REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**81-8000**
SRP Section:	**03.10 – Seismic and Dynamic Qualification of Mechanical and Electrical Equipment.**
Application Section:	**3.10**
Date of RAI Issue:	**07/16/2015**

Question No. 03.10-4

SRP Section 3.10 indicates that the following mechanical and electrical equipment should be seismically qualified: equipment associated with systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, containment and reactor heat removal or are otherwise essential in preventing significant release of radioactive material to the environment, and instrumentation that is needed to assess plant and environmental conditions during and after an accident, as described in RG 1.97.

Also covered by SRP Section 3.10 is equipment (1) that performs the above functions automatically, (2) that is used by the operators to perform these functions manually, and (3) whose failure can prevent the satisfactory accomplishment of one or more of the above safety functions.

The NRC staff recognizes that these equipment within the scope of seismic qualification may contain more than the safety-related equipment as defined in 10 CFR 50.2.

As an example, the instrumentation that is needed to assess plant and environmental conditions during and after an accident may not be included in the safety-related equipment as defined in 10 CFR 50.2.

In DCD Tier 2, Rev. 0, Section 3.10, the applicant refers to the equipment within the scope of seismic qualification as safety-related equipment. In DCD Tier 2, Rev. 0, Section 3.10.4.1, COL Item 3.10(3), the applicant refers to the equipment within the scope of seismic qualification as safety-related seismic Category I equipment.

The NRC staff requests that the applicant update the DCD to refer to the equipment included in the scope of SRP 3.10 as “seismic Category I equipment,” “equipment as defined in DCD Tier 2, Section 3.10,” or other alternative terminologies. The NRC staff also requests that the applicant review Technical Report, APR1400-E-X-NR-14001-P, Rev. 0, Part 2 and apply the updated terminology consistently.

Response

DCD Table 1.8-2, Section 3.10, and Technical Report APR1400-E-X-NR-14001-P, Rev. 0, Part 2 will be updated to refer to the equipment included in the scope of SRP 3.10 as “seismic Category I equipment” since seismic Category I is not limited only to safety related equipment.

Impact on DCD

DCD Table 1.8-2 and Section 3.10 will be revised as indicated in the Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

Technical Report, APR 1400-E-X-NR-14001-P/NP Rev.0, Part 2 will be revised as indicated in the Attachment.

ABSTRACT

The APR1400 Equipment Qualification Program consists of two parts which are classified into Environmental Qualification Program and Seismic Qualification Program respectively. These are discussed in separate parts.

Part 1

This report describes the program used to meet the requirements of 10 CFR 50.49, NRC RG 1.89, NUREG-0588 Category I, IEEE Std. 323, and NUREG-0800 (SRP 3.11). The program described herein applies to Class 1E electrical equipment and safety-related active mechanical equipment important to safety for nuclear power plants committed to the above requirements. Description of the elements of the environmental qualification program, methodology, and technical bases are presented. Type test, analysis, and other methods of qualification compliant with NUREG-0588 are discussed. It is expected that this report may be referenced by license applicants for the scope and methods to be employed for qualification of Class 1E electrical equipment and safety-related active mechanical equipment.

Part 2

This program is to establish the seismic and dynamic qualification procedure and criteria for ~~Safety-Related~~ seismic Category I mechanical equipment, controls and instrumentation and Class 1E electrical equipment in APR1400. This program is a part of the overall APR1400 Equipment Qualification Program, hereinafter referred to as EQP. This program provides the seismic and dynamic qualification requirements and general procedures to qualify safety-related equipment in accordance with IEEE Std. 344 and NRC RG 1.100. It is expected that this report may be referenced by license applicants for the scope and methods.

1 OBJECTIVES

electrical and active mechanical

Seismic qualification is a means to verify the ~~Class 1E safety-related electrical equipment and active~~ equipment can meet its performance requirements during and following one safe shutdown earthquake (SSE) preceded by a number of operating basis earthquakes (OBEs). This program establishes the seismic and dynamic qualification procedures and criteria for ~~safety-related mechanical equipment, controls and instrumentation, and Class 1E electrical~~ equipment in APR1400. This program is part of the overall APR1400 Equipment Qualification Program (EQP). This program provides the seismic and dynamic qualification requirements and general procedures to qualify ~~safety-related~~ equipment in accordance with NRC RG 1.100 (References 7.1 and 7.5) and IEEE Std 344. It is expected that this report may be referenced by license applicants for the scope and methods employed herein.

electrical and active mechanical

seismic Category I

seismic Category I

1.1 CRITERIA AND STANDARDS

The seismic requirements to be considered in the design of all the ~~safety-related~~ equipment are embodied in Title 10 Code of Federal Regulations (10 CFR), Appendix A to Part 50, General Design Criterion 3.

The qualification program is designed to meet the requirements of SRP 3.9.2 (Reference 7.3), NRC RG 1.100, IEEE Std 344, and IEEE Std 627. IEEE Std 344 was issued to provide guidance for demonstrating the seismic qualifications of Class 1E equipment for nuclear generating stations. The individual supporting standards that the A/E will employ, either in whole or in part, are listed in Section 7.

1.2 SUMMARY

seismic Category I

A summary of the various sections of this program is given below:

Scope of Equipment Seismic and Dynamic Qualification (Section 3)

The general scope of supply and the various qualification program activities are described. This program will cover ~~safety-related electrical and all the mechanical equipment including passive mechanical~~ equipment in harsh and mild environments.

Seismic Qualification Requirements (Section 4)

The methods required in performing seismic qualification are presented.

Qualification Programs (Section 5)

Information is provided for the detailed seismic qualification methods to be employed in compliance with NRC RG 1.100, IEEE Std 344, and ASME QME-1 (Reference 7.6) requirements. Demonstration of the conservatism of the qualification parameters is described.

Documentation (Section 6)

This section describes the documentation required for qualification. The qualification reports and their generation are described. Documentation necessary to support the review of a particular applicant's docket will be available for audit.

2 DEFINITIONS

2.1 Safe Shutdown Earthquake (SSE)

An earthquake that is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake that produces the maximum vibratory ground motion for which certain structures, systems, and components are designed to remain functional.

2.2 Operating Basis Earthquake (OBE)

An earthquake that could reasonably be expected to occur at the plant site during the operating life of the plant considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake that produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public, are designed to remain functional.

2.3 Safety-Related Equipment ~~(Seismic Category I Equipment)~~

Safety-related equipment is the equipment necessary to provide reasonable assurance of:

a. The integrity of the reactor coolant pressure boundary,

b. The capability to shut down the reactor and maintain it in a safe shutdown condition, or

c. The capability to prevent or mitigate the consequences of accidents that could result in potential off-site exposures in excess of the limits stated in 10 CFR 100.

Electrical equipment falling in this category is called Class 1E equipment.

All safety-related equipment shall be either active or passive.

2.3.1 Active Equipment

Equipment containing moving parts, which in order to accomplish its function, must undergo mechanical movement of those parts, or must prevent a movement of those parts to ensure that the equipment will remain in its last position.

2.3.2 Passive Equipment

Equipment that must maintain its pressure boundary and/or structural integrity, but not necessarily perform mechanical motion or have certain deflection limits, during the course of accomplishing a system safety function.

2.7.3 Damping

An energy dissipation mechanism that reduces the amplification and broadens the vibratory response in the region of resonance. Damping is usually expressed as a percentage of critical damping. Critical damping is defined as the least amount of viscous damping that causes a single-degree-of-freedom system to return to its original position without oscillation after initial disturbance.

2.8 Resonance

The condition that exists when the equipment has the same predominant period as does the applied forcing function.

2.9 Mathematical Model

The idealization of a component, structure, or piece of equipment as an assemblage of linear systems suitable for detailed dynamic analyses.

2.10 Dynamic Analysis

An analysis procedure for multi-degree-of-freedom systems in which the responses are obtained for each normal mode and then combined to predict the true response and the associated stress and deflection due to any forcing function.

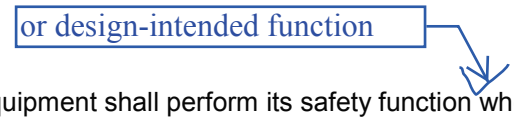
2.11 Static (Coefficient) Analysis

An analysis that evaluates the stresses and deflections due to equivalent steady state forces acting through the center of gravity of the equipment. These forces shall be chosen conservatively such that it results in stresses and deflections higher than those predicted by dynamic analyses.

2.12 Supporting Tests

Tests that are conducted to determine the properties and characteristics of the equipment and to provide data needed for the analysis or qualification tests. These tests are either dynamic or static.

2.13 Qualification Tests



Tests that are conducted to prove that the equipment shall perform its safety function when subjected to the loading combinations associated with different postulated plant conditions.

2.14 Device

An item of electric equipment that is used in connection with, or as an auxiliary to, other pieces of equipment.

2.15 Assembly

Two or more devices (or elements) sharing a common mounting or supporting structure.

3 SCOPE OF EQUIPMENT SEISMIC AND DYNAMIC QUALIFICATION

3.1 ~~SAFETY-RELATED EQUIPMENT (~~SEISMIC CATEGORY I EQUIPMENT~~)~~

Seismic Category I equipment is required to be seismically and dynamically qualified by demonstrating that its structural integrity and safety function during and after a postulated earthquake in conjunction with the full range of applicable normal and accident loads and conditions.

Seismic Category I equipment requiring qualification in accordance with the APR1400 EQP is described as follows:

a. Equipment associated with systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment reactor heat removal

b. Equipment and systems used to power, control, or monitor other structures, systems, and components (SSCs) important to safety

c. Equipment essential to preventing significant release of radioactive material to the environment

d. Instrumentation (including accident and post-accident monitoring) needed to assess plant and environmental conditions during and after an accident, as described in NRC RG 1.97, “Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants”

The equipment seismic qualification program criteria define specific technical requirements for seismic and dynamic qualification of seismic category I, safety-related mechanical equipment (excluding piping), and seismic category I (Class 1E) electrical and instrumentation equipment, including associated supports and mountings. The program includes qualification of category I tanks and reservoirs for hydrodynamic seismic loads, where applicable. All such equipment that is required to perform functionally or maintain its structural integrity, as described above, is subject to rigorous seismic/dynamic qualification. A detailed listing of APR1400 standard plant seismic category I equipment, requiring seismic qualification, is given in Table 3 ~~of the Environmental Qualification Parameters Report (EQPR)~~.

It should be noted that detailed criteria for functionality testing and inspection of mechanical and electrical equipment (e.g., performance tests, hydrostatic tests, and leakage tests) are not within the scope of the equipment seismic qualification program.

of Part 1 of this report

3.2 ~~IMPORTANT TO SAFETY (~~SEISMIC CATEGORY II EQUIPMENT~~)~~

The equipment seismic qualification program criteria also define technical requirements for seismic and dynamic qualification of equipment important to safety whose failure could prevent satisfactory accomplishment of one or more of the safety-related functions.

This includes seismic Category II equipment, defined as that equipment which performs non-safety-related functions, and whose continued function is not required, but whose structural or functional failure or interaction could degrade the function or integrity of a seismic Category I SSC to an unacceptable level, or could result in incapacitating injury to occupants of the control room.

Therefore, seismic Category II equipment can be seismically qualified by demonstrating that it retains its position sufficiently in an SSE that it will not cause unacceptable structural interaction with or failure of

Some non-safety related equipment are identified to meet seismic Category I requirements in Table 3 of Part 1 of this report. These equipment shall be capable of providing their intended function and maintaining structural integrity in accordance with specific design requirement.

4 SEISMIC QUALIFICATION REQUIREMENTS

seismic Category I

The dynamic qualification of ~~safety-related~~ equipment is achieved by providing reasonable assurance of its structural integrity and verifying the operability of active equipment when subjected to equivalent conditions that would be present during the postulated plant conditions. The following qualification programs are required:

a. Qualification by tests only

b. Qualification by analytical methods only

c. Qualification by the use of experience data

d. Qualification by any combination of supporting tests, supporting calculations, qualification tests, analytical calculations and experience.

Regardless of the equipment qualification programs chosen, the conditions and requirements for those portions of the program are stated in the following sections and shall be met.

5 QUALIFICATION PROGRAMS

Many factors control the design of a qualification program. If qualification is to be achieved by analysis only, all assumptions used in the analysis shall be given and justified. If testing alone is used for qualification, all applicable loads shall be simulated during the test unless it can be shown that the simultaneous application of certain loads is not necessary for providing reasonable assurance of the equipment's safety function

or design-intended function

5.1 QUALIFICATION BY TESTING ONLY

Qualification by testing only is recommended when the following conditions are fulfilled:

a. The test machine is capable of producing the required motion in accordance with the conditions stated in Section 5.7 of this program.

b. The applicable loads are of a simple nature or it is possible to simulate them.

c. The test table allows the simulation of actual mounting.

d. It is possible to monitor the functional capability of active equipment during the test.

e. The structural configuration of the equipment is extremely complex and beyond the capability of mathematical modeling techniques.

f. The response of the equipment is expected to be extremely nonlinear.

g. Qualification by analytical methods only. Analytical calculations only may be used as a qualification method in the following cases:

   1) When maintaining the structural integrity is an assurance for the safety function

   2) When the equipment is structurally simple

   or design-intended function

   3) When the response of the equipment is linear or is a simple nonlinear behavior

   4) When the effects of attached components and the superposition of load conditions are too complex for testing

5.2 QUALIFICATION BY THE USE OF EXPERIENCE DATA

Experience data may be used for qualification of the equipment as follows:

a. When qualifying equipment that is similar in function and physical characteristics to the equipment that has been previously qualified by testing, analysis, or a combination of testing and analysis

b. When the equipment type is similar to the equipment that has been in service for various periods of time and has been exposed to in-plant vibration and natural seismic disturbances

b. The dynamic coefficients to be used in qualification tests shall be based on the values obtained from the design response spectrum increased by the cross-coupling factors, rij, obtained from the supporting tests or estimated by other acceptable means.

5.7.2 Mounting

The equipment shall be mounted to simulate the recommended service mounting. If this cannot be done, the effect of the actual supporting structure shall be considered in determining the input motion.

5.7.3 Nozzle Loads

The expected (or calculated) piping reaction loads on the equipment shall be used in the qualification.

5.7.4 Other Loads

Any other loads that may act on the equipment (mechanical, electrical, or instrument) during the postulated dynamic event shall be simulated during the test, unless the supporting tests (or calculations) show that they are insignificant.

5.7.5 Basis of Acceptability

Inspection shall be made by the test conductor to provide reasonable assurance that no structural damage has occurred. For active equipment, sufficient monitoring devices shall be used to evaluate the performance of the tested equipment during the test. The equipment shall demonstrate its ability to perform its intended ~~safety~~ function when subjected to all applicable loads. A test report, which includes all test data, results and conclusions, shall be submitted to the combined license applicant for review. A suggested format for the test report is presented in Section 6. It is recommended that the Supplier follow the outline of Section 6 for documenting the dynamic testing. This will facilitate the review of the material in the report and support its completeness.

5.8 ANALYTICAL TECHNIQUES

Analytical calculations may be used for one of three purposes:

a. To develop supporting data for performing qualification tests

b. To qualify the equipment using the data obtained from supporting tests

c. To qualify the equipment without tests

5.9 SUPPORTING CALCULATIONS FOR QUALIFICATION TESTS

Calculations may be used to evaluate the effect of the floor motion on the base of the equipment. This would be in such cases as a device installed in a panel or cabinet, equipment mounted on a complex structure, a valve mounted on a piping system. Calculations may also be used to justify reducing the requirements for qualification testing.

SRSS to obtain the dynamic stresses and deflections. These dynamic stresses and deflections shall be added to all stresses and deflections resulting from all applicable loads and then compared with the design limits stated in Subsection 5.11.

5.11.6 Basis of Acceptability

The resultant stresses and deflections due to all loads included in the loading combinations stated in the procurement specification shall be within the design limits stated also in the procurement specification. Any deviation from these criteria shall be justified and the calculations shall show that the structural integrity of ~~all safety related~~ equipment, as well as the operability of active equipment, is maintained when subjected to the specified loading combinations. The Supplier shall submit to the combined license applicant a report that includes the data, calculations, results, and conclusions of the analysis. A suggested form for the report is presented in Section 5.14.

5.12 EXPERIENCE DATA

The method to be used for qualification by the use of experience data is described in this section. This method may be accomplished by justifying similarity with previously qualified equipment or with equipment that has proven performance during earthquakes. Experience data may be derived from the following sources:

a. Previous qualifications: Analysis or test data from previous equipment qualification programs

b. Earthquakes: Documented performance for similar equipment in facilities that have been subjected to earthquakes

c. Other experience: Data from operating dynamic loading or other dynamic environments

Similarity

Qualification by the use of experience data shall be based on the concept of dynamic similarity for excitation, physical system, dynamic response, and operability as follows:

a. Similarity of excitation exists, such as spectral characteristics, duration, directions of excitation axes, and location of measurement, for the motions relative to the equipment mounting.

b. Similarity of the equipment configuration shall be established.

c. A physical system dynamic response can be described through the same quantities as those applied to excitation or through a physical system description.

The experience data shall provide documented evidence to support the demonstration of proper operability.

5.13 OPERABILITY OF ACTIVE EQUIPMENT

The methods and guidance in ASME QME-1 including Appendix QRA, with exceptions provided in NRC RG 1.100, are used for seismic qualification of active mechanical equipment. The seismic and dynamic

6 DOCUMENTATION

The dynamic qualification documentation shall include all the information stated in Section 6.1 in an auditable form.

6.1 FORMAT OF THE DYNAMIC QUALIFICATION REPORTS

The dynamic qualification reports shall include both information suggested below and in IEEE 344 Section 10.3., and should present a clear, logical explanation of how the data have been used to achieve qualification.

Title Page

The following information should be shown on the title page:

a. Buyer

b. Supplier and Equipment Name

c. Specification Number

d. Revision Number

e. Date

f. Equipment Tag No.

I – General

This section shall include a description of the equipment, its ~~safety~~ function(s), and the qualification program used to verify the safety function(s). In addition, the following information shall be provided:

or design-intended function(s)

a. Project and the Buyer Names

b. Specification and Purchase Order Numbers

c. Equipment Name and Number

d. Organization(s) performing qualification program

e. Similarity analysis showing the similarity between the equipment being qualified and the equipment purchased from Supplier.

II – Data and Assumptions

a. Testing Section

The following data shall be included:

3.10 Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

This section describes the acceptance criteria, code and standards, procedures, and methods applied to the seismic and dynamic qualification of mechanical and electrical equipment including instrumentation to provide reasonable assurance that they will withstand the effects of postulated events and accidents and still be capable of performing their safety-related functions under the full range of normal, transient, seismic, and accident loadings.

Safety-related equipment is the equipment necessary to provide reasonable assurance of the following:

a. The integrity of the reactor coolant pressure boundary

b. The capability to shut down the reactor and maintain it in a safe shutdown condition

c. The capability to prevent or mitigate the consequences of accidents that would result in potential offsite exposure in excess of the limits stated in 10 CFR Part 100

This safety-related equipment includes equipment associated with systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment reactor heat removal; equipment essential to preventing significant release of radioactive material to the environment; and instrumentation needed to assess plant and environs conditions during and after an accident as described in NRC RG 1.97 (Reference 1).

The function of this equipment may include:

~~The safety-related equipment is identified as:~~

a. Equipment that performs the above functions automatically

b. Equipment that operators use to perform the above functions manually

c. Equipment for which failure can prevent satisfactory accomplishment of one or more of the above safety functions

This includes equipment in the reactor protection system (RPS), the engineered safety features (ESF) Class 1E equipment, the emergency power system, and all auxiliary safety-related systems and supports.

Examples of mechanical equipment are valves, pumps, fans, and heat exchangers. Examples of electrical and I&C equipment are motor control centers, load centers, battery racks, and indicators. This equipment is divided into two categories:

a. Active Equipment – The equipment that must remain functional both during and after all postulated dynamic event such as fans, pumps, valves, motors, switches, relays, and transmitters.

b. Passive Equipment – The equipment whose safety-related function does not involve operability but that does require assurance of its structural and pressure integrity both during and after postulated dynamic events. Examples of some common items of equipment classified as passive include tanks, heat exchangers, and filter cabinets.

Seismic Category I SSCs are identified in Table 3.2-1. Safety-related mechanical and electrical equipment including instrumentation is designed to meet seismic Category I requirements to provide reasonable assurance of the ability to initiate required protective actions and to supply power to components required to mitigate the consequences of events that require safety system operation during and after a safe shutdown earthquake (SSE).

Mechanical and electrical equipment including instrumentation designated as seismic Category II is shown to maintain its structural integrity and not adversely impact safety-related equipment during an SSE and during all static and dynamic loads from normal, transient, and accident conditions.

3.10.1 Seismic Qualification Criteria

The seismic and dynamic qualification of mechanical and electrical equipment demonstrates the ~~safety system~~ equipment's ability to perform its required function during and/or after the time it is subjected to the forces resulting from SSE and other related

Some non-safety-related equipment are identified to meet seismic Category I requirements in Table 3.2-1. These equipment shall be capable of providing their intended function and maintaining structural integrity in accordance with specific design requirement. Fire protection system equipment can be in such category.

analysis, or a combination of test and analysis are performed except an experience-based qualification. An experience-based qualification is not used for any equipment until it is endorsed by NRC RG 1.100.

The safety-related, seismic Category I mechanical equipment is designed to provide reasonable assurance of structural integrity of pressure boundary components for the intended service load conditions identified in the equipment's design specification, in accordance with the requirements in ASME Section III (Reference 6) described in Section 3.9. For seismic qualification of active mechanical equipment, the methods and guidance in ASME QME-1-2007 (Reference 7), including Appendix QR-A, with exceptions provided in NRC RG 1.100, are used.

For procurement of equipment, the dynamic requirements for the seismic qualification are specified in the equipment's design specifications. The equipment supplier is to submit a seismic qualification plan/procedure for review and approval prior to performing the seismic qualification. When test is employed, the equipment supplier is to submit a detailed test plan prior to conducting the test. When analysis is employed, the equipment supplier is to submit a detailed analysis procedure showing the methodology, approval, and description of the computer program used. If the plan/procedure is not acceptable, the seismic test plan or analysis procedure will be modified accordingly. The choice between testing and analysis may be made by the equipment supplier. However, the selected qualification program shall satisfy the requirements of the purchase specifications in accordance with the guidelines provided in IEEE Std. 344-2004.

An existing seismic qualification is acceptable if it is properly documented, and if it meets all the requirements of the purchase specifications. The equipment supplier is to submit the seismic qualification documentation for review and approval prior to installation in the plant. The seismic qualification documentation is to include all the information stated in Subsection 3.10.4, to demonstrate that the equipment is qualified in accordance with the requirements of the purchase specifications.

3.10.1.2 Input Motion

The postulated dynamic loads related to the qualification of seismic Category I equipment are seismic loads (OBE and SSE), if applicable, hydrodynamic loads, and non-seismic

For qualification of non-safety-related, seismic Category I mechanical equipment is designed to provide reasonable assurance of structural integrity and its design intended function.

loads (loads induced by pump trip, safety-relief valve open-case, etc.). The applicable loads are combined as part of the qualification of seismic Category I equipment.

These postulated dynamic loads are generally defined by the required response spectra (RRS). For in-line mounted equipment, they are defined by seismic coefficients. The location(s) in the plant will determine which spectra to use. Floor response spectra (FRS) are generated for specific buildings and elevations (floors) within a building as described in Subsection 3.7.2.5. When equipment is not directly mounted on floors, RRS reflects the amplification of the FRS due to the flexibility of equipment supporting structure. Selection of damping values for equipment to be qualified is made in accordance with NRC RG 1.61 (Reference 8) and IEEE Std. 344-2004. Higher damping values are used only if justified by documented test data with proper identification of the source and mechanism. Margins are added to RRS for testing. Subsection 6.3.2.5 of IEEE Std. 323-2003 recommends a 10 percent margin.

In considering the high-frequency seismic effect, the COL applicant is to investigate if site-specific spectra generated for the COLA exceed the APR1400 design spectra in the high-frequency range. Accordingly, the COL applicant is to provide reasonable assurance of the functional performance of vibration-sensitive components in the high-frequency range (COL 3.10(2)).

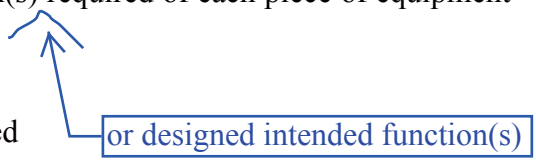
3.10.1.3 Selection of Qualification Method

The dynamic qualification of equipment is performed by analysis, testing, or a combination of testing and analysis. The dynamic qualification of equipment is concerned with the following.

a. Identifying which equipment must be qualified

b. Identifying what the safety-related function(s) required of each piece of equipment is (are)

c. Defining the dynamic loads to be considered



d. Demonstrating the capability of the equipment to perform its ~~safety-related~~ function

e. Documenting that the process has been done in accordance with accepted regulatory and industry standards

In general, seismic Category I electrical equipment, for which functional operability must be demonstrated, is qualified by tests. Analysis alone is used for qualification of seismic Category I mechanical equipment if structural integrity alone can provide reasonable assurance of the design intended function.

For equipment whose functional operability cannot be demonstrated by analysis or testing because of its size, complexity, or the large number of similar configurations, a combination of test and analysis may be used. With the elimination of OBE, analysis checks for fatigue effects can be performed at a fraction of the SSE (such as 50 cycles at one-half of the SSE peak amplitude, or 150 cycles at one-third of the SSE peak amplitude).

3.10.2 Methods and Procedures for Qualifying Mechanical and Electrical Equipment and Instrumentation

Qualification of seismic Category I equipment and its supports meets the requirements of NRC RG 1.100 and IEEE Std. 344-2004. Qualification methods of testing and analysis for confirming the functionality of equipment during and after an SSE, and for all static and dynamic loads from normal, transient, and accident conditions, are presented in this section.

3.10.2.1 Qualification by Analysis

The seismic analysis methods are in accordance with the guidance of IEEE Std. 344-2004. Analysis without testing may be acceptable only if structural integrity alone can provide reasonable assurance of the design-intended function.

Procedures are presented that can be used to seismically qualify equipment by analysis for a number of OBEs followed by an SSE. Two approaches to seismic analysis are described. One approach is based on dynamic analysis, the other on static coefficient analysis.

performed with a simulator capable of independent motions in all three orthogonal directions. The input motions should be statistically independent.

d. The test response spectra (TRS) should envelop the RRS over the frequency range of interest. The TRS should be computed with a damping value equal to or greater than that of the RRS. The shake table maximum peak acceleration should equal or exceed the ZPA of the RRS. The total test duration and number of equivalent maximum peak cycles should be per IEEE Std. 344-2004.

Testing is performed to provide reasonable assurance that equipment can withstand the effects of seismic events and accidents and still be capable of performing its safety-related functions.

Seismic ground motion occurs simultaneously in all directions in a random fashion. Currently, single-axis, biaxial, and triaxial testing are allowed. A 10 percent margin is added on RRS during testing in accordance with Subsection 6.3.2.5 of IEEE-323. The TRS must envelop the RRS in order for an item of equipment to be qualified (or justified). Sometimes, in a low-frequency area (below 3 Hz), TRS does not envelop RRS because of machine limitations. This requires justification based on the dynamic characteristics of the equipment. The TRS and RRS should be compared at the same damping value. A conservative TRS is greater than the RRS. Justification must be made when the TRS is less than the RRS.

Vibration aging testing may be performed preceding the OBE and SSE tests to show that the lower levels of normal and transient vibration associated with the plant operation will not adversely affect the equipment's ~~performance of its safety~~ function.

Seismic qualification tests include five OBE test preceding the SSE for specified seismic events.

3.10.2.3 Operability of Active Equipment

The supplier is to prove the operability of all active equipment before, during, and after design basis events including seismic by test and/or analysis and provide the test or analysis report as a part of the dynamic qualification report.

3.10.2.3.1 Mechanical Equipment

The methods and procedures used for qualifying active mechanical equipment (i.e., valves and pumps) are described in Subsections 3.9.3, 3.10.2, and this subsection. Analysis, test, or a combination of test and analysis are used for qualification of seismic Category I active mechanical equipment to show it maintains structural integrity and functionality. The methods are used to provide reasonable assurance of equipment operability for its intended ~~safety-related~~ function under required plant conditions.

Seismic Category I active mechanical equipment is designed to withstand seismic and other dynamic loads, including the intended service load conditions in the equipment design specifications, in accordance with the requirements in ASME Section III described in Subsection 3.9.3.

Seismic qualification for active mechanical equipment is in accordance with IEEE Std. 344-2004, ASME QME-1, and NRC RG 1.100 as stated in Subsection 3.10.2.

For mechanical equipment, the functionality by analysis and/or tests is proven as follows:

a. Pumps

   A static deflection analysis and/or test for the shaft and rotor (if applicable) should be performed under design basis loading, including the maximum allowable nozzle loads specified in the equipment design specification. The deflection is less than the allowable/recommended deflection by the equipment supplier.

installed in a nonoperational mode for the support test, the response at the equipment mounting location is monitored and characterized in the manner as stated in Subsection 3.10.2.2. In such a case, equipment is tested separately for operability and the actual input motion to the equipment in this test is to be more conservative in amplitude and frequency content than the monitored response from the support test.

3.10.4 Test and Analysis Results and Experience Database

Complete and auditable records are maintained for the life of the plant at the plant administrative facilities. These records are updated and kept current as equipment is replaced, further tested, or otherwise further qualified.

The COL applicant is to develop the equipment seismic qualification files that summarize the component's qualification, including a list of equipment classified as seismic Category I in Table 3.2-1 and seismic qualification summary data sheets (SQSDS) for each piece of ~~safety-related~~ seismic Category I equipment (COL 3.10(3)). The SQSDS include the following information:

a. Identification of equipment, including vendor, model number, and location within each building. Valves that are part of the RCPB are identified.

b. Physical description, including dimensions, weight, and field mounting condition

c. A description of the equipment's function within the system

d. Identification of all design (functional) specifications and qualification reports, and their locations

e. Description of the required loads and their intensities for which the equipment is qualified

f. If qualified by test, identification of the test methods and procedures, important test parameters, and a summary of the test results that includes test response spectra (TRS) enveloping required response spectra (RRS)

functional performance of vibration-sensitive components in the high-frequency range.

COL 3.10(3) The COL applicant is to develop the equipment seismic qualification files that summarize the component's qualification, including a list of equipment classified as seismic Category I in Table 3.2-1 and SQSDS for each piece of ~~safety-related~~ seismic Category I equipment.

COL 3.10(4) The COL applicant is to perform equipment seismic qualification for seismic Category I equipment and provide milestones and completion dates of the equipment seismic qualification program.

3.10.6 References

1. Regulatory Guide 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," Rev. 4, U.S. Nuclear Regulatory Commission, June 2006.

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

3. IEEE Std. 323-2003, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, 2003.

4. Regulatory Guide 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," Rev. 3, U.S. Nuclear Regulatory Commission, September 2009.

5. IEEE Std. 344-2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, 2004.

6. ASME Boiler and Pressure Vessel Code, Section III, Disvion 1, "Rules for Construction of Nuclear Facility Components," The American Society of Mechanical Engineers, the 2007 Edition with the 2008 Addenda.

7. ASME QME-1-2007, "Qualification of Active Mechanical Equipment Used in Nuclear Power Plants," The American Society of Mechanical Engineers, 2007.

Table 1.8-2 (6 of 29)

Item No.	Description
COL 3.10(1)	The COL applicant is to provide documentation that the designs of seismic Category I SSCs are analyzed for OBE, if OBE is higher than 1/3 SSE.
COL 3.10(2)	The COL applicant is to investigate if site-specific spectra generated for the COLA exceed the APR1400 design spectra in the high-frequency range. Accordingly, the COL applicant is to provide reasonable assurance of the functional performance of vibration-sensitive components in the high-frequency range.
COL 3.10(3)	The COL applicant is to develop the equipment seismic qualification files that summarize the component's qualification, including a list of equipment classified as seismic Category I in Table 3.2-1 and seismic qualification summary data sheets (SQSDS) for each piece of ~~safety-related~~ seismic Category I equipment.
COL 3.10(4)	The COL applicant is to perform equipment seismic qualification for seismic Category I equipment and provide milestones and completion dates of equipment seismic qualification program.
COL 3.11(1)	The COL applicant is to identify and qualify the site-specific mechanical, electrical, I&C, and accident monitoring equipment specified in RG 1.97.
COL 3.11(2)	The COL applicant is to document the qualification test results and qualification status in an auditable file for each type of equipment in accordance with the requirements 10 CFR 50.49(j).
COL 3.11(3)	The COL applicant is to describe the EQP implementation milestones based on the APR1400 EQP.
COL 3.11(4)	The COL applicant is to identify the nonmetallic parts of mechanical equipment in procurement process.
COL 3.12(1)	The COL applicant is to prepare design reports for ASME Class 1, 2, and 3 piping system in accordance with ASME Section III.
COL 3.12(2)	The COL applicant is to design the piping exposed to wind and/or tornado, if any, to the plant design basis loads.
COL 3.12(3)	The COL applicant is to perform fatigue evaluations of ASME Class 1 piping.
COL 3.12(4)	The COL applicant is to perform stress evaluations for ASME Class 2 and 3 piping.
COL 3.12(5)	The COL applicant is to perform fatigue evaluations of environmental impact on ASME Class 1 piping, except for the RCS primary loop, using methods acceptable to the NRC at the time of evaluation.