



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

3.7.4 SEISMIC INSTRUMENTATION

REVIEW RESPONSIBILITIES

Primary - Organization responsible for reviews of seismic issues

Secondary - Organization responsible for reviews of radiation protection

I. AREAS OF REVIEW

Standard Review Plan (SRP) 3.7.4 discusses the seismic instrumentation for the plant during operation. The staff reviews information presented by the applicant for a construction permit (CP), operating license (OL), design certification (DC), or combined license (COL) concerning the seismic instrumentation to determine that the seismic instrumentation system provided for the plant is acceptable and meets the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20 and Appendix S to 10 CFR Part 50.

Draft Revision 3 - August 2013

USNRC STANDARD REVIEW PLAN

This Standard Review Plan (SRP), NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission (NRC) staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC regulations. The Standard Review Plan is not a substitute for the NRC regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The SRP sections are numbered in accordance with corresponding sections in Regulatory Guide (RG) 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of RG 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov

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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 discussions of the bases for selection of the instrumentation and its locations and the extent to which the seismic instrumentation will be maintained to enable a rapid determination of the severity of the vibratory ground motion at the site.

2. Comparison with RG 1.166. A comparison is made of the proposed procedures (1) 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 50, Appendix S as it relates to meeting the capabilities and performance of the instrumentation system to adequately measure the effects of earthquakes. 10 CFR Part 50, Appendix S, Paragraph IV(a)(4) 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, Paragraph IV(a)(3) requires shutdown of the nuclear power plant if vibratory ground motion exceeding that of the Operating Basis Earthquake (OBE) occurs.
2. 10 CFR Part 20 requires licensees to make every reasonable effort to maintain radiation exposure as low as is reasonably achievable (ALARA). 10 CFR 20.1101(b), requires the provision of engineering controls based upon sound radiation protection principles to achieve occupational doses ALARA.
3. 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 facility that incorporates the design certification has been constructed and will be operated in conformity with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.
4. 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 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 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.

COL, DC, CP, and OL applicants should provide digital instrumentation with sufficient dynamic range, pre-event memory and sampling rate to accurately record the vibratory ground motion and enable the processing of data at the plant site within 4 hours of a seismic event. A triaxial time-history accelerograph should be provided at each of the locations specified in RG 1.12, such as at a free-field location, at the containment foundation and two other elevations on structures inside containment, and on other Seismic Category I structure foundations located at elevations different from the containment elevation. Refer to the latest version of RG 1.12 for a complete list of locations. 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 that is consistent with maintaining occupational radiation exposures ALARA for the location. Consistent with the guidance provided within RG 8.8 Positions C.2, for meeting the requirements of 10 CFR Part 20, appropriate station layout and design features should be provided to reduce the potential doses to personnel who must operate, service, or inspect station instrumentation and controls. Instrumentation must satisfy functional requirements, but the exposure of personnel can be reduced if the instruments are designed, selected, specified, and located with consideration for long service life, ease and low frequency of maintenance and calibration. The free-field instrumentation should be located on the ground surface at the location sufficiently distant from the structures to be essentially unaffected by the vibration of the structures. The subsurface structure under the free-field sensor should be similar to that under the nuclear island. In-structure instrumentation located at key locations in Seismic Category I structures provide data for direct comparison with the seismic design parameters.

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 (i.e., the greatest number of instruments possible given the constraints of the system) 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, as well as any additional technical specifications listed here. 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. 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, CP, and OL 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 observed ground motion. 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.

If a free-field instrument is installed at a different location (e.g., elevation or geological profile) than the OBE is defined, the applicant should perform a site response analysis to develop a transfer function between the location at which the OBE is defined and the location of the instrument. This will enable an accurate comparison of the OBE spectrum and the response spectrum from the recorded vibratory ground motion.

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.

3. Comparison with the requirements of 10 CFR 20.1101 (ALARA). Appropriate station layout and design features should be provided to reduce the potential doses to personnel who must operate, service, or inspect station instrumentation and controls.

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 digital time-history accelerographs with sufficient dynamic range, pre-event memory and sampling rate, to accurately record the ground motion at designated locations will provide time history data on the seismic response of the free-field, containment structure, and other Seismic Category I structures located at elevations different from the containment elevation, as well as maintaining occupational radiation exposures ALARA for the location as required by 10 CFR Part 20.

III. REVIEW PROCEDURES

The primary 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 RG 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. The reviewer should verify that the applicant demonstrates that suitable instrumentation is provided to promptly evaluate the seismic response of safety-related or risk significant plant features after an earthquake. 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 might 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.
4. Comparison with RG 8.8. The primary review organization and the organization responsible for the review of radiation protection should verify that the layout and design of the seismic instrumentation are consistent with the guidance provided in RG 8.8 for meeting the requirements of 10 CFR 20.1101(b), as it relates to providing engineering controls based upon sound radiation protection principles to achieve occupational doses that are ALARA. The primary review organization and the organization responsible for the review of radiation protection should verify that the station layout and design features provided reduce the potential doses to personnel who must operate, service, or inspect station instrumentation and controls by checking that instruments specified are designed, selected, and located with consideration for long service life, ease and low frequency of maintenance and calibration.

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 the observed ground motion 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 Part 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."
3. Regulatory Guide 1.12, "Nuclear Power Plant Instrumentation for Earthquakes."
4. Regulatory Guide 1.166, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions."
5. Electric Power Research Institute, "A Criterion for Determining Exceedance of the Operating Basis Earthquake," EPRI NP-5930, Palo Alto, California, July 1988.
6. Regulatory Guide 8.8 "Information Relevant To Ensuring That Occupational Radiation Exposures At Nuclear Power Stations Will Be As Low As Is Reasonably Achievable."

**SRP Section 3.7.4
Description of Changes**

Section 3.7.4 “SEISMIC INSTRUMENTATION”

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in Revision 2, dated March 2007 of this SRP. See ADAMS Accession No. ML070460349. Changes include considerations in areas related to seismic instrumentation based on lessons learned from past 3.7.4 reviews. Each section of the SRP has text that was updated for editorial and clarifying purposes. The technical changes incorporated in Revision 3, dated May 2013:

Secondary reviewers added for the purpose of the review of radiation protection regarding the ALARA review.

II. ACCEPTANCE CRITERIA

1. Clarified the criteria for digital seismic instrumentation and where the instruments should be located.
2. Clarified that a transfer function is needed between elevation of the definition of the operating basis earthquake (OBE) and the location of the seismic instrumentation.
3. 10 CFR 20.1101(b) was added regarding the ALARA review.

III. REVIEW PROCEDURES

1. Clarified that suitable seismic instrumentation promptly evaluates the seismic response of safety-related or risk significant plant features after an earthquake.
2. Clarified the review of ALARA.

VI. REFERENCES

Added Regulatory Guide 8.8.