



DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-1337

(Proposed Revision 1 of Regulatory Guide 1.167 dated March 1997)

RESTART OF A NUCLEAR POWER PLANT SHUT DOWN BY A SEISMIC EVENT

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes the process, inspections and tests that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable to demonstrate that a nuclear power plant is safe for restarting after a shutdown caused by a seismic event. This guide also describes long term evaluations to provide evidence that the power plant will continue to operate safely.

Applicability

This RG applies to applicants and licensees subject to Title 10 of the *Code of Federal Regulations* Part 50 (10 CFR 50), “Domestic Licensing of Production and Utilization Facilities,” (Ref. 1), and 10 CFR Part 52 (10 CFR 52), “Licenses, Certifications, and Approvals for Nuclear Power Plants” (Ref. 2).

Applicable Regulations

- 10 CFR 50.54(ff), “Conditions of Licenses,” for licensees of nuclear power plants that have implemented the earthquake engineering criteria in Appendix S of Part 50, requires demonstration that no functional damage has occurred to features necessary for operation without undue risk to the health and safety of the public, prior to resuming operations following a shutdown required due to provisions in 10 CFR 50 Appendix S.
- 10 CFR 50 Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants,” for plants licensed after January 10, 1997, requires plant shutdown if the Operating Basis Earthquake Ground Motion is exceeded or if significant plant damage occurs. The licensee must demonstrate that no functional damage has occurred for continued operation without undue risk to health and safety of the public.

This RG is being issued in draft form to involve the public in the development of regulatory guidance in this area. It has not received final staff review or approval and does not represent an NRC final staff position. Public comments are being solicited on this draft guide and its associated regulatory analysis. Comments should be accompanied by appropriate supporting data. Comments may be submitted through the Federal rulemaking Web site, <http://www.regulations.gov>, by searching for Docket ID: **NRC-2016-26524**. Alternatively, comments may be submitted to the Rules, Announcements, and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments must be submitted by the date indicated in the *Federal Register* notice.

Electronic copies of this draft regulatory guide, previous versions of this guide, and other recently issued guides are available through the NRC’s public Web site under the Regulatory Guides document collection of the NRC Library at <http://www.nrc.gov/reading-rm/doc-collections/reg-guides/>. The draft regulatory guide is also available through the NRC’s Agencywide Documents Access and Management System (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html>, under Accession No. ML16182A321. The regulatory analysis may be found in ADAMS under Accession No. ML16182A319.

- 10 CFR 100 Appendix A, “Seismic and Geologic Siting Criteria for Nuclear Power Plants,” for either an operating license applicant or holder whose construction permit was issued before January 10, 1997, requires plant shutdown if the Operating Basis Earthquake Ground Motion is exceeded. The licensee must demonstrate that no functional damage has occurred for continued operation without undue risk to health and safety of the public.

Related Guidance

- Regulatory Guide 1.166, “Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Postearthquake Actions” (Ref. 3), provides guidance acceptable to the NRC staff for timely evaluation of recorded instrumentation data after an earthquake and for determining whether plant shutdown is required by 10 CFR Part 50.
- Regulatory Guide 1.12, “Nuclear Power Plant Instrumentation for Earthquakes” (Ref. 4), describes seismic instrumentation acceptable to the NRC staff for satisfying the requirements in 10 CFR 50 Appendix S.

Purpose of Regulatory Guides

The NRC issues RGs to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency’s regulations, to explain techniques that the staff uses in evaluating specific problems or postulated events, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations and compliance with them is not required. Methods and solutions that differ from those set forth in RGs will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

Paperwork Reduction Act

This Draft Regulatory Guide contains information collection requirements that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.). These information collections were approved by the Office of Management and Budget (OMB), approval number 3150-0011.

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.

B. DISCUSSION

Reason for Revision

This revision of the guide (Revision 1) incorporates lessons learned following the shutdown and restart of nuclear power plants due to earthquake ground shaking and post-earthquake evaluations since issuance of Revision 0 in 1997. It addresses short term actions and evaluations to be performed by a licensee as well as longer-term post-shutdown inspections, tests, and evaluations.

Background

The initial version of RG 1.167 (Revision 0) endorsed Electric Power and Research Institute (EPRI) NP-6695 “Guidelines for Nuclear Power Plant Response to an Earthquake” (1989, Ref. 5). In the years following the issuance of EPRI-6695, a significant amount of experience has been gained on the effects of earthquakes on nuclear power plants worldwide and the actions needed for their restart. The International Atomic Energy Agency (IAEA) documented lessons learned from all significant earthquakes affecting nuclear power plants pre-2010 in Safety Reports Series No. 66, “Earthquake Preparedness and Response for Nuclear Power Plants” (2011, Ref. 6). The report draws upon insights from three multiunit nuclear power plants in Japan and one in Armenia that experienced beyond-design-basis earthquakes. In addition to those plants, experience has been gained with the 2011 shutdown of the North Anna nuclear power plant following the Mineral, Virginia earthquake due to ground motion exceeding the safe shutdown earthquake. Based on the lessons learned in establishing the effects of the earthquakes on the plants and the actions undertaken to restart them, a significant update of the EPRI-6695 was prepared and published in 2013 as EPRI report 3002000720, “Guidelines for Nuclear Plant Response to an Earthquake,” (Ref. 7).

The American Nuclear Society/American National Standards Institute (ANS/ANSI) standard ANS/ANSI-2.23-2016 (Ref. 8), “Nuclear Power Plant Response to an Earthquake,” incorporates the significant changes and additions included in EPRI report 3002000720. ANS/ANSI-2.23-2016 provides guidance that implements both observed damage level and earthquake shaking level to determine post-earthquake actions; whereas, EPRI NP-6695 considers only observed damage level to determine post-earthquake actions for an event that exceeds the operating basis earthquake ground motion (OBE). In addition, ANS/ANSI-2.23-2016 builds on EPRI NP-6695 by adding guidance on action levels that clarify what should be done, when it should be done, and by whom. It provides more comprehensive guidance than EPRI NP-6695 for short term actions to be performed by a licensee following an earthquake, and for long term post-earthquake evaluations. To take advantage of the more comprehensive guidance, this revision endorses ANS/ANSI-2.23-2016 rather than the earlier guidance of EPRI NP-6695.

Harmonization with International Standards

The International Atomic Energy Agency (IAEA) has established a series of safety guides and standards constituting a high level of safety for protecting people and the environment. IAEA safety guides present international good practices and increasingly reflects best practices to help users achieve high levels of safety. Pertinent to this regulatory guide, IAEA Safety Reports Series No. 66, “Earthquake Preparedness and Response for Nuclear Power Plants” that addresses pre-earthquake planning, actions to follow after a felt earthquake, actions to take prior to restart, and long term actions. This RG incorporates guidelines on actions of licensees to demonstrate plant readiness for restart similar to those provided in IAEA Safety Report Series No. 66.

Documents Discussed in Staff Regulatory Guidance

This RG endorses, in part, the use of one or more codes or standards developed by external organizations, and other third party guidance documents. These codes, standards and third party guidance documents may contain references to other codes, standards or third party guidance documents (“secondary references”). If a secondary reference has itself been incorporated by reference into NRC regulations as a requirement, then licensees and applicants must comply with that standard as set forth in the regulation. If the secondary reference has been endorsed in a RG as an acceptable approach for meeting an NRC requirement, then the standard constitutes a method acceptable to the NRC staff for meeting that regulatory requirement as described in the specific RG. If the secondary reference has neither been incorporated by reference into NRC regulations nor endorsed in a RG, then the secondary reference is neither a legally-binding requirement nor a “generic” NRC approved acceptable approach for meeting an NRC requirement. However, licensees and applicants may consider and use the information in the secondary reference, if appropriately justified, consistent with current regulatory practice, and consistent with applicable NRC requirements.

C. STAFF REGULATORY GUIDANCE

C. 1 General Guidance

This guide contains information specific to requirements for restarting a nuclear power plant following shutdown by an earthquake due to observed damage or exceeding the operating basis earthquake (OBE). Pre-earthquake planning activities play an important role in evaluating plant response to a seismic event and the related RG 1.166 provides guidance on pre-earthquake planning. In addition, RG 1.166 provides guidance on assessing exceedance of the OBE.

The staff endorses the sections of ANS/ANSI-2.23-2016 that relate to post-shutdown inspection and tests, inspection criteria, documentation, and long-term evaluations. After a plant has been shut down by an earthquake, the guidelines for post-shutdown actions, including inspections and tests of nuclear power plant equipment and structures, and long-term evaluations that are in ANS/ANSI-2.23-2016, with the exceptions in the numbered staff positions specified below, are acceptable to the NRC staff for satisfying the requirements in Paragraph IV(a)(3) of 10 CFR Part 50 Appendix S and Paragraph V(a)(2) of 10 CFR Part 100 Appendix A. The ANS/ANSI guidance includes an action level matrix to direct actions based on the earthquake level and observed damage levels at a nuclear power plant.

Specifically, this RG addresses the following sections in ANS/ANSI-2.23-2016: Sections 6.3.2, 6.4.2, 6.4.3, 7, 8 and 9. Sections 6.3.2, 6.4.2, 6.4.3 provide acceptable guidance for determining if the SSE has been exceeded. Table 7-1 from ANS/ANSI-2.23-2016 provides a matrix acceptable for determining the actions to perform based on earthquake level and damage level. Acceptable post-earthquake actions for high frequency and low frequency exceedance are specified in Section 7.3 of the standard. Section 8.1 through 8.7 provide acceptable guidance on post-shutdown inspections and tests. Guidance on documentation to be submitted to the NRC is provided in Section 8.8. Long-term evaluations acceptable to the NRC are specified in Sections 9.1 through 9.5.

C. 2 Exceptions and Clarifications to Section 7 of ANS/ANSI 2.23-2016

a. Exception to Section 7.3 Recommended post-earthquake action levels

Table 7-1 of ANS/ANSI-2.23-2016 directs the licensee to follow Action Level 1 when the earthquake level exceeds the safe shutdown earthquake (SSE) and the observed damage level is categorized as Damage Level 0 or Damage Level 1. Action Level 1 relies on focused visual inspections and tests but does not require the analysis of any SSCs prior to restart. Additional justification is needed prior to restart to provide reasonable assurance of continued performance and safety for SSCs which are located in areas where visual inspections and tests are not deemed effective (such as inaccessible locations, insulated piping, etc.). Licensees should perform an evaluation of SSCs selected on a sampling basis; this evaluation should be performed using sound engineering principles and in a manner similar to that of evaluations meeting the expectations of NRC Inspection Manual Chapter (IMC) 0326, Sections C.04 and C.07. The intent of this evaluation is to demonstrate that there are no unobserved latent or safety impacts on continued operation from SSCs that were possibly damaged, but not inspected, as a result of the earthquake. Because plant configurations do not rapidly change, licensees should consider developing a list of these SSCs in advance of an event.

b. Documentation

Results and interpretation of analyses performed in accordance with the guidance in C.3.a of this regulatory guide, together with the documentation described in Section 8.8 of ANS/ANSI-2.23-2016, should be submitted to the NRC for review and acceptance. Documentation should include the condition reports methodology, assumptions, assessments, technical specification surveillance requirement number for each surveillance tests, etc., that demonstrated that the operability of all safety-related SSCs was not affected. In addition, the documentation should demonstrate that any non-safety related SSC impacts are corrected, or that the risk is properly managed in accordance with 10 CFR 50.65; that is if the plant is restarted with non-safety related equipment impacts left uncorrected or unevaluated then the increase in risk must be monitored and accounted for in the daily risk assessments. In addition, regarding the selection of SSCs for item C.3.a above, the method or logic for determining which SSCs were selected and how the sample population was narrowed should be documented.

C.3 Exception to Section 9.5 of ANS/ANSI-2.23-2016

Section 9.5 of ANS/ANSI-2.23-2016 provides guidance on development of a seismic evaluation and verification plan. Section 9.5 states that the plan should require that new and replacement safety related SSCs be qualified to both the licensing basis design spectra and the observed spectra unless it can be demonstrated that the SSCs involved do not pose a significant seismic risk. However, compliance with that statement would not be sufficient to meet NRC requirements: all new or replacement equipment must meet current or amended site licensing basis requirements.

C.4 Clarification Regarding Initial and Short-Term Evaluations

If the seismic event resulted in a plant automatic shutdown, the licensee needs to understand the cause, and evaluate the extent of condition (EOC) prior to plant restart. This understanding is needed to ensure: (1) that operability exists for safety related SSCs, and (2) that risk is managed as required by 10 CFR 50.65 for both safety and non-safety related SSCs. To accomplish this, as is done after any automatic reactor shutdown, an assessment of the performance of both safety and non-safety related SSCs is conducted to determine if all SSCs performed as designed, installed, and maintained.

C.5 Clarification Regarding Long-Term Evaluations

Coincident with the long-term evaluations as described in Section 9 of ANS-2.23-2016, the plant should be restored to its current licensing basis.

Correction of, or operation with, degraded or nonconforming conditions related to SSCs is accomplished, as appropriate, through evaluation, restoration, amendment, modification or relief (e.g., Notice of Enforcement Discretion (NOED), emergency technical specification (TS) changes, exigent TS change, emergency amendment request, or if relief is needed from a regulatory requirement it must be granted by the commission). Operation with SSCs deemed operable/functional, but degraded or non-conforming, is permitted if an analysis is performed, documented, and corrective actions completed in a manner that meets the expectations of IMC 0326; otherwise one of the other methods should be adopted for resolution.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees¹ may use this guide and information regarding the NRC's plans for using this regulatory guide. In addition, it describes how the NRC staff complies with 10 CFR 50.109, "Backfitting" and any applicable finality provisions in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

Use by Applicants and Licensees

Applicants and licensees may voluntarily² use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described in this regulatory guide may be deemed acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable for complying with the identified regulations as long as their current licensing basis remains unchanged.

Licensees may use the information in this regulatory guide for actions which do not require NRC review and approval such as changes to a facility design under 10 CFR 50.59, "Changes, Tests, and Experiments." Licensees may use the information in this regulatory guide or applicable parts to resolve regulatory or inspection issues.

Use by NRC Staff

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this regulatory guide. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this regulatory guide, unless the licensee makes a change to its licensing basis. The NRC staff does not expect or plan to request licensees to voluntarily adopt this regulatory guide to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action which would require the use of this regulatory guide. Examples of such unplanned NRC regulatory actions include issuance of an order requiring the use of the regulatory guide, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this regulatory guide, generic communication, or promulgation of a rule requiring the use of this regulatory guide without further backfit consideration.

During regulatory discussions on plant specific operational issues, the staff may discuss with licensees various actions consistent with staff positions in this regulatory guide, as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions would not ordinarily be considered backfitting even if prior versions of this regulatory guide are part of the licensing basis of the facility. However, unless this regulatory guide is part of the licensing basis for a facility, the staff may not represent to the licensee that the licensee's failure to comply with the positions in this regulatory guide constitutes a violation.

If an existing licensee voluntarily seeks a license amendment or change and (1) the NRC staff's consideration of the request involves a regulatory issue directly relevant to this new or revised regulatory guide and (2) the specific subject matter of this regulatory guide is an essential consideration in the staff's

¹ In this section, "licensees" refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52; and the term "applicants," refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52, and applicants for standard design approvals and standard design certifications under 10 CFR Part 52.

² In this section, "voluntary" and "voluntarily" means that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

determination of the acceptability of the licensee's request, then the staff may request that the licensee either follow the guidance in this regulatory guide or provide an equivalent alternative process that demonstrates compliance with the underlying NRC regulatory requirements. This is not considered backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

Additionally, an existing applicant may be required to comply with new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

If a licensee believes that the NRC is either using this regulatory guide or requesting or requiring the licensee to implement the methods or processes in this regulatory guide in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in the NRC Management Directive 8.4, "Management of Facility-Specific Backfitting and Information Collection" (Ref. 9) and NUREG-1409, "Backfitting Guidelines," (Ref. 10).

REFERENCES³

1. *U.S. Code of Federal Regulations* (CFR), “Domestic Licensing of Production and Utilization Facilities,” Part 50, Chapter 1, Title 10, “Energy.”
 2. CFR, Title 10, Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Part 52, Chapter 1, Title 10, “Energy.”
 3. U.S. Nuclear Regulatory Commission (NRC), Regulatory Guide (RG) 1.166, “Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Postearthquake Actions,” Washington, DC.
 4. NRC, Regulatory Guide (RG) 1.12, “Nuclear Power Plant Instrumentation for Earthquakes,” Washington, DC.
 5. Electric Power Research Institute, (EPRI) NP-6695, “Guidelines for Nuclear Power Plant Response to an Earthquake,” Palo Alto, CA, 1989.⁴
 6. International Atomic Energy Agency Safety Reports Series No. 66, “Earthquake Preparedness and Response for Nuclear Power Plants,” Vienna, Austria, 2011.⁵
 7. EPRI report 3002000720, “Guidelines for Nuclear Plant Response to an Earthquake,” Palo Alto, CA. 2013.
 8. American Nuclear Society, “Nuclear Power Plant Response to an Earthquake,” ANSI/ANS-2.23-2016, LaGrange Park, IL.⁶
 8. NRC, “NRC Inspection Manual,” Chapter 0326, “Operability Determinations & Functionality Assessments for Conditions Adverse to Quality or Safety,” Washington DC.
 9. NRC, Management Directive (MD) 8.4, “Management of Facility-Specific Backfitting and Information Collection,” Washington, DC.
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- 3 Publicly available NRC published documents are available electronically through the NRC Library on the NRC’s public Web site at <http://www.nrc.gov/reading-rm/doc-collections/> and through the NRC’s Agencywide Documents Access and Management System (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html>. The documents can also be viewed online or printed for a fee in the NRC’s Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD. For problems with ADAMS, contact the PDR staff at 301-415-4737 or (800) 397-4209; fax (301) 415-3548; or e-mail pdr.resource@nrc.gov.
 - 4 Copies of Electric Power Research Institute (EPRI) standards and reports may be purchased from EPRI, 3420 Hillview Ave., Palo Alto, CA 94304; telephone (800) 313-3774; fax (925) 609-1310.
 - 5 Copies of International Atomic Energy Agency (IAEA) documents may be obtained through their Web site: WWW.IAEA.Org/ or by writing the International Atomic Energy Agency, P.O. Box 100 Wagramer Strasse 5, A-1400 Vienna, Austria.
 - 6 Copies of American Nuclear Society (ANS) standards may be purchased from the ANS Web site (<http://www.new.ans.org/store/>); or by writing to: American Nuclear Society, 555 North Kensington Avenue, La Grange Park, Illinois 60526, U.S.A., Telephone 800-323-3044.

10. NRC, "Backfitting Guidelines," NUREG-1409, Washington, DC, July 1990. (ADAMS No. ML032230247)