U.S. NUCLEAR REGULATORY COMMISSION

DRAFT REGULATORY GUIDE DG-1328

Proposed Revision 4 to Regulatory Guide 1.100

Issue Date: February 2019
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SEISMIC QUALIFICATION OF ELECTRICAL AND ACTIVE MECHANICAL EQUIPMENT AND FUNCTIONAL QUALIFICATION OF ACTIVE MECHANICAL EQUIPMENT FOR NUCLEAR POWER PLANTS

A. INTRODUCTION

Purpose

This regulatory guide (RG) describes methods that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for use in the seismic qualification of electrical and active mechanical equipment and the functional qualification of active mechanical equipment for nuclear power plants (NPPs).

Applicability

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

Applicable Regulations

- 10 CFR Part 50 provides for the licensing of production and utilization facilities.
  - Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 contains general design criteria (GDC) for NPPs. GDC related to seismic qualification of electrical and active mechanical equipment and functional qualification of active mechanical equipment for nuclear power plants include the following:
    - GDC 1, "Quality Standards and Records"
    - GDC 2, "Design Bases for Protection against Natural Phenomena"
    - GDC 14, "Reactor Coolant Pressure Boundary"

        - GDC 15, “Reactor Coolant System Design”
        - GDC 30, “Quality of Reactor Pressure Boundary”
        - GDC 37, “Testing of Emergency Core Cooling System”
        - GDC 40, “Testing of Containment Heat Removal System”
        - GDC 43, “Testing of Containment Atmosphere Cleanup Systems”
        - GDC 46, “Testing of Cooling Water System”
        - GDC 54, “Systems Penetrating Containment”

    - Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” to 10 CFR Part 50 establishes quality assurance requirements for the design, manufacture, construction, and operation of NPP structures, systems, and components (SSCs) that prevent or mitigate the consequences of postulated accidents that could cause undue risk to public health and safety. The pertinent requirements of Appendix B apply to all activities that affect the safety-related functions of those SSCs.

    - Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants,” to 10 CFR Part 50 requires that all NPPs must be designed to ensure that certain SSCs remain functional if the safe-shutdown earthquake (SSE) ground motion occurs. These SSCs are those that are necessary to ensure (1) the integrity of the reactor coolant pressure boundary; (2) the capability to shut down the reactor and maintain it in a safe shutdown condition; or (3) the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures comparable to the guideline exposures of 10 CFR 50.34(a)(1) or 10 CFR 100.11, “Determination of Exclusion Area, Low Population Zone, and Population Center Distance.”

- 10 CFR Part 52 governs the issuance of early site permits, standard design certifications, combined licenses, standard design approvals, and manufacturing licenses for nuclear power facilities.

Related Guidance

- NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition” (SRP) (Ref. 3), provides guidance to the NRC staff for review of license applications for NPPs:

    - SRP Section 3.2.1, “Seismic Classification,” provides guidance to the NRC staff in reviewing the seismic classification of SSCs for NPP applications.

    - SRP Section 3.7.2, “Seismic System Analysis,” provides guidance to the NRC staff on an applicant’s seismic analysis methods (response spectrum analysis method, time history analysis method, or equivalent static load analysis method) for all seismic Category I SSCs.

- SRP Section 3.9.6, “Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints,” provides guidance to the NRC staff in reviewing functional qualification for pumps, valves, and dynamic restraints.

- SRP Section 3.10, “Seismic and Dynamic Qualification of Mechanical and Electrical Equipment,” provides guidance to the NRC staff in reviewing equipment qualification to withstand seismic and dynamic loads.

- SRP Section 19.0, “Probabilistic Risk Assessment and Severe Accident Evaluation for New Reactors,” provides guidance to the NRC staff in reviewing probabilistic risk assessment and severe accidents for new reactor licensing applications.

- RG 1.29, “Seismic Design Classification” (Ref. 4), describes a method that the NRC staff considers acceptable for use in identifying and classifying those features of light-water reactor NPPs that must be designed to withstand the effects of the SSE.

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 RG provides guidance for implementing the mandatory information collections in 10 CFR Parts 50 and 52 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), under control numbers 3150-0011 and 3150-0151. Send comments regarding this information collection to the Information Services Branch, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0011, 3150-0151), Office of Management and Budget, Washington, DC 20503.

Public Protection Notification

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the document requesting or requiring the collection displays a currently valid OMB control number.

B. DISCUSSION

Reason for Revision

This revision to RG 1.100 (Revision 4) addresses changes in standards endorsed by Revision 3 of RG 1.100 (Ref. 5) since its issuance in September 2009. The following are the revised standards endorsed by this RG:

- Institute of Electrical and Electronics Engineers (IEEE) Standard (Std) 344-2013, "IEEE Standard for Seismic Qualification of Equipment for Nuclear Power Generating Stations" (Ref. 6).

- IEEE Std C37.98-2013, "IEEE Standard for Seismic Qualification Testing of Protective Relays and Auxiliaries for Nuclear Facilities" (Ref. 7).

- American Society of Mechanical Engineers (ASME) Qualification of Mechanical Equipment (QME)-1-2017, "Qualification of Active Mechanical Equipment Used in Nuclear Facilities" (Ref. 8).

Background

1. Seismic Qualification of Electrical and Active Mechanical Equipment

The major changes from IEEE Std 344-2004 (Ref. 9) to IEEE Std 344-2013 are updates based on experience gained since 2004 that address seismic qualification programs with higher frequency content based on the high-frequency ground motion. Based on IEEE Std 344-2004, previous qualification programs traditionally used a cutoff frequency of 33 hertz (Hz). In current practice, cutoff frequency is generally between 33 Hz and 50 Hz for a building structure subjected to an earthquake, with the exception of the hard rock regions in the Central and Eastern U.S., which may experience energy content up to 100 Hz. IEEE has included a reference to RG 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis" (Ref. 10), to Clause 7 of IEEE Std 344-2013 to provide guidance for addressing the missing mass and combination of modal responses. The update to Clause 7 also discusses rigid and flexible equipment and clarifies the differences between static, static coefficient, and dynamic (response spectrum and time history) analysis methods. In addition, IEEE expanded IEEE Std 344-2013, Annex C, to provide guidance in determining equipment fragility levels, and rearranged the text in the Annex in a logical order. Clause 10 and relevant parts of Clause 11 of IEEE Std 344-2013 describe the use of experience data as a method for the seismic qualification of nuclear plant equipment. Experience data include earthquake experience data and test experience data. Nonmandatory Appendix QR-A, "Seismic Qualification of Active Mechanical Equipment," to ASME QME-1-2017 also includes the use of experience data as a method for the seismic qualification of active mechanical equipment.

The use of earthquake experience data for the seismic qualification of electrical and mechanical equipment has its origin in the NRC research program associated with Unresolved Safety Issue (USI) A-46, "Seismic Qualification of Mechanical and Electrical Equipment in Operating Nuclear Power Plants." In 1980, the NRC staff raised a safety concern that licensees had not conducted the seismic qualification of electrical and mechanical equipment in some plants with construction permit applications docketed before about 1972 in a manner that would comply with the licensing criteria that the staff had adopted by 1980 (i.e., RG 1.100, Revision 1, issued August 1977 (Ref. 11), which endorses IEEE Std 344-1975 (Ref. 12)). Therefore, equipment in the older NPPs might not have been adequately qualified to ensure its structural integrity or proper functionality in the event of an SSE ground motion. As a result, the NRC established the USI A-46 program in December 1980 and, in February 1987, issued

Generic Letter (GL) 87-02, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46" (Ref. 13), to address this safety concern. The NRC staff categorized approximately 70 NPP units in the United States as "USI A-46 plants."

In 1982, the Seismic Qualification Utility Group (SQUG) developed a database using earthquake experience and test experience to address USI A-46. Because of the scarcity of data on equipment in U.S. NPPs subjected to strong earthquake motion, the SQUG and its contractors performed a pilot study to determine the feasibility of using actual earthquake experience data from nonnuclear plants located worldwide (e.g., fossil-fueled power plants, substations, and petrochemical plants) and existing test experience data from U.S. NPPs to evaluate the performance of electrical and mechanical equipment in those facilities to infer the susceptibility of similar NPP equipment to seismic loads. The SQUG concluded, and the NRC agreed, that the use of experience data was feasible to verify the seismic adequacy of equipment in the older USI A-46 plants. The staff does not accept the use of SQUG guidelines for the seismic qualification of equipment in non-USI A-46 plants licensed under 10 CFR Part 50 or in plants licensed under 10 CFR Part 52.

Large uncertainties exist in the seismic qualification of equipment, as a class, on the basis of earthquake experience data, because (1) it is difficult to compile a credible earthquake experience database (e.g., estimation of ground and floor earthquake excitations used in the earthquake experience database), (2) the inclusion and exclusion rules (termed "prohibited features" in IEEE Std 344-2013) of equipment in the database might be incomplete, (3) the similarity between equipment in fossil or petrochemical plants in the database and the equipment in NPPs is difficult to establish, and (4) the earthquake experience database does not have sufficient credible information to provide assurance that certain active electrical equipment will function properly during earthquakes.

In using the test experience data for the seismic qualification of electrical equipment, quantifying the damage potential of equipment under testing should capture the combination of input motion and the equipment item that is exhibiting a particular malfunction. Because the resonant frequency for items of equipment of the same class might differ significantly, multiple malfunction mechanisms for components and subcomponents should be considered in comparing the test response spectra (TRS) and the required response spectra (RRS).

As a result of the more prevalent use of digital rather than analog instrumentation and control components, the technology and design of certain electrical components (such as certain types of relays and microprocessor-based components) have undergone significant changes since the NRC issued RG 1.100, Revision 2 (Ref. 14), in June 1988. Some solid-state relays and microprocessor-based components might be sensitive to earthquake excitations. Therefore, the use of test experience data from the older electrical components may not be appropriate for the seismic qualification of the new generation of such electrical components. Furthermore, a number of original manufacturers of electrical or active mechanical equipment are no longer in business, and the use of the test experience of old equipment made by these manufacturers for the seismic qualification of modern equipment designs made by different manufacturers may not be appropriate.

Recent studies related to applications for early site permits at certain hard rock-based sites along the east coast of the United States indicate that the site-specific spectra might exceed the certified design spectra of those proposed new plant sites in the high-frequency range (20 hertz and above). This exceedance cannot always be eliminated even with incoherency added to the soil-structure interaction analyses. As a result of the high-frequency ground motion, the seismic input to SSCs might also contain high-frequency excitations. For operating boiling-water reactor (BWR) plants, the seismic qualifications of some safety-related electrical and active mechanical equipment were performed using IEEE Std 344-type tests with intentional high-frequency content to account for concurrent BWR hydrodynamic loads.

However, most existing seismic qualification tests used input frequencies up to only 33 hertz, although the TRS might have shown a zero-period acceleration (nonamplified frequency range) up to 100 hertz. Ball joints and kinematics linkages of the shake tables likely generated these high frequencies inadvertently, without both the proper frequency content and sufficient energy being compatible with the amplified region of the RRS at high frequencies. Therefore, the use of such past test experience data for the seismic qualification of high-frequency-sensitive equipment or components in such a plant is inappropriate unless the frequency content of the power spectral density (PSD) of the test waveform was evaluated in accordance with Annex B, “Frequency Content and Stationarity,” to IEEE Std 344-2013. When licensees plan new seismic qualification tests for equipment in such plants, the formulation of the test input waveforms needs to consider this high-frequency excitation.

2. Functional Qualification of Active Mechanical Equipment

ASME QME-1-2017 describes requirements and guidelines for qualifying active mechanical equipment used in nuclear facilities. The foreword to the standard indicates that it may be applied to future NPPs or existing operating NPP component replacements, modifications, or additions, as determined by regulators and the licensees. ASME QME-1-2017 provides functional qualification guidance for pumps, valves, dynamic restraints, and nonmetallic parts for those components. The following sections and appendices of ASME QME-1-2017 provide the functional qualification guidance for this active mechanical equipment:

- Section QR, “General Requirements,” and its Mandatory Appendix QR-I, “Qualifications and Duties of Registered Professional Engineers for Certification Activities;” Nonmandatory Appendix QR-A, “Seismic Qualification of Active Mechanical Equipment;” and Nonmandatory Appendix QR-B, “Guide for Qualification of Nonmetallic Parts”

- Section QDR, “Qualification of Dynamic Restraints,” and its Mandatory Appendix QDR-I, “Qualification Specification for Dynamic Restraints;” Nonmandatory Appendix QDR-A, “Restraint Similarity;” and Nonmandatory Appendix QDR-B, “Typical Values of Restraint Functional Parameters”

- Section QP, “Qualification of Active Pump Assemblies,” and its Mandatory Appendix QP-I, “Qualification Specification for Active Pump Assemblies;” Nonmandatory Appendix QP-D, “Pump Similarity Checklist;” and Nonmandatory Appendix QP-E, “Guidelines for Shaft-Seal System Material and Design Consideration”

- Section QV, “Functional Qualification Requirements for Active Valve Assemblies for Nuclear Facilities,” and its Mandatory Appendix QV-I, “Qualification Specification for Active Valves,” and Nonmandatory Appendix QV-B, “Static Side Load Testing for Power-Actuated and Relief Valve Assemblies”

- Section QVG, “Guide to Section QV: Determination of Valve Assembly Performance Characteristics”

The major change from ASME QME-1-2007 to ASME QME-1-2017, in terms of the functional qualification of mechanical equipment, is the incorporation of lessons learned from the qualification of active mechanical equipment since the publication of ASME QME-1-2007.

In the 1980s and 1990s, operating experience at NPPs revealed a number of weaknesses in the initial design, qualification, testing, and performance of motor-operated valves (MOVs). For example, some engineering analyses used in the original sizing and setting of MOVs inadequately predicted the thrust and torque for opening and closing valves under design-basis conditions. Similarly, some testing methods used to measure valve stroke times under zero differential pressure and flow conditions did not detect deficiencies that could prevent MOVs from performing their safety functions under design-basis conditions. Both regulatory and industry research programs later confirmed weaknesses in the performance of MOVs.

Responding to weaknesses found in the initial design, qualification, testing, and performance of MOVs, in June 1989, the NRC issued GL 89-10, “Safety-Related Motor-Operated Valve Testing and Surveillance” (Ref. 15), which directed licensees to (1) ensure the capability of MOVs in safety-related systems to perform their intended functions by reviewing MOV design bases, (2) verify MOV switch settings initially and periodically, (3) test MOVs under design-basis conditions when practicable, (4) improve evaluations of MOV failures and necessary corrective action, and (5) trend MOV problems. The NRC staff evaluated NPP MOV programs by conducting onsite inspections of the design-basis capability of safety-related MOVs.

In support of the regulatory activities to ensure an MOV design-basis capability, the NRC conducted a research program to test several MOVs under normal flow and blowdown conditions. The NRC summarized the results of this MOV research program in Information Notice (IN) 90-40, “Results of NRC-Sponsored Testing of Motor-Operated Valves,” dated June 5, 1990 (Ref. 16). The tests revealed the following:

- More thrust was needed to operate gate valves than that predicted by standard industry methods.
- Some valves were internally damaged under blowdown conditions, and the valves’ operability was unpredictable.
- Static and low-flow testing might not predict valve performance under design-basis flow conditions.
- During valve opening strokes, the highest thrust might be needed at unseating or in the flow stream.
- Partial valve stroking did not reveal the total thrust needed to operate the valve.
- Torque, thrust, and motor-operating parameters were needed to fully characterize MOV performance.
- Reliable use of MOV diagnostic data requires accurate equipment and trained personnel.

To assist NPP licensees in responding to GL 89-10, the Electric Power Research Institute (EPRI) developed the MOV performance prediction methodology to determine the minimum dynamic thrust and torque requirements for gate, globe, and butterfly valves based on first principles of MOV design and operation. EPRI Topical Report (TR)-103237, “EPRI MOV Performance Prediction Program,” Revision 2, issued April 1997 (Ref. 17), describes the methodology. In March 1996, the NRC staff issued “Safety Evaluation on EPRI MOV Performance Prediction Methodology” (Ref. 18), finding the EPRI program to provide an acceptable methodology with certain conditions and limitations. The NRC staff also issued supplements to the safety evaluation in February 1997 (Ref. 19), April 2001 (Ref. 20), September 2002 (Ref. 21), and February 2009 (Ref. 22) to address updates to the EPRI MOV program. The NRC staff alerted licensees to lessons learned from the EPRI program in NRC Information Notice 96-48, “Motor-Operated Valve Performance Issues,” dated August 21, 1996 (Ref. 23).

In the late 1990s, the NRC conducted research to study the performance of alternating current (ac)-powered MOV motor actuators manufactured by Limitorque Corporation (Limitorque) under various temperature and voltage conditions. The NRC documented its study of ac-powered MOV output in NUREG/CR-6478, "Motor-Operated Valve (MOV) Actuator Motor and Gearbox Testing," issued July 1997 (Ref. 24). In response to the new information on ac-powered MOV performance, Limitorque updated its guidance in Technical Update 98-01, "Actuator Output Torque Calculation," issued May 1998, and in Supplement 1 to Technical Update 98-01, issued July 1998 (Ref. 25), for the prediction of ac-powered MOV motor-actuator output. The NRC alerted licensees to the new information on ac-powered MOV output in NRC Information Notice 96-48, "Motor-Operated Valve Performance Issues," Supplement 1, dated July 24, 1998 (Ref. 26).

Following its review of ac-powered MOV performance, the NRC conducted research to study the performance of Limitorque direct current (dc)-powered MOV motor actuators under various temperature and voltage conditions. NUREG/CR-6620, "Testing of dc-Powered Actuators for Motor-Operated Valves," issued May 1999 (Ref. 27), documents this research. In June 2000, the BWR Owners Group forwarded to the NRC its TR-NEDC-32958, "BWR Owners' Group DC Motor Performance Methodology—Predicting Capability and Stroke Time in DC Motor-Operated Valves," issued March 2000 (Ref. 28). In August 2001, the NRC issued Regulatory Issue Summary (RIS) 2001-15, "Performance of dc-Powered Motor-Operated Valve Actuators" (Ref. 29), to inform licensees of the availability of improved industry guidance for predicting dc-powered MOV actuator performance.

For power-operated valves other than MOVs, many lessons learned from MOV testing and performance are applicable to valves operated by other types of actuators. The NRC issued RIS 2000-03, "Resolution of Generic Safety Issue 158: Performance of Safety-Related Power-Operated Valves under Design-Basis Conditions" (Ref. 30), to provide guidance for programs to verify the design-basis capability of power-operated valves at NPPs. In RIS 2000-03, the NRC staff indicated that it would continue to monitor licensee activities to ensure that power-operated valves are capable of performing their safety-related functions under design-basis conditions. In an attachment to RIS 2000-03, the NRC staff provides a list of attributes to support the development of a successful power-operated valve program at NPPs.

Through an extensive effort spanning many years, the ASME QME Standards Committee revised Section QV in ASME QME-1 to incorporate the lessons learned from the MOV operating experience and research programs for the functional qualification of all power-operated valves. The initial ASME QME Standards Committee efforts resulted in the publication of ASME QME-1-2007 with additional improvements provided in ASME QME-1-2012 (Ref. 31) and ASME QME-1-2017. Section C of this RG presents the staff's regulatory positions on ASME QME-1-2017.

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 striving to achieve high levels of safety. Pertinent to this regulatory guide, Sections 4 and 6 of IAEA Safety Guide NS-G-1.6, "Seismic Design and Qualification for Nuclear Power Plants," issued October 2003 (Ref. 32), includes guidance for establishing various recommended approaches to qualify structures and equipment so that they meet the safety requirements established in IAEA Specific Safety Requirement 2/1, "Safety of Nuclear Power Plants: Design," issued March 2016 (Ref. 33). This RG incorporates similar design and performance guidelines and is consistent with the safety principles provided in these publications.

Documents Discussed in Staff Regulatory Guidance

This regulatory guide 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 was endorsed in a regulatory guide 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 regulatory guide. If the secondary reference has neither been incorporated by reference into NRC regulations nor endorsed in a regulatory guide, 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

This section provides detailed descriptions of the methods, approaches, or data that the staff considers acceptable for meeting the requirements of the Applicable Regulations stated in Section A of this guide. The following standards are endorsed as noted below:

- IEEE Std 344-2013 is endorsed with exceptions and clarifications;
- ASME QME-1-2017 is endorsed with exceptions and clarifications; and
- IEEE Std C37.98-2013 is endorsed without exception or clarification.

1. Seismic Qualification of Electrical and Active Mechanical Equipment

1.1 Regulatory Positions on IEEE Std 344-2013

1.1.1 General NRC Staff Positions

IEEE Std 344-2013 is, in general, acceptable to the NRC staff for the seismic qualification of (1) electrical equipment in new NPPs and (2) new or replacement electrical equipment in operating NPPs, subject to the following provisions:

a. Rigorous seismic qualification by analysis, testing, or combined analysis and testing, as described in Clauses 7, 8, and 9 of IEEE Std 344-2013, are acceptable methods for the seismic qualification of electrical equipment.

b. The NRC staff will review the use of experience data (earthquake or test experience data) for the seismic qualification of electrical equipment. The licensee or applicant may submit the information, perhaps as a technical report (TR), to the NRC for approval. The staff's review will include areas such as (1) the credibility and completeness of the compilation of the experience database, (2) the inclusion and exclusion rules (termed "prohibited features" in IEEE Std 344-2013) for electrical equipment in the experience database, (3) the justification used to demonstrate the similarity among the member items in a reference equipment class, (4) the justification used to demonstrate the similarity between electrical equipment in the experience database and equipment in the NPP for seismic qualification purposes, and (5) the justification used to demonstrate the functionality of candidate equipment and the member items in a reference equipment class during and after an earthquake.

c. The NRC staff concurs with the limitations specified in IEEE Std 344-2013, Section 10.4.2, for the use of earthquake or test experience data for the seismic qualification of certain active electrical components that might inadvertently change state or chatter during an earthquake and thus might not consistently perform their intended safety functions during or after an earthquake (e.g., certain types of relays, contactors, circuit breakers, switches, sensors, microprocessor-based components, and potentiometers). A seismic test might be needed to confirm that a component is not sensitive to high-frequency ground motion, if applicable.

d. If the licensee or applicant proposes to use test experience data for seismic qualification in accordance with IEEE Std 344-2013, Clause 10.3, it should submit, for staff review and approval, the details of the test experience database, including applicable implementation procedures, to ensure the structural integrity and functionality of the in-scope electrical equipment.

Test experience with older electrical components is generally not applicable for the qualification of the new generation of digital instrumentation and control electrical components due to significant differences in component design.

Supporting documentation for equipment identified in the database should confirm that such equipment will remain functional during and after the equivalent effect of five postulated occurrences of an operating-basis earthquake (OBE) and one SSE (or the alternative described in Regulatory Position C.1.1.1.h), in combination with other relevant static and dynamic loads, consistent with the design basis for the facility.

e. The NRC staff does not find it acceptable to simply restrict the frequency range of testing up to 33 hertz. The tested frequency range should be consistent with the RRS of the specific plant equipment. Different sections of this RG and IEEE Std 344-2013 refer to one-third-octave spacing for use with low-frequency excitation. For high-frequency sensitive equipment, an interval of one-sixth-octave spacing should be used, extending up to the frequency of interest shown in the RRS.

f. For certain hard rock-based plants, the site-specific spectra might exceed the certified design spectra in the high-frequency range. As a result of the high-frequency ground motion, the seismic input to SSCs might also contain high-frequency excitations. Most existing seismic qualification tests used input frequencies up to only 33 hertz. The use of these prior test results should be justified by demonstrating that the frequency content of the PSD of the test waveform is sufficient in accordance with IEEE Std 344-2013, Annex B.

g. If licensees or applicants plan new seismic qualification tests for equipment in plants with high-frequency ground motion, the tests should demonstrate the adequacy of the frequency content and the stationarity of the frequency content of the synthesized input waveforms. The frequency content of the Fourier transform of the test waveform or the frequency content of the PSD of the test waveform must be compatible with the amplified portion of the RRS. IEEE Std 344-2013, Annex B, provides acceptable guidelines on frequency content and stationarity.

h. For NPPs that do require an evaluation of an OBE, electrical equipment that has been qualified by testing should be qualified with five events at one-half of the SSE followed by one full SSE event. Alternatively, the equipment may be qualified with a number of fractional peak cycles equivalent to the maximum peak cycles for five one-half SSE events, in accordance with IEEE Std 344-2013, Annex D, when such events are followed by one full SSE event. This is discussed in SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," dated April 2, 1993 (Ref. 34). For other reactors, the staff will review the seismic qualification based on the OBE level in accordance with the design basis.

i. The damping values used in the analysis should be in accordance with the damping values for mechanical and electrical components listed in RG 1.61, "Damping Values for Seismic Design of Nuclear Power Plants" (Ref. 35), or as approved in the plant's design basis.

1.1.2 Specific NRC Staff Positions

The NRC staff has the following specific positions on IEEE Std 344-2013, including exceptions and clarifications:

a. Clause 10.2.3.1 and Clause 10.3.3.1 (Earthquake and Test Experience Data—Attributes of Equipment Class)

   The NRC staff will review the attributes of the equipment for establishing the inclusion rules that constitute the reference equipment class for earthquake or test experience, as described in Clause 10.2.3.1 or Clause 10.3.3.1, respectively, to determine the acceptability of similarity arguments to define a reference equipment class.

   The licensee or applicant should address fatigue failure at low-cycle loads. Earthquake experience data or test data are needed to demonstrate that all electrical equipment in the reference equipment class, including the enclosed or attached devices or subassemblies, performed successfully (structural integrity and specified functionality) under the equivalent of five OBE and one SSE loadings or the alternative described in Regulatory Position C.1.1.1.h for plants that are not required to evaluate an OBE.

b. Clause 10.2.3.3 (Earthquake Experience Data—Reference Equipment Class Functionality)

   Licensees or applicants should submit detailed information on the justification used to demonstrate the reference equipment class functionality during and after an earthquake.

c. Clause 10.2.4 (Earthquake Experience Data—Qualification of Candidate Equipment)

   Licensees or applicants should ensure that in-structure response spectra used as the RRS for the qualification of candidate equipment are in accordance with the design basis. They should justify the use of an RRS that is less conservative than that described in the design basis.

d. Clause 10.3.2 (Test Experience Data—Test Experience Spectra)

   (1) Use of the frequency-by-frequency mean of the successful TRS may be inadequate to define test experience spectra (TES). Therefore, the NRC takes exception to the existing second sentence in the first paragraph of Clause 10.3.2. Instead, the NRC finds the following statement acceptable:

      The TES shall be the frequency-by-frequency mean of the response spectra from successful tests without malfunction. When using test experience data, both the mean and the standard deviation of the data leading to the TES curve should be provided for review and approval.

   (2) The second paragraph of Clause 10.3.2 is inappropriate; instead, the NRC staff's position is stated in Regulatory Position C.1.1.1.h.

e. Clause 10.3.3 (Test Experience Data—Characterization of Reference Equipment Class)

This clause specifies that the significant natural frequencies of the reference equipment class should lie within approximately a one-third octave spacing. That will not provide an adequate range of significant natural frequencies in the high-frequency range of the reference equipment in a class. A one-sixth-octave spacing should be used instead of a one-third-octave spacing.

f. Clause 10.3.3.2 (Test Experience Data—Number of Independent Items for Reference Equipment Class)

Licensees or applicants should provide justification to show the adequacy of using a minimum of five independent items to define a reference equipment class for test experience.

g. Clause 10.4.2 (Special Considerations—Limitations)

The list of limitations for the use of earthquake-based or test experience-based methods for the seismic qualification of equipment, as described in Clause 10.4.2, might be incomplete. The list should be expanded to include additional limitations based on new findings from the testing of new equipment or on new studies.

1.2 Regulatory Positions on ASME QME-1-2017

1.2.1 General NRC Staff Positions on Seismic Qualification of Active Mechanical Equipment

ASME QME-1-2017 is, in general, acceptable to the NRC staff for the seismic qualification of (1) electrical equipment in new NPPs and (2) new or replacement electrical equipment in operating NPPs, subject to the provisions found below.

In the discussion of the seismic qualification of some active mechanical equipment, ASME QME-1-2017 references IEEE Std 344-1987 (Ref. 36) or ASME QME-1-2017, Nonmandatory Appendix QR-A. Such references appear in several sections of ASME QME-1-2017, such as Section QP-7500 for pumps and Sections QV-7450, QV-7650, and QV-7750 for valves. The NRC finds these acceptable to the extent that their application is consistent with the NRC staff's positions delineated in this RG, as described below.

In general, the NRC staff finds ASME QME-1-2017, Nonmandatory Appendix QR-A, acceptable for the seismic qualification of (1) active mechanical equipment in new NPPs and (2) new or replacement active mechanical equipment in operating NPPs. The NRC staff acknowledges that the section on test experience-based qualification (QR-A7500) in ASME QME-1-2017 is "to be added in a later edition." Positions specific to test experience-based qualification are listed below. The NRC staff has the following positions on Nonmandatory Appendix QR-A to ASME QME-1-2017, including exceptions and clarifications:

a. The staff notes that several appendices to ASME QME-1-2017 are designated as either nonmandatory or mandatory (e.g., Mandatory Appendix QR-I; Nonmandatory Appendices QR-A, QR-B, and QR-C; Mandatory Appendix QDR-I; Nonmandatory Appendices QDR-A and QDR-B; Mandatory Appendix QP-I; Nonmandatory Appendices QP-D and QP-E; Mandatory Appendix QV-I; and Nonmandatory QV-B). The staff position is that, if a licensee or applicant commits to the use of nonmandatory appendices in ASME QME-1-2017 for its qualification of active mechanical equipment in NPPs, the criteria and procedures delineated in those nonmandatory appendices become part of the basis for its qualification program unless it requests and justifies specific deviations.

b. Seismic qualification by analysis, testing, or similarity, as described in Sections QR-A7100, QR-A7200, and QR-A7300 of ASME QME-1-2017, respectively, is an acceptable method for the seismic qualification of active mechanical equipment.

c. ASME Class 1, 2, and 3 active mechanical equipment are subject to, and must meet, the requirements in the Section III, "Rules for Construction of Nuclear Power Plant Components," of the ASME Boiler and Pressure Vessel Code (BPV Code) (Ref. 37). The NRC staff considers this position to apply to ASME QME-1-2017 in (1) Section QR-6000, "Qualification Specification," as item (j), (2) Section QR-A7440, "Qualification of Candidate Equipment," as item (g), and (3) Section QR-A8330, "Earthquake Experience-Based Qualification Documentation," as item (f).

d. The NRC staff will review the use of earthquake experience data for the seismic qualification of active mechanical equipment, as described in ASME QME-1-2017, Section QR-A7400. Licensees or applicants may submit the information, perhaps as a TR, to the NRC for approval. The staff's review will include areas such as (1) the credibility and completeness of the compilation of the experience database, (2) the inclusion and exclusion rules for active mechanical equipment in the experience database, (3) the justification used to demonstrate the similarity among the member items in a reference equipment class, (4) the justification used to demonstrate the similarity between active mechanical equipment in the experience database and equipment in the NPP for seismic qualification purposes, and (5) the justification used to demonstrate the functionality of candidate equipment and the member items in a reference equipment class during and after an earthquake.

e. If the licensee or applicant proposes to use test experience data for seismic qualification, it should submit the details of the test experience database, including applicable implementation procedures, to ensure the structural integrity and functionality of the in-scope mechanical equipment. Supporting documentation for equipment identified in the database should confirm that such equipment will remain functional during and after the equivalent effect of five postulated occurrences of an OBE and one SSE (or the alternative described in Regulatory Position C.1.2.1.i), in combination with other relevant static and dynamic loads, consistent with the design basis.

f. The NRC staff does not find it acceptable to restrict the frequency range of testing up to 33 hertz. As identified in IEEE Std 344-2013, the frequency range should be consistent with the RRS of specific plant equipment. Different sections of this RG, ASME QME-1-2017, and IEEE Std 344-2013 refer to one-third-octave spacing for use with low-frequency excitation. For high-frequency sensitive equipment, the licensee or applicant should use an interval of one-sixth-octave spacing, extending up to the cutoff frequency shown in the RRS.

g. For certain hard rock-based plants, the site-specific spectra might exceed the certified design spectra for active mechanical equipment in the high-frequency range. As a result of the high-frequency ground motion, the seismic input to SSCs might also contain high-frequency excitations. Most existing seismic qualification tests used input frequencies up to only 33 hertz. The licensee or applicant should justify its use of these prior test results by demonstrating that the frequency content of the PSD of the test waveform is sufficient, in accordance with IEEE Std 344-2013, Annex B.

h. If licensees or applicants plan new seismic qualification tests for active mechanical equipment in plants with high-frequency ground motion, the tests should demonstrate the adequacy of the frequency content and the stationarity of the frequency content of the synthesized input waveforms. The frequency content of the Fourier transform of the test waveform or the frequency content of the PSD of the test waveform should be compatible with the amplified portion of the RRS. IEEE Std 344-2013, Annex B, provides guidelines on frequency content and stationarity.

i. For NPPs that do not require an evaluation of an OBE, active mechanical equipment that has been qualified by testing should be qualified with five one-half SSE events followed by one full SSE event. Alternatively, the equipment may be qualified with a number of fractional peak cycles equivalent to the maximum peak cycles for five one-half SSE events, in accordance with IEEE Std 344-2013, Annex D, when such events are followed by one full SSE event. This is discussed in SECY-93-087. For other reactors, the staff will review the seismic qualification based on the OBE level in accordance with the design basis.

1.2.2 Specific NRC Staff Positions

The NRC staff has the following specific positions on ASME QME-1-2017, Nonmandatory Appendix QR-A, including exceptions and clarifications:

a. Section QR-A6200 (Seismic Qualification Requirements—Damping)

The damping values used in analysis should be in accordance with the damping values for mechanical and electrical components listed in Table 6 of RG 1.61 or as approved in the plant design basis.

b. Section QR-A6300 (Seismic Qualification Requirements—Required Response Spectrum)

Section QR-A6300 states, "For in-line active mechanical equipment qualified in accordance with QR-A7400 [Earthquake Experience-Based Qualification], the RRS is typically the building filtered response spectrum at the distribution system support attachments to the building." The use of the building-filtered response spectrum at the distribution system support attachments to the building as the RRS for the in-line equipment might be inadequate. The RRS for in-line active mechanical equipment should account for the potential motion amplification of the distribution system.

c. Section QR-A7331 (Qualification by Similarity—Excitation)

Section QR-A7331 states that "a conservative composite excitation may be generated by extrapolations or interpolations of data whose parameters are not identical but are justifiable. Likewise, excitation whose spectral content [is] significantly different may be used to generate lower level composite estimates, provided that an account is taken of possible multiaxis response, cross-axis coupling, or both." The licensee or applicant should justify these statements.

d. Section QR-A7421 (Earthquake Experience-Based Qualification—Attributes of Equipment Class)

The NRC staff will review the attributes of the equipment for establishing the inclusion rules that constitute the reference equipment class for earthquake experience, as described in Section QR-A7421, to determine the acceptability of similarity arguments to define a reference equipment class.

Section QR-A7421 states the following: "Prohibited features should include any attributes that would contribute to fatigue failure from low cycle loads. The rules of this Section apply to active mechanical equipment that may undergo five OBEs or aftershocks and one SSE, resulting in 60 full-range stress cycles during facility life. If a component contains items which could experience a fatigue failure from low cycle loads (fewer than 60 full-range stress cycles), it shall be evaluated in accordance with QR-A6800."

The staff's position on the preceding quote is that plants that do not require an evaluation of an OBE may use the alternative described in Regulatory Position C.1.2.1.i.

e. Section QR-A7423 (Earthquake Experience-Based Qualification—Functionality During Earthquake)

Licensees or applicants should submit detailed information about the justification used to demonstrate the functionality of the reference equipment class during and after an earthquake.

f. Section QR-A7431 (Earthquake Experience-Based Qualification—Inherently Rugged Active Mechanical Equipment)

To justify the active mechanical equipment class as an "inherently rugged active mechanical equipment" class, the licensee or applicant should provide information on the operational or shipping loads, as compared to the expected seismic loads that the equipment could be subjected to, and the explicit design standards applied to this equipment class. Licensees or applicants should also provide detailed information on the simplified and reduced rules, including the technical justification and data that were used to characterize the inherently rugged active mechanical equipment class and the procedure for defining the seismic capacity for this equipment class (i.e., the earthquake experience spectrum).

g. Section QR-A7432 (Earthquake Experience-Based Qualification—Limitations)

The list of limitations for the use of an earthquake experience-based method of seismic qualification of equipment, as described in Section QR-A7432, might be incomplete. The NRC staff will consider additional limitations in its reviews based on new findings from the testing of new equipment or on new studies.

h. Section QR-A7440 (Earthquake Experience-Based Qualification—Qualification of Candidate Equipment)

In-structure response spectra used as the RRS for the qualification of candidate equipment should be in accordance with the design basis. The licensee or applicant should justify its use of an RRS that is less conservative than that described in the design basis.

i. ASME QME-1-2017, Nonmandatory Appendix QV-B, and QME Case QME-007, "Alternative Methods for Seismic Qualification of Power Actuated and Relief Valve Assemblies," specify provisions for seismic qualification of Section QV Category A and B power-actuated valve assemblies and Section QV Category B relief valve assemblies. The NRC staff considers the provisions in Nonmandatory Appendix QV-B and QME Case QME-007 to be acceptable when such provisions are implemented consistent with this RG.

1.3 Regulatory Positions on IEEE Std C37.98-2013

The NRC staff finds IEEE Std C37.98-2013 acceptable for the seismic qualification testing of protective relays and auxiliaries based on the following features of the standard. Fragility testing is used to determine the ultimate capability of protective relays and auxiliaries to perform their intended function, whereas proof testing is used to qualify protective relays and auxiliaries for a particular requirement. Generic testing of protective relays and auxiliaries may be considered a special case of proof testing to show qualification for a wide variety of applications during one test program. Section 6 provides test methods and acceptance criteria for fragility testing, proof testing, and generic testing. Annex B provides guidance to develop seismic test levels to conduct fragility testing, and Annex C provides guidance on the measurement of contact chatter that may be recorded during the seismic testing of relays. The protective relays and auxiliaries important to safety should be seismically qualified and application-specific criteria and requirements should be considered (i.e., the floor elevation, mounting, and location of the relay at the nuclear facility/station could change the seismic qualification requirements because the specific application could have further restrictions on the acceptable level of relay chatter for ensuring the reliability of digital control/protective systems).

2. Functional Qualification of Active Mechanical Equipment

2.1 Regulatory Positions on ASME QME-1-2017

2.1.1 General NRC Staff Positions

In general, the NRC staff finds ASME QME-1-2017 acceptable for the functional qualification of (1) active mechanical equipment in new NPPs and (2) new or replacement active mechanical equipment in operating NPPs, subject to the following provisions:

a. Appendices

The staff notes that several appendices of ASME QME-1-2017 are designated as either nonmandatory or mandatory (e.g., Mandatory Appendix QR-I; Nonmandatory Appendices QR-A, QR-B, and QR-C; Mandatory Appendix QDR-I; Nonmandatory Appendices QDR-A and QDR-B; Mandatory Appendix QP-I; Nonmandatory Appendices QP-D and QP-E; Mandatory Appendix QV-I; and Nonmandatory QV-B). The staff's position is that, if a licensee or applicant commits to the use of nonmandatory appendices in ASME QME-1-2017 for its qualification of active mechanical equipment in NPPs, the criteria and procedures delineated in those nonmandatory appendices become part of the requirements for its qualification program unless it requests and justifies specific deviations.

b. Nonmandatory Appendix QR-B

This appendix recommends a methodology and describes the documentation that should be available in a user's files to demonstrate the qualification of nonmetallic parts, materials, or lubricants. It addresses the steps for the user of the active mechanical equipment to follow to qualify and maintain the qualification of the nonmetallic material that is part of the active mechanical equipment. The NRC staff considers Nonmandatory Appendix QR-B to provide a reasonable approach to the qualification of nonmetallic material in active mechanical equipment.

c. Sections QDR and QP

Sections QDR and QP provide a reasonable approach to the qualification of dynamic restraints and active pump assemblies, respectively. These sections adequately document the state of the art of the nuclear industry in the qualification of dynamic restraints and active pump assemblies where implemented as described in Regulatory Position C.2.1.2.

d. Section QV

ASME QME-1-2017, Section QV, reflects valve performance information obtained from nuclear industry programs and the NRC's research since the original development of ASME QME-1 in the 1980s. With the active involvement of industry personnel and the NRC staff in the development of ASME QME-1-2007 and its later editions, only a few NRC staff exceptions and clarifications are necessary for Section QV, including those based on experience with the initial implementation of ASME QME-1, as described in Regulatory Position C.2.1.2.

e. Nonmandatory Appendix QV-B

ASME QME-1-2017, Section QV, states that, for valve assemblies with extended structures and actuators qualified under IEEE Std 382-2006, "IEEE Standard for Qualification of Safety-Related Actuators for Nuclear Power Generating Stations," (Ref. 38) static side load testing may be used as one acceptable method of seismic validation of the valve/actuator interface. Nonmandatory Appendix QV-B provides requirements and recommended practices for the "static side load testing" method of seismically qualifying active valve assemblies to demonstrate that active mechanical equipment in nuclear facilities can function as required during a design-basis earthquake. When determining the seismic test load force, users of ASME QME-1 should use the weight of the extended structure of the valve assembly in the calculation as described in Appendix QV-B. The seismic test load force should be applied at the center of gravity of the extended structure of the valve in the seismic side load test as described in Appendix QV-B. Users of ASME QME-1 should develop a method to establish the boundary between the valve body and the extended structure of the valve consistent with the definition of "extended structure" in Article QV-4000, "Definitions," of Section QV. For example, the boundary of the extended structure for a valve with a flanged body to bonnet joint could be established as the flange joint between the valve body and bonnet.

2.1.2 Specific NRC Staff Positions

a. The definition of "valve assembly" in Article QV-4000 refers to power-operated valves. The NRC staff considers the power actuators for valve assemblies to include all types of power actuators, such as motor, pneumatic, hydraulic, solenoid, and pyrotechnic-actuated, as added in ASME QME-1-2017, and other drivers.

b. Article QV-6000, "Qualification Specification," states that the owner or owner's designee is responsible for identifying the functional performance characteristic requirements for a valve assembly and that a qualification specification prepared in accordance with Mandatory Appendix QV-I shall provide these requirements. The NRC staff considers Mandatory Appendix QV-I to be a necessary part of the implementation of ASME QME-1-2017, Section QV. For example, Mandatory Appendix QV-I provides the definitions of Section QV Category A and B valve assemblies in ASME QME-1-2017, Section QV.

c. ASME QME-1-2017, Section QDR, specifies provisions for the qualification of viscoelastic dampers in addition to other dynamic restraints. In addition, QME Case QME-006, "Qualification of Viscoelastic Dampers as Dynamic Restraints," specifies provisions to allow viscoelastic dampers to be qualified as dynamic restraints. In light of the design differences between viscoelastic dampers and other dynamic restraints, applicants or licensees that intend to apply ASME QME-1-2017 or QME Case QME-006 for the qualification of viscoelastic dampers should justify their application to the NRC.

d. Design certification applications under 10 CFR Part 52 for NPPs with passive postaccident heat removal systems may include certain active mechanical equipment from nonsafety systems in the regulatory treatment on nonsafety systems (RTNSS) program. The staff considers the provisions in ASME QME-1-2017 as addressed in this RG to be acceptable for the qualification of active mechanical equipment within the scope of the RTNSS program for NPPs with passive postaccident heat removal systems.

e. ASME periodically prepares errata to correct editorial errors in the printing of ASME QME-1. The NRC staff reviews those errata as part of its participation on the ASME QME committees but does not formally endorse them until they are incorporated into a full edition of the standard endorsed in this RG. Therefore, applicants or licensees should not consider errata to be endorsed by this RG unless justified to the NRC.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees[1] 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 voluntarily[2] 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 previously found acceptable for complying with the identified regulations, as reflected in the plant's current licensing basis.

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 to require it. 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 license 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

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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.

guide and (2) the specific subject matter of this regulatory guide is an essential consideration in the staff's 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 to 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. 39) and NUREG-1409, "Backfitting Guidelines," (Ref. 40).

REFERENCES[3]

1. *U.S. Code of Federal Regulations* (CFR), "Domestic Licensing of Production and Utilization Facilities," Part 50, Chapter 1, Title 10, "Energy."

2. CFR, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Part 52, Chapter 1, Title 10, "Energy."

3. U.S. Nuclear Regulatory Commission (NRC), NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Washington, DC.

4. NRC, Regulatory Guide (RG) 1.29, "Seismic Design Classification," Washington, DC.

5. NRC, RG 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," Revision 3, Washington, DC, September 2009.

6. Institute of Electrical and Electronics Engineers (IEEE) Standard (Std) 344-2013, "IEEE Standard for Seismic Qualification of Equipment for Nuclear Power Generating Stations," Piscataway, NJ, November 2013.[4]

7. IEEE Std C37.98-2013, "IEEE Standard for Seismic Qualification Testing of Protective Relays and Auxiliaries for Nuclear Facilities," Piscataway, NJ, April 2014.

8. American Society of Mechanical Engineers (ASME) QME-1-2017, "Qualification of Active Mechanical Equipment Used in Nuclear Facilities," New York, NY, October 2017.[5]

9. IEEE Std 344-2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," Piscataway, NJ, June 2005.

10. NRC, RG 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis," Washington, DC.

11. NRC, RG 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," Revision 1, Washington, DC, August 1977.

12. IEEE Std 344-1975, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," Piscataway, NJ.

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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 https://www.nrc.gov/reading-rm/doc-collections/ and through the NRC's Agencywide Documents Access and Management System (ADAMS) at https://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 IEEE documents may be purchased from the Institute of Electrical and Electronics Engineers Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855 or through the IEEE's public Web site at http://www.ieee.org/publications_standards/index.html.

[5] Copies of ASME standards may be purchased from the American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990; telephone (800) 843-2763. Purchase information is available through the ASME Web-based store at http://www.asme.org/Codes/Publications/.

13. NRC, Generic Letter (GL) 87-02, "Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46," Washington, DC, February 1987.

14. NRC, RG 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," Revision 2, Washington, DC, June 1988.

15. NRC, GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," Washington, DC, June 1989.

16. NRC, Information Notice (IN) 90-40, "Results of NRC-Sponsored Testing of Motor-Operated Valves," Washington, DC, June 1990.

17. Electric Power Research Institute (EPRI) Topical Report (TR)-103237, "EPRI MOV Performance Prediction Program," Revision 2, and Addenda 1 and 2, nonproprietary versions, Palo Alto, CA, April 1997.[6]

18. NRC, "Safety Evaluation on EPRI MOV Performance Prediction Methodology," Washington, DC, March 1996 (ADAMS Accession No. 9608070288).

19. NRC, "Supplement to Safety Evaluation on EPRI MOV Performance Prediction Methodology," Washington, DC, February 1997 (ADAMS Accession No. 9704300106).

20. NRC, Safety Evaluation Supplement, "Supplement 2 to Safety Evaluation on EPRI MOV Performance Prediction Methodology," Washington, DC, April 2001 (ADAMS Accession No. ML011100121).

21. NRC, "Supplement 3 to Safety Evaluation on EPRI MOV Performance Prediction Methodology," Washington, DC, September 2002 (ADAMS Accession No. ML022410364).

22. NRC, "Supplement 4 to Final Safety Evaluation on Addenda 3, 4, 5, 6, and 7 to EPRI TR-103237, "EPRI MOV Performance Prediction Program, Revision 2," Washington, DC, February 2009 (ADAMS Accession No. ML090400621).

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24. NRC, NUREG/CR-6478, "Motor-Operated Valve (MOV) Actuator Motor and Gearbox Testing," Washington, DC, July 1997 (ADAMS Accession No. ML18086B223).

25. Limitorque Corporation, Technical Update 98-01, "Actuator Output Torque Calculation," Lynchburg, VA, May 1998, and Supplement 1, July 1998 (ADAMS Accession No. ML18086B210).

26. NRC, Information Notice 96-48, "Motor-Operated Valve Performance Issues," Supplement 1, Washington, DC, July 24, 1998.

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[6] Copies of EPRI documents may be obtained by contacting the Electric Power Research Institute, 3420 Hillview Avenue, Palo Alto, CA 94304; telephone: (650) 855-2000; or online at http://my.epri.com/portal/server.pt.

27. NRC, NUREG/CR-6620, "Testing of dc-Powered Actuators for Motor-Operated Valves," Washington, DC, May 1999.

28. Boiling Water Reactor Owners' Group, TR-NEDC-32958, "BWR Owners' Group DC Motor Performance Methodology—Predicting Capability and Stroke Time in DC Motor-Operated Valves," March 2000 (ADAMS Accession No. ML003733225).

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30. NRC, Regulatory Issue Summary 2000-03, "Resolution of Generic Safety Issue 158: Performance of Safety-Related Power-Operated Valves under Design-Basis Conditions," Washington, DC, March 2000.

31. American Society of Mechanical Engineers (ASME) QME-1-2012, "Qualification of Active Mechanical Equipment Used in Nuclear Facilities," New York, NY, April 2013.[5]

32. International Atomic Energy Agency (IAEA) NS-G-1.6, "Seismic Design and Qualification for Nuclear Power Plants," Vienna, Austria, October 2003.[7]

33. IAEA Specific Safety Requirement 2/1, "Safety of Nuclear Power Plants: Design," Vienna, Austria, March 2016.

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35. NRC, RG 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Washington, DC.

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37. ASME Boiler and Pressure Vessel Code, Section III, "Rules for Construction of Nuclear Power Plant Components," New York, NY.

38. IEEE Std 382-2006, "IEEE Standard for Qualification of Safety-Related Actuators for Nuclear Power Generating Stations," Piscataway, NY, December 2006.

39. NRC, Management Directive 8.4, "Management of Facility-Specific Backfitting and Information Collection," Washington, DC.

40. NRC, NUREG-1409, "Backfitting Guidelines," Washington, DC.

[7] Copies of IAEA documents may be obtained through its Web site at www.iaea.org or by writing the International Atomic Energy Agency, P.O. Box 100, Wagramer Strasse 5, A-1400 Vienna, Austria.