MEB-CQ-201505-3.10_#1 Response

DCD Tier 2, SECTION 3.10, Issue #1

Standard Review Plan Section 3.10 states that if qualification by an experience-based approach is proposed, the staff reviews the details of the experience database, including applicable implementation procedures, to ensure structural integrity and functionality of the in-scope mechanical and electrical equipment. DCD Tier 2, Rev. 0, Section 3.10.1.1 states that an experience-based qualification is not used for any equipment until it is endorsed by NRC RG 1.100. However, Technical Report APR1400-E-X-NR-14001-P, Rev. 0, Part 2, Section 5.2 states that experience data may be used for qualification of the equipment when (1) 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, and (2) 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. The staff requests that the applicant revise the technical report to be consistent with DCD, or provide details of the test experience database, including applicable implementation procedures.

Response

Technical Report APR1400-E-X-NR-14001-P, Part 2, will be updated to be consistent with the DCD.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports

The Technical Report APR1400-E-X-NR-14001-P, Part 2 will be revised as shown in markup MEB-CQ-201505-3.10_#1.

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.

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

   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~~

An experience-based qualification is not used for any equipment until it is endorsed by NRC RG 1.100.

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.

An experience-based qualification is not used for any equipment until it is endorsed by NRC RG 1.100.

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

MEB-CQ-201505-3.10_#2 Response

DCD Tier 2, SECTION 3.10, Issue #2

RG 1.199, "Anchoring Components and Structural Supports in Concrete" endorsed ACI 349-01, "Code Requirements for Nuclear Safety Related Concrete Structures," Appendix B with conditions. Technical Report APR1400-E-X-NR-14001-P, Rev. 0, Part 2, Table 3 references ACI 349-01 Appendix B for the design of equipment anchoring to building structure. The applicant indicated in DCD Tier 2, Table 1.9-1 that it conforms with this regulatory guide. The staff requests that the applicant add a note to Table 3 of the technical report to indicate that the conditions in RG 1.199 will be followed. Technical report, Part 2, Section 7, "References" should also list RG 1.199.

Response

Technical Report APR1400-E-X-NR-14001-P, Part 2, Table 3 will add a note to Table 3 and will include RG 1.199 as a reference in Section 7.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports

The Technical Report APR1400-E-X-NR-14001-P, Part 2, Table 3, Section 7 and other impacted reference numbering throughout the report will be revised as shown in markup MEB-CQ-201505-3.10_#2.

7 REFERENCES

All codes and standards shall be the edition in effect as of December 31, 2010 unless identified otherwise.

1 Regulatory Guide 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," Rev. 3, U.S. Nuclear Regulatory Commission, September 2009.

2 Regulatory Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis," Rev. 2, U.S. Nuclear Regulatory Commission, July 2006.

3 NUREG-0800, Standard Review Plan, Section 3.11, "Environmental Qualification of Mechanical and Electrical Equipment." Rev. 3, U.S Nuclear Regulatory Commission, Marcg 2007.

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

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

7 Generic Letter 89-10, "Safety-Related MOV Testing and Surveillance," U.S. Nuclear Regulatory Commission, June 28, 1989.

8 IEEE Std 387-1995, "IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Suppliers for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, 1995.

9 Regulatory Guide 1.9, "Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants," Rev. 4, U.S. Nuclear Regulatory Commission, June 2007.

10 ACI 349-01, "Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-01) and Commentary," American Concrete Institute, February 2001.

11 ANSI/AISC N690-1994, "Specification for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities," American National Standard Institute, 1978

12. Regulatory Guide 1.199, "Anchoring Components and Structural Supports in Concrete", U.S. Nuclear Regulatory Commission, November 2003.

Table 3 (1 of 2)

STRENGTH LIMITS FOR ANCHORING TO BUILDING STRUCTURE[7)]
(INDEPENDENT OF EQUIPMENT CLASSIFICATION)

Add "8)"

Plant Operating Condition	Loading Combination	Strength Limits per ACI 349-01 Appendix B (~~Reference 7.10~~) 7.10, 7.12
Normal	(0.9) Dead Loads[5)] + (1.7) Pressure Loads + (1.3) Thermal Expansion Loads + (1.4) Equip. Operation Loads[1)]	Tensile Strength $\phi_n N_s = \phi_n A_{se} f_{ut} \geq N_u$ where, f_{ut} shall not be taken greater than $1.9 f_y$ or 125,000 psi. Shear Strength $\phi_s V_s = \phi_s (0.6) A_{se} f_{ut} \geq V_u$ where, f_{ut} shall not be taken greater than $1.9 f_y$ or 125,000 psi. Tension / Shear Interaction $\frac{N_u}{\phi_n \cdot N_s} + \frac{V_u}{\phi_s \cdot V_s} \leq 1.2$ where, $\phi_n = 0.80$, $\phi_s = 0.75$ Note) Tl ss area for anchor shall be taken as A $\frac{43}{n}]^2$ where, D: Major thread diameter *n:* Number of threads per inch Minimum center-to-center spacing For untorqued anchors: $4d_o$ For torqued anchors: $6d_o$ Maximum anchor diameter Anchor diameter(d_o) ≤ 2 in where, d_o: Outside diameter of anchor If the concrete strength of the equipment foundation, as designed by A/E, does not meet the anchor bolt ductile failure requirements of ACI 349-01, Appendix B, Vendor shall modify anchor bolt details including bolt diameter, number of bolts, bolt material, and bolt arrangement as recommended by A/E. See ACI 349-01, Appendix B for explanation of nomenclature shown in this table.
Upset	(0.9) Dead Loads[5)] + (1.7) Pressure Loads + (1.3) Thermal Expansion Loads + (1.4) Equip. Operation Loads[1)] + (1.7) Upset Condition Dynamic Loads[2)]	

Table 3 (2 of 2)

Plant Operating Condition	Loading Combination	Strength Limits per ACI 349-01 Appendix B
Emergency and Faulted	(0.9) Dead Loads + (1.0) Pressure Loads + (1.0) Thermal Expansion Loads + (1.0) Equip. Operation Loads[1)] + (1.0) Emergency / faulted Condition Dynamic Loads[3)]	

Add "8)"

Notes:

1) Equipment operating loads are those loads associated with the operation of the equipment being qualified. Equipment operating loads include but are not limited to:

   a) Piping nozzle reactions
   b) Motor startup and running torque
   c) Valve seating torque and/or thrust
   d) Thrust load on fans and pumps

2) Upset condition dynamic loads include the postulated dynamic loads as identified in the purchase specification.

3) Faulted condition dynamic loads include the safe shutdown earthquake plus other postulated dynamic loads as identified in the purchase specification.

4) Weld allowable stresses shall be per AISC N690-94 Q1.5.3 for Normal and Upset Load Cases. For Emergency and Faulted Load Cases, the allowable stresses per AISC N690-94, Table Q1.5.3 may be increased by 1.6 but shall not exceed 0.95 Fy for tension and by 1.4 but shall not exceed 0.95 Fy/$\sqrt{3}$ for shear.

5) When calculating the overturning moments induced from eccentricity between weight center and anchor group center, the load factor of dead load shall be 1.4 instead of 0.9.

   When calculating the horizontal forces and overturning moments induced from seismic condition, the load factor of dead load shall be 1.4 instead of 0.9.

6) For active components, shaft (rotor) deflection analysis shall be performed for verifying operability.

7) Building structure; refer to A/E-designed components (see Figure 1).

8) Strength limits follow the conditions set forth in Regulatory Guide 1.199.

MEB-CQ-201505-3.10_#3 Response

DCD Tier 2, SECTION 3.10, Issue #3

The following are clarification questions:

a. The staff requests that the applicant reference Technical Report APR1400-E-X-NR-14001-P, "Equipment Qualification Program" in DCD Tier 2, Rev. 0, Section 3.10.

Response
Section 3.10 of DCD will be updated to reflect Technical Report APR1400-E-X-NR-14001-P, "Equipment Qualification Program" as a reference.

Impact on DCD
The DCD Section 3.10 will be revised as shown in in markup MEB-CQ-201505-3.10_#3.

Impact on PRA
There is no impact on the PRA.

Impact on Technical Specifications
There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports
There is no impact on the Technical /Topical/Environmental Report.

b. Technical Report APR1400-E-X-NR-14001-P, Rev. 0, Part 2, "Seismic Qualification Program," Section 1.1 states "the qualification program is designed to meet the requirements of SRP 3.9.2 (Reference 7.3)." However, Reference 7.3 is SRP 3.11. The staff requests that the applicant correct the reference inconsistency.

Response
The Section 1.1 and Section 7 of APR1400-E-X-NR-14001-P, "Equipment Qualification Program", Part 2 will be updated to refer to and list SRP 3.10 "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment".

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA.

Impact on Technical Specifications
There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports
The Technical Report of APR1400-E-X-NR-14001-P will be revised as shown in markup MEB-CQ-201505-3.10_#3.

c. The staff requests that the applicant list IEEE Std 344 in Section 7, "References" of Technical Report APR1400-E-X-NR-14001-P, Rev. 0, Part 2.

Response
IEEE Std 344 was included as Reference 6 in Section 7 of Technical Report, APR1400-E-X-NR-14001-P, Rev. 0, Part 2.

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA.

Impact on Technical Specifications
There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports
There is no impact on the Technical /Topical/Environmental Report.

d. Technical Report APR1400-E-X-NR-14001-P, Rev. 0, Part 2, Section 3.1 states that 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). Is there a document number for this report? Is the applicant planning to submit this report to the NRC?

Response
Section 3.1 of Technical Report APR1400-E-X-NR-14001-P, Rev. 0, Part 2 will be updated to reference the appropriate location for the listing of the APR1400 standard plant seismic category I equipment being in Part 1 Table 3 of the Technical Report

Impact on DCD
There is no impact on the DCD.

Impact on PRA
There is no impact on the PRA.

Impact on Technical Specifications
There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports
The Technical Report of APR1400-E-X-NR-14001-P will be revised as shown in markup MEB-CQ-201505-3.10_#3.

8. Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Rev. 1, U.S. Nuclear Regulatory Commission, March 2007.

9. SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs," U.S. Nuclear Regulatory Commission, 1993.

10. Regulatory Guide 1.9, "Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants," Rev. 4, U.S. Nuclear Regulatory Commission, June 2007.

11. IEEE Std. 387-1995, "IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, 1995.

12. ANSI/AISC N690-1994, "Specification for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities," American National Standard Institute, 1994

Issue #3a

13. APR1400-E-X-NR-14001-P, "Equipment Qualification Program" Rev. 0, KHNP, November 2014.

1 OBJECTIVES

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.

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.

SRP 3.10 Issue #3b

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

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.

7 REFERENCES

All codes and standards shall be the edition in effect as of December 31, 2010 unless identified otherwise.

1 Regulatory Guide 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," Rev. 3, U.S. Nuclear Regulatory Commission, September 2009.

2 Regulatory Guide 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis," Rev. 2, U.S. Nuclear Regulatory Commission, July 2006.

3 NUREG-0800, Standard Review Plan, Section ~~3.11, "Environmental Qualification of Mechanical and Electrical Equipment~~." Rev. 3, U.S Nuclear Regulatory Commission, ~~Marcg~~ March 2007.

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

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

7 Generic Letter 89-10, "Safety-Related MOV Testing and Surveillance," U.S. Nuclear Regulatory Commission, June 28, 1989.

8 IEEE Std 387-1995, "IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Suppliers for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, 1995.

9 Regulatory Guide 1.9, "Application and Testing of Safety-Related Diesel Generators in Nuclear Power Plants," Rev. 4, U.S. Nuclear Regulatory Commission, June 2007.

10 ACI 349-01, "Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-01) and Commentary," American Concrete Institute, February 2001.

11 ANSI/AISC N690-1994, "Specification for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities," American National Standard Institute, 1978

Issue #3b

3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment"

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).~~

Issue #3d Part 1 Table 3 of APR1400-E-X-NR-14001-P

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.

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