sound~~ acceptable geologic principles and ~~all available~~ have considered appropriate geologic and geophysical data. ~~When special investigations are conducted to determine structural relationships between faults that pass within 8 km (5 mi) of the site and regional faults, the reviewer assesses~~ The reviewer considers the resolution accuracy of the ~~investigative technique~~ investigation methods used by the applicant.
- ~~6. Characterization of Capable Tectonic Sources. The reviewer evaluates information related to characterization of capable tectonic sources presented in the application to determine whether sufficiently detailed investigations have been conducted by the applicant to define specific characteristics of all potential capable tectonic sources, any part of which is located within 8 km (5 mi) of the site (i.e., within the site area). Characteristics of a structure that must be defined include fault orientation; relationship of the fault (or fold) to regional structures; type, amount, and chronologic history of displacements (including slip rates and recurrence intervals) along the fault; and extent of the deformed zone as established by mapping the extent of Quaternary deformation both along and across the deformed zone to determine length and width of the zone. The reviewer assesses adequacy of the applicant's field investigations, including~~

~~whether a large enough area was analyzed in sufficient detail to demonstrate that there is little likelihood of near-surface deformation within the site area associated with capable but undetected tectonic sources (e.g., blind faults).~~

- ~~7. Designation of Zones of Quaternary Deformation in the Site Region. The reviewer examines published literature to determine acceptability of the applicant's investigative results related to designation of zones of Quaternary deformation in the site region. The reviewer also evaluates investigative techniques employed by the applicant for defining the zones to ascertain whether they are consistent with state-of-the-art practices, and staff may ask technical experts to review specific aspects of the investigative program. The reviewer analyzes results of the investigations to determine whether analysis of Quaternary deformation at the outer limits of the 40 km (25 mi) radius (i.e., the site vicinity) zone are appropriately conservative.~~
- ~~8. Potential for Surface Tectonic Deformation of the Site. If detailed investigations for the proposed commercial nuclear power plant reveal a potential for surface or near-surface deformation at the site, staff recommends that an alternative location be considered for the proposed plant. No commercial nuclear power plant has ever been constructed on a known capable tectonic deformation feature, and it is questionable whether it may be feasible to design for surface or near-surface tectonic displacements with any degree of confidence that safety-related plant features would remain intact and functional if displacements were to occur. If it becomes feasible in the future to design for surface faulting with confidence that safety-related plant features would remain intact and functional, it will be necessary for an applicant to present the design basis for surface faulting and supporting data in a very high degree of detail.~~
6. Potential for Surface Deformation at the Site. The reviewer evaluates the information provided by the applicant to characterize past surface deformation events in the site region. The reviewer then assesses the applicant's approach for integrating this information into an assessment of the potential for future surface deformation at the site per 10 CFR 100.23 (d)(2). The assessment should distinguish between tectonic and nontectonic surface deformation. If the potential for future surface deformation exists at the site, information in the application must demonstrate the potential effects of surface deformation are within the design basis of the proposed facility.

Review Procedures Considerations Specific to 10 CFR Part 52 Application Type

1. Early Site Permit Reviews

- ~~Subpart A to~~ 10 CFR Part 52, Subpart A 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~~ 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~~shall propose geologic site characteristics that will form a set of ~~minimum~~ values for design and construction of a new plant to be built at the site.

~~At the COL stage and 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 ~~should, for SRP Section 2.5.3~~ shall ensure that all geologic ~~and seismic-site~~ characteristics ~~-that pertain to surface deformation and~~ that could affect the design basis of ~~SSCs important to~~ safety-related SSCs, are reflected in the site characteristics, design parameters, ~~and~~ terms and conditions of the ~~early site permit~~.~~

~~2. Standard Design Certification Reviews~~

~~DC applications do not contain general descriptions of site characteristics because~~ESP. Nevertheless, ~~this information is site-specific and will be addressed by~~ requirement does not relieve the COL applicant. ~~However, pursuant to 10 CFR 52.47(a)(1), a DC applicant must provide site parameters postulated for~~ or permit holder from the design. The reviewer verifies that:

- ~~a. The postulated site parameters are representative~~ requirements of a reasonable number of sites that have been or may be considered Part 52.6(b) to notify the NRC of new information having a significant implication for a COL application; public health and safety or common defense and security that might be developed following issuance of an ESP.
- ~~b. The appropriate site parameters are included as Tier 1 information. This convention has been used by previous DC applicants. Additional guidance on site parameters is provided in SRP Section 2.0;~~
- ~~c. Pertinent parameters are stated in a site parameters summary table; and~~
- ~~d. The applicant has provided a basis for each of the site parameters.~~

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 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.

2. Combined License Reviews

~~For NRC staff reviews~~ a COL application referencing a certified standard design, ~~NRC staff reviews to determine that application to ensure~~ sufficient information ~~was presented~~ is provided to demonstrate that ~~the site~~ characteristics ~~of the site~~ fall within ~~the site parameters~~ specified ~~in site parameters~~ of the DC rule. Should the actual geologic ~~and seismic~~ site characteristics not fall within the certified standard design site parameters, the COL applicant will ~~need to~~ demonstrate by some other means that the proposed ~~facility~~ site is ~~acceptable~~ suitable for the proposed ~~site~~. ~~This demonstration might be accomplished by re-analyzing or redesigning the proposed facility.~~

~~For~~ 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 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.

NRC staff reviews a COL application referencing an ESP, ~~NRC staff reviews the application to ensure the applicant provided~~ determine that sufficient information is provided to demonstrate that the design of the facility falls within the site characteristics and design parameters specified in the ~~early site permit~~ ESP as applicable to this SRP section. In accordance with 10 CFR 52.79(b)(2), ~~should~~ if the design parameters of the facility ~~do~~ 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 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 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 **final safety evaluation report (FSER)** to ensure that any ~~early site permit~~ESP conditions, restrictions to the DC, or COL action items identified in the FSERs are appropriately handled in the COL application. **Per 10 CFR 52.47(a)(1), a DC will provide site parameters postulated for the design. For a COL application referencing a DC, the reviewer verifies that the applicant has provided a basis for each of site parameter as stated in the DC site parameters summary table.**

IV. EVALUATION FINDINGS

The review should document the ~~staff's~~staff's evaluation of geologic and seismic site characteristics with respect to the relevant regulatory criteria. The evaluation should support the ~~staff's~~staff's conclusions as to whether the regulations are met. The reviewer should state what was done to evaluate the ~~applicant's~~applicant's safety analysis report. The ~~staff's~~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~~might 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~~might 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~~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 geologic and seismic aspects of the plant site,~~The staff has **carefully** considered ~~pertinent~~information ~~gathered~~provided by the applicant in support of the license application ~~about the determination of the potential for surface tectonic and non-tectonic deformation at the site and site suitability.~~ The information reviewed includes data from the site vicinity, ~~site~~area, and ~~site~~location related to ~~geologic, seismic, geophysical, and geotechnical~~geoscience investigations ~~as well as;~~ geologic reconnaissance. ~~Information considered also includes data from for the site vicinity; the staff's independent~~ ~~staff~~ review of ~~state-of-the-art~~published literature ~~and other sources;~~ and discussions with knowledgeable geoscientists with the USGS, State Geological Surveys, local universities, consulting firms, or other non-governmental and professional organizations.

As a result of this review, staff concludes that geologic, seismic, geophysical, and geotechnical investigations and information provided by the applicant in accordance with

10 CFR 52.17(a)(1)(vi), 10 CFR 100.23(c), and 10 CFR 100.23(d)(2) provide an adequate basis to establish ~~that no capable tectonic sources exist in the plant site vicinity or site area that would cause potential for future surface or near-surface deformation or localize earthquake to occur at or near the site location, which could affect the design and operation of the proposed facility.~~

2. ~~Design Certification Reviews~~

~~The following statement should be preceded by a summary of geologic and seismic parameters assumed for the site:~~

~~The applicant has selected the site parameters referenced above for plant design inputs (a subset of which is included as Tier 1 information), and the staff agrees that they are representative of a reasonable number of sites that have been or may be considered for a COL application. Local and regional geologic and seismic parameters are specific to the site and region and will be addressed by the COL applicant. This should include the provision of information sufficient to demonstrate that the design of the plant falls within the values of the actual site characteristics specified in a COL or CP application.~~

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

If staff completes review of geologic and seismic aspects of the ~~plant~~ site related to potential for surface deformation ~~due to faulting~~ and confirms that the applicant has met all applicable requirements (i.e., appropriate portions of GDC 2 in Appendix A to 10 CFR Part 50, 10 CFR 52.79(a)(iii), 10 CFR 100.23(c), and 10 CFR 100.23(d)(2)) and guidelines (i.e., ~~Regulatory Guides 1.165, 1.132, 1.198, RG 1.208, 4.7, and 1.206~~), 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 ~~subject proposed~~ nuclear power plant site in relation to potential for ~~future~~ surface deformation ~~due to faulting~~. Licensing conditions established by 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 ~~potentially~~ significant new information derived ~~from site vicinity, site area, or site location~~ geologic, seismic, geophysical, and geotechnical investigations ~~in the site region~~ that had not been previously applied to tectonic and ground motion models used in the PSHA, ~~and that information has been identified to reviewers in SRP Section 2.5.2.~~

~~Determinations regarding geologic and seismic suitability of the site are made by 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, 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 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 excavations for Seismic Category I facilities; and (3) notifying NRC staff when the excavations and associated geologic maps are~~

~~available for examination and evaluation. 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 staff during the COL application review have been implemented. The site visit will also include an appraisal by staff of the applicant's engineering solutions for mitigating any potential non-tectonic geologic hazards.~~

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.

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

Information reviewed for the proposed nuclear power plant concerning potential for surface ~~and near-surface tectonic~~ deformation is summarized in SER Section 2.5.3. Staff concludes that the site ~~is acceptable from~~ has been adequately evaluated for the ~~perspective of tectonic surface and near-~~ potential for future surface deformation that may affect the design and operation of the proposed facility and meets requirements of 10- CFR Part 50, Appendix A, ~~General Design Criterion (GDC) 2; and~~ 10 CFR 52.17(a)(1)(vi), 10 CFR 100.23-(c), and 10 CFR 100.23(d)(2). This conclusion is based on the applicant having met the requirements and guidelines of:

1. ~~General Design Criterion~~GDC 2 (“(Design Bases for Protection ~~Against~~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 faulting and resultant vibratory ground motion.
2. 10 CFR 100.23-~~(“Geologic and Seismic Siting Criteria”)~~(c) (“Geological, seismological, and engineering characteristics”) with respect to ~~obtaining geologic~~ the adequate evaluation of geological, seismological, and ~~seismic information necessary to determine engineering~~ characteristics of a site ~~suitability and appropriate plant design,~~ its environs as affecting tectonic and ~~ascertain that any new information derived from nontectonic deformation of the site-specific investigations does not impact the SSE derived by a probabilistic seismic hazard analysis.~~ In complying with this regulation, the applicant also meets applicable guidance in ~~Regulatory Guides 1.132 (“Site Investigations for Foundations of Nuclear Power Plants”); 1.165 (“Identification and Characterization of Seismic~~

~~Sources and Determination of Safe Shutdown Earthquake Ground Motion”); RG 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 Plants”); and 1.206 (“Combined License Applications for Nuclear Power Plants - LWR Edition”).~~

3. 10 CFR 100.23(d)(2) (“Geologic and Seismic Siting Factors) with respect to determination of the potential for surface tectonic and nontectonic deformations.

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 excavation for safety-related structures; and (3) notify the NRC once excavations for safety-related structures are open for inspection by NRC staff.

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, COL, or ESP~~ applications submitted by applicants pursuant to 10 CFR ~~Part 50 or 10 CFR~~ Part 52. ~~Except when~~The staff will use the method described herein, to evaluate conformance with Commission regulations. If 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~~ Commission’s regulations.

~~The provisions of this SRP section apply to reviews of applications submitted six months or more after, the applicant must demonstrate the date of issuance of this SRP section, unless superseded by a later revision~~acceptability of its alternate method.

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 in the 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. ~~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.~~
2. ~~8. General Design Criterion~~ 10 CFR 100.23, "Geologic and Seismic Siting Criteria," in 10 CFR Part 100, "Reactor Site Criteria."
3. Divisions of Geologic Time-Major Chronostratigraphic and Geochronologic Units, US Department of the Interior, US Geological Survey, Fact Sheet 2010-3059, July 2010.
- 2.4. GDC 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," in 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."~~

5. ~~11. Regulatory Guide~~ K.K.E. Neuendorf, J.P. Mehl, Jr., and J. A. Jackson, Editors, "Glossary of Geology," Fifth Edition (revised), American Geosciences Institute, Alexandria, Virginia, 2011.
6. McCalpin, James P., 2009, Paleoseismology, International Geophysics Series, Vol 95, 613 pp, 2nd edition, Elsevier.
- ~~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 1.198, U.S. NRC,~~ "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites."
- 4-8. ~~14.~~ ~~Regulatory Guide~~ RG 4.7, ~~US NRC,~~ "General Site Suitability Criteria for Nuclear Power Stations."
- 5-9. ~~15.~~ ~~Regulatory Guide 1.208, U.S. NRC,~~ "RG 1.206, Combined License Applications for Nuclear Power Plants - LWR Edition."
10. ~~16.~~ Sowers, J.M., et al, "Dating and Earthquakes - Review of Quaternary Geochronology and its Application to Paleoseismology," NUREG/CR-5562, USNRC, Washington, DC, 1998.
11. Technical Report: Central and Eastern United States Seismic Source Characterization for Nuclear Facilities. EPRI, Palo Alto, CA, U.S. DOE, and U.S. NRC: 2012, NUREG-2115.

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 2.5.3
Description of Changes**

Section 2.5.3 “SURFACE DEFORMATION”

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in Revision 4, March 2007, of this SRP. See ADAMS Accession No. ML070730597. Changes include focus on the determination of the potential for surface tectonic and nontectonic deformations and on the sufficiency of geological, seismological and geophysical data to make that determination. The technical changes incorporated in Revision 5, dated May 2013, 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 review interfaces especially with respect to SRP Sections 2.5.2 and 2.5.3
 - c. Clarified the emphasis on Quaternary aged features
 - d. Removed outdated EPRI references
 - e. Removed review of PSHA assessment, inserted direct link to SRP Section 2.5.2.
- II. Acceptance Criteria
 - a. Enhanced and clarified the link to 10 CFR 100.23 (c), 10 CFR 52.17 and 10 CFR 52.79
 - b. Removed RG 1.132, 1.138, 1.165, 1.198
- III. Review Procedures
 - a. Modified the review process 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 (100.23(d)(2), 100.23(c), 52.17, 52.79 and GDC 2.

V. Implementation

Clarified and updated text according to recommendation by DARR

VI. References

a. Removed the following references:

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

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