U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

3.7.4 SEISMIC INSTRUMENTATION

REVIEW RESPONSIBILITIES

Primary - The organization responsible for reviews of seismic/geotechnical issues

Secondary - None

I. AREAS OF REVIEW

The specific areas of review are as follows:

1. Comparison with guidance provided in Regulatory Guide 1.12. A comparison is made of the proposed seismic instrumentation with the seismic instrumentation guidelines of Regulatory Guide (RG) 1.12. In addition, the bases for elements of the program that differ from RG 1.12 are reviewed.

   The locations for the installation of seismic instrumentation that will be installed in selected Category I structures and components are reviewed. Also reviewed are the bases for selection of the instrumentation and locations and a discussion of the extent to which the seismic instrumentation will be maintained to enable a rapid determination of the severity of the earthquake.

2. Comparison with RG 1.166. A comparison is made of (1) the proposed procedures for a timely evaluation after an earthquake of the recorded seismic instrumentation data and (2) for determining whether plant shutdown is required with the post-earthquake guidelines of RG 1.166. Also reviewed are the criteria for evaluation of the ground motion records and for determining the exceedance of the Operating Basis Earthquake (OBE) ground motion.

3. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

4. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

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

Review Interfaces

None

II. ACCEPTANCE CRITERIA

Requirements

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

1. 10 CFR Part 20 and 10 CFR Part 50, Appendix S as they relate to meeting the capabilities and performance of the instrumentation system to adequately measure the effects of earthquakes.

2. 10 CFR Part 20 requires licensees to make every reasonable effort to maintain radiation exposure as low as is reasonably achievable (ALARA).

3. 10 CFR Part 50, Appendix S, requires that suitable instrumentation be provided to promptly evaluate the seismic response of nuclear power plant features important to safety after an earthquake. Appendix S also requires shutdown of the nuclear power plant if vibratory ground motion exceeding that of the OBE occurs.

4. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations;

5. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

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

The type, locations, operability, characteristics, installation, actuation, remote indication, and maintenance of seismic instrumentation should meet the guidance discussed below. Where an applicant proposes specific details different from these, acceptability should be based upon meeting applicable regulations, as stated above, consistent with current proven technologies and intended use of the recorded information.

1. Comparison with RG 1.12. The seismic instrumentation program is considered to be acceptable if it is in accordance with guidance provided in RG 1.12. The bases for elements of the proposed seismic instrumentation program that differ from RG 1.12 must be provided. This guide recommends installation of solid-state digital time-history accelerographs at appropriate locations in order to provide time history data on the seismic response of the free-field, containment structure, and other Seismic Category I structures.

   The COL, DC, and construction permit (CP) applicants should provide solid-state digital instrumentation that will enable the processing of data at the plant site within 4 hours of the seismic event. A triaxial time-history accelerograph should be provided at each of the locations specified in RG 1.12. Triggering of the free-field or any foundation-level accelerograph should be annunciated in the control room. In addition, applicants should provide a rationale for the placement of instrumentation which is consistent with maintaining occupational radiation exposures ALARA for the location.

   With regard to operability and installation, applicants should demonstrate that the seismic instrumentation will be operable during all modes of plant operation, including periods of plant shutdown. In addition, the applicant's maintenance and repair procedures should provide for keeping the maximum number of instruments in service during plant operation and shutdown. Instruments should be designed and installed so that the mounting is rigid and oriented so that the horizontal components are parallel to the orthogonal axes assumed for the seismic analysis. Also, protections against accidental impacts should be provided.

   With regard to capabilities and characteristics, the seismic instrumentation should include each of the specifications identified in RG 1.12. This includes provisions for in-service testing, a remote alarm to indicate actuation, recording capabilities, sufficient

dynamic range and sampling rate, and a low and adjustable actuating level or trigger. In addition, both vertical and horizontal input vibratory ground motion should actuate the same time-history accelerograph.

2. Comparison with RG 1.166. The seismic instrumentation program is considered to be acceptable if it contains pre-earthquake planning and post-earthquake actions in accordance with RG 1.166. The bases for elements of the proposed seismic instrumentation program that differ from RG 1.166 must be provided. This guide provides guidance for a timely evaluation after an earthquake of the recorded seismic instrumentation data and for determining whether plant shutdown is required.

   The COL, DC, and CP applicants should provide a description of both pre-earthquake planning and post-earthquake actions in order to make a rapid determination of the degree of severity of the seismic event. The data from the seismic instrumentation, coupled with information obtained from a plant walkdown, should be used to make the initial determination of whether the plant must be shut down.

   With regard to the necessary baseline data, information related to seismic instrumentation, including instrument calibration, should be kept at the plant. The applicant's program should also describe the necessary actions, such as selecting equipment and structures for inspections and the content of the baseline inspections, that are to be taken immediately after an earthquake, as described in RG 1.166.

   With regard to the evaluation of ground motion records, the applicant's program should describe data identification (i.e., record collection log), data collection, and record evaluation procedures. Shutdown of the nuclear power plant is required if the vibratory ground motion experienced exceeds that of the OBE. A criterion for determining exceedance of the OBE is provided in the Electric Power Research Institute (EPRI) document EPRI NP-5930, "A Criterion for Determining Exceedance of the Operating Basis Earthquake." This criterion is based on a threshold response spectrum ordinate check and a cumulative absolute velocity (CAV) check. The ground motion evaluation should consist of a check on the response spectrum and CAV and a check on the operability of the instrumentation as described in RG 1.166. This evaluation should take place within 4 hours of the earthquake.

Technical Rationale

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

10 CFR Part 50, Appendix S, requires that suitable instrumentation be provided to promptly evaluate the seismic response of nuclear power plant features important to safety after an earthquake. Appendix S also requires shutdown of the nuclear power plant if vibratory ground motion exceeding that of the OBE occurs.

The seismic instrumentation program with installation of solid-state digital time-history accelerographs at appropriate locations will provide time history data on the seismic response of the free-field, containment structure, and other Seismic Category I structures, as well as maintaining occupational radiation exposures ALARA for the location as required by 10 CFR Part 20.

III. REVIEW PROCEDURES

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

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

1. Comparison with RG 1.12. The seismic instrumentation program is checked to ensure that the instrumentation is in accordance with the guidelines of Regulatory Guide 1.12. Any differences between the proposed and the regulatory guide seismic instrumentation, which have not been adequately justified, are identified and the applicant is informed of the need for additional technical justification.

   The locations and descriptions of the seismic instrumentation are reviewed to determine that these are in accordance with the acceptance criteria of Subsection II of this SRP section. If the instrumentation provided is judged to be insufficient, the need for additional instrumentation is transmitted to the applicant.

   The program is checked to verify that the triggering of the free-field or any foundation-level accelerograph is annunciated in the control room. If there is no provision for both audio and visual signals in the applicant's seismic instrumentation plan, the applicant is so informed with a request for compliance. The program is checked to ensure that the provisions for in-service testing, remote alarm to indicate actuation, recording capabilities, sufficient dynamic range and sampling rate with a low and adjustable actuating level or trigger are in accordance with RG 1.166.

2. Comparison with RG 1.166. The seismic instrumentation program is checked to ensure that the pre-earthquake planning and post-earthquake actions are in accordance with RG 1.166. Any differences between the proposed and the regulatory guide seismic instrumentation, which have not been adequately justified, are identified and the applicant is informed of the need for additional technical justification.

   The pre-earthquake planning and post-earthquake actions are checked to verify that a rapid determination of the degree of severity of the seismic event can be accurately made. The data from the seismic instrumentation coupled with information obtained from a plant walkdown should be used to make the initial determination of whether the plant must be shut down. Any deficiency in the required information is identified and the applicant is requested to provide further information.

3. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

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

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

IV. EVALUATION FINDINGS

The reviewer verifies that 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.

The staff concludes that the seismic instrumentation system provided for the plant is acceptable and meets the requirements of 10 CFR Part 20 and Appendix S to 10 CFR Part 50. This conclusion is based on the following:

The applicant has met the requirements of 10 CFR Part 50, Appendix S by providing the instrumentation that is capable of promptly measuring the severity of a seismic event and by providing a program that allows for the data from the seismic instrumentation, coupled with information obtained from a plant walkdown, to be used to make the initial determination of whether the plant must be shut down. The applicant has met the requirements of 10 CFR 20 by providing seismic instrumentation at locations which are consistent with maintaining occupational radiation exposures ALARA for the location. The seismic instrumentation program complies with RG 1.12 and 1.166.

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

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

V. IMPLEMENTATION

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

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. 10 CFR Part 20, "Standards for Protection Against Radiation."

2. 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants.”

4. Regulatory Guide 1.12, "Nuclear Power Plant Instrumentation for Earthquakes."

5. Regulatory Guide 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions."

6. Electric Power Research Institute, "A Criterion for Determining Exceedance of the Operating Basis Earthquake," EPRI NP-5930, Palo Alto, California, July 1988.