



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 2.5.1

BASIC GEOLOGIC AND SEISMIC INFORMATION

REVIEW RESPONSIBILITIES

Primary - Site Analysis Branch (SAB)

Secondary - None

I. AREAS OF REVIEW

SAB reviews the geologic and seismic information submitted in the applicant's safety analysis report (SAR) in accordance with Appendix A to 10 CFR Part 100, "Seismic and Geologic Siting Criteria for Nuclear Power Plants." SAB judges the adequacy of the geologic and seismic information cited in support of the applicant's conclusions concerning the suitability of the plant site. The geologic and seismic information which must be provided in order for the site review to proceed is divided into the following three categories:

1. Geologic features: mass-wasting, differential subsidence, faulting, soil and foundation instability, chemical weathering, cavernous or karst terrains, and volcanism.
2. Seismic features: ground failure under dynamic loading, liquefaction, vibratory ground motion, site amplification, tsunamis, and residual stresses.
3. Man-made conditions: subsidence or collapse caused by withdrawal of fluids or mineral extraction, and fault movement caused by fluid injection or withdrawal.

Information relating to the above conditions should be presented in SAR Sections 2.5.1.1 (Regional Geology) and 2.5.1.2 (Site Geology). This information should be discussed in terms of the regional and site physiography, geomorphology, stratigraphy, lithology, and tectonics. In addition, with specific reference to site geology, the following subjects should be discussed as they relate to the above-mentioned conditions: topography, slope stability, fluid injection or withdrawal, mineral extraction, faulting, shearing, jointing and fracturing.

The above information should be documented by appropriate references to all relevant published and unpublished materials. Illustration should include but should not be limited to physiographic, topographic, geologic, tectonic, gravity, and magnetic maps, structure and stratigraphic sections, boring logs, and aerial photographs. Certain sites will require illustrations of specialized character such as maps of subsidence, irregular weathering

USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to Revision 2 of the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

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conditions, landslide potential, hydrocarbon extraction (oil or gas wells), and karst features. Some site characteristics must be documented by reference to seismic reflection or refraction profiles or to maps produced by various remote sensing techniques.

As appropriate, maps should include a superimposed plot plan of the plant facilities. Other documentation should show the relationship of all seismic Category I facilities (clearly identified) to subsurface geology. Core boring logs, logs and maps of trenches, aerial and Environmental Resources Technology Satellite (ERTS) photographs, and geophysical data should be presented for evaluation. In addition, a plot plan showing the locations of all structures, borings, trenches, profiles, etc. should be included.

The review can be brought to an earlier conclusion if the following suggestions are followed by the applicant. The SAR should contain sufficient data to allow the reviewer to make an independent assessment of the applicant's conclusions. That is, the reviewer should be led in a logical manner from the data and premises given to the conclusions that are drawn without having to make an extensive independent literature search. Controversial information should not be ignored so as to enhance a particular position. The geologic terminology used should conform to standard reference works (Refs. 3, 6). Finally, the objective of Section 2.5 of the SAR is to describe geologic and seismic features as they affect the site under review, and all data, information, discussions, interpretations, and conclusions should be directed to this objective. Aimless presentation of data, although it may appear to satisfy the investigative requirements, will result in a disjointed SAR and cause needless delays in completing the safety review.

II. ACCEPTANCE CRITERIA

The "Seismic and Geologic Siting Criteria for Nuclear Power Plants" (Ref. 1) and the Standard Format (Ref. 2) are the basis for the staff review of all cases. The information presented in the SAR must be complete and thoroughly documented, and must be consistent with the requirements of References 1 and 2. United States Geological Survey (USGS) and other federal or state agency published and open file papers, maps, aerial photographs, geophysical data, etc., covering the region in which the site is located, are used to establish the staff's conclusions as to the completeness and acceptability of the SAR.

Subsection 2.5.1.1, "Regional Geology," will be considered acceptable if a complete and documented discussion is presented of all geologic, seismic, and man-made features. This section should contain a review of the regional physiography, geomorphology, stratigraphy, structure, and geologic history to provide a framework within which the geologic, seismic and man-made features of safety significance to the site can be evaluated.

Subsection 2.5.1.2, "Site Geology," will be judged acceptable if it contains a description and evaluation of site-related geologic features, seismic conditions, and man-made conditions which are a potential hazard to the site. This section should also contain the following general site information:

1. The site stratigraphy, including relationship to and correlation with the regional stratigraphy.

2.5.1-2

2. The structural geology of the site and the relationship of site structure to regional tectonics.
3. The geologic history of the site as it relates to the regional geologic history.
4. The engineering significance of geologic features underlying the site as they relate to:
 - a. Dynamic behavior during prior earthquakes.
 - b. Zones of alteration, irregular weathering, or zones of structural weakness.
 - c. Unrelieved residual stresses in bedrock.
 - d. Materials that could be unstable because of their mineralogy or unstable physical properties.
 - e. Effects of man's activities in the area.
5. The site groundwater conditions.

III. REVIEW PROCEDURES

The staff review is conducted in three phases. The first phase is the acceptance review, a brief review of the SAR to evaluate its completeness and to identify obvious safety issues that could result in delays at subsequent stages of the review. After an SAR is docketed, the staff conducts a thorough review of the material. In this second phase of the review an effort is made to identify all safety issues. The reviewer should carefully examine the SAR to see that all interpretations are founded on sound geological and seismological practice and do not exceed the limits of validity of the applicant's data or of other data published in the literature. The questions and comments transmitted to the applicant will identify issues that have not been addressed, areas where staff interpretations differ from those given in the SAR, and issues that have not been sufficiently documented to permit the staff to concur in the conclusions reached by the applicant. When possible, the staff should take positions on safety-related issues at this point. The third review phase is the staff evaluation of the applicant's responses to questions raised in the second phase. At the end of the third phase, the staff takes positions on all safety-related issues, either concurring with the applicant's positions or taking more conservative positions as may be necessary in the staff's view to assure the required degree of safety.

Pertinent references, such as published geological reports, professional papers, open file material, university theses, physiographic and geological maps, and aeromagnetic and gravity maps, are ordered from the appropriate sources and reviewed. The general references used extensively by the staff are References 3 and 4. The GEO-Reference File (Ref. 5) is used to identify specific references.

The judgments on acceptance or rejection of the SAR are governed by two criteria: (1) adherence to the Standard Format in identifying and describing the geologic, seismic and

man-made features that affect safety of the site; and (2) provision of adequate information and documentation to allow for an independent review of the conclusions made therein.

During the acceptance review the staff decides to what extent consultants such as the USGS, the Corps of Engineers, state geological survey organizations, or other specialists should be involved. The necessary information is then made available to these consultants. Consultants are asked to handle such varied tasks as reviewing the foundation engineering aspects of plants located at sites with complex foundation conditions, verifying an applicant's mineral identifications, or evaluating the adequacy of foundation and slope stability conditions for safety-related dams and dikes.

After docketing, a detailed review of the SAR and relevant references is conducted by the staff and its advisors. Questions and comments are developed from items that have not been adequately addressed by the applicant, those which become apparent during the detailed review, or those which develop from the additional information provided as a result of the acceptance review. These questions (Q-1) usually require the applicant to conduct additional investigations or to supply clarifying information. Many questions result from the reviewer's discovery of references not cited by the applicant that contain conclusions which are in conflict with those made by the applicant. When the applicant provides insufficient data to support his interpretations and conclusions, and there are alternative interpretations in the literature, the staff will request additional investigations. This phase of the review will usually involve meetings with the applicant to clarify questions and allow him to present new data. In addition, during the Q-1 phase, the staff visits the site.

The applicant's responses to Q-1 are reviewed and any remaining issues are settled either by additional questions or by staff positions. A staff position is usually in the form of a requirement to design for a specific condition in a way which the staff considers to be conservative and consistent with the requisites of Reference 1. When all safety issues have been resolved, the staff provides its input to the safety evaluation report (SER).

IV. EVALUATION FINDINGS

The staff's findings for construction permit (CP) reviews will consist of a report summarizing the geology at the site and the pertinent design aspects of the plant. All geologic features that may potentially affect the safety of the plant will be identified, described, and measures taken to deal with them will be given. The seismic design basis will be described.

Operating license (OL) applications are reviewed for any new information developed subsequent to the CP. The review will also determine whether the CP recommendations have been implemented.

A typical CP-stage finding for this section of the SER follows:

"Based on our review of the PSAR materials and our independent review of the relevant published literature, we have concluded that the site is located in the Piedmont tectonic province. The last recognizable regional tectonic event occurred here in

Triassic to Jurassic time (225 - 136 mybp). No Holocene faulting of tectonic origin is known in the province and no capable faults within the meaning of Appendix A to 10 CFR Part 100 have been recognized."

V. REFERENCES

1. 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants."
2. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Revision 2.
3. M. Gray, R. McAfee, Jr., and C. L. Wolf, eds., "Glossary of Geology," American Geological Institute, Washington (1972).
4. G. V. Cohee (chairman) et al., "Tectonic Map of the United States," U. S. Geological Survey and American Association of Petroleum Geologists (1962).
5. "Geo-Reference: Computerized File of Earth Science Titles," American Geological Institute, Washington.
6. M. W. Higgins, "Cataclastic Rocks," Professional Paper 687, U. S. Geological Survey (1971). (Includes extensive discussion of the terminology of cataclastic rocks.)

11/24/75

SRP 2.5.2