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Response to NRC's Comment on the Seismic Qualification of Electrical and Mechanical Equipment

Ref. 1: Letter, Getachew Tesfaye (NRC) to Sandra M. Sloan (AREVA NP Inc.), "AREVA NP Inc. - U.S. EPR Standard Design Certification Application Review Schedule," March 26, 2008.

In Reference 1, the NRC provided a comment on the use of experience data approach for seismic and dynamic qualification of mechanical and electrical equipment and its potential impact on the review schedule for the U.S. EPR design certification application. This was further discussed with the NRC staff in a telephone call on April 24, 2008. Attachment A is AREVA NP's response to the NRC's comment in order to eliminate this area of potential uncertainty in the design certification review schedule. Supporting changes to the Final Safety Analysis Report (FSAR) are provided in Attachment B.

If you have any questions related to this submittal, please contact me at 434-832-2369 or by e-mail at sandra.sloan@areva.com.

Sincerely,

Sandra M. Sloan

Sandra M. Sloan, Manager
New Plants Deployment Regulatory Affairs
AREVA NP Inc.

Enclosures

cc: J. Rycyna
G. Tesfaye
Docket No. 52-020

Attachment A
AREVA NP's Response to NRC's Comment on the Seismic Qualification of Electrical and Mechanical Equipment

NRC Comment:

In a letter to AREVA NP dated March 26, 2008 (see Reference 1 of the cover letter), NRC stated:

The proposed use of earthquake experience and/or test experience approach for seismic and dynamic qualification of mechanical and electrical equipment is highly dependent on the selection of equipment and the type of experience database proposed AREVA will be requested to submit the database and the equipment to be qualified. Based on past experience with similar applications, it has taken longer than anticipated to complete the review. If AREVA chooses to proceed with this approach the scheduled may be impacted.

AREVA NP Response:

AREVA NP does not intend to use earthquake and/or test experience data to seismically qualify electrical and mechanical equipment. Also the U.S. EPR FSAR will be revised to eliminate the option of a COL applicant to use experience data for the seismic qualification of equipment. Specifically, the following COL action item will be deleted from Sections 1.8 and 3.10.2 of the FSAR:

> *If experience data are used to establish equipment qualification, a COL applicant that references the U.S. EPR design certification will document the qualification methodology and supporting data.*

Marked-up pages to the FSAR to reflect the above change are provided in Attachment B. Corresponding marked-up changes to FSAR Sections 3.10 and 3D Attachment E are also provided in Attachment B to clarify that use of earthquake and/or test experience data is not permitted to seismically qualify electrical and mechanical equipment.

ATTACHMENT B

REVISED FSAR PAGES

Table 1.8-2—U.S. EPR Combined License Information Items
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Item No.	Description	Section	Action Required by COL Applicant	Action Required by COL Holder
3.9-11	A COL applicant that references the U.S. EPR design certification will provide a summary of the maximum total stress, deformation (where applicable), and cumulative usage factor values for each of the component operating conditions for ASME Code Class 1 components. For those values that differ from the allowable limits by less than 10 percent, the COL applicant will provide the contribution of each of the loading categories (e.g., seismic, pipe rupture, dead weight, pressure, and thermal) to the total stress for each maximum stress value identified in this range.	3.9.3.1		Y
3.9-12	A COL applicant that references the U.S.EPR design certification will provide a table identifying the safety-related systems and components that use snubbers in their support systems, including the number of snubbers, type (hydraulic or mechanical), applicable standard, and function (shock, vibration, or dual-purpose snubber). For snubbers identified as either a dual-purpose or vibration arrester type, the COL applicant shall indicate whether the snubber or component was evaluated for fatigue strength.	3.9.6.4		Y
3.9-13	A COL applicant that references the U.S. EPR design certification will identify the implementation milestones and applicable ASME OM Code for the preservice and inservice examination and testing programs. These programs will be consistent with the requirements in the latest edition and addenda of the OM Code incorporated by reference in 10 CFR 50.55a on the date 12 months before the date for initial fuel load.	3.9.6	Y	
~~3.10-1~~	~~If experience data is used to establish equipment qualification, a COL applicant that references the U.S. EPR design certification will document the qualification methodology and supporting data.~~	~~3.10.2~~		~~Y~~

Table 1.8-2—U.S. EPR Combined License Information Items
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Item No.	Description	Section	Action Required by COL Applicant	Action Required by COL Holder
3.10-21	A COL applicant that references the U.S. EPR design certification will create and maintain the SQDP file during the equipment selection and procurement phase.	3.10.4		Y
3.10-32	A COL applicant that references the U.S. EPR design certification will identify any additional site specific components that need to be added to the equipment list in Table 3.10-1.	3.10.1.1	Y	
3.10-43	If the seismic and dynamic qualification testing is incomplete at the time of the COL application, a COL applicant that references the U.S. EPR design certification will submit an implementation program, including milestones and completion dates, for NRC review and approval prior to installation of the applicable equipment.	3.10.4	Y	
3.11-1	A COL applicant that references the U.S. EPR design certification will maintain the equipment qualification test results and qualification status file during the equipment selection, procurement phase and throughout the installed life in the plant.	3.11		Y
3.11-2	A COL applicant that references the U.S. EPR design certification will identify additional site specific components that need to be added to the environmental qualification list in Table 3.11-1.	3.11.1.1.3	Y	
3.11-3	If the equipment qualification testing is incomplete at the time of the COL application, a COL applicant that references the U.S. EPR design certification will submit an implementation program, including milestones and completion dates, for NRC review and approval prior to installation of the applicable equipment.	3.11.3	Y	

- Section 3.13 defines the adequacy of programs for assuring the integrity of bolting and threaded fasteners, including provisions for installation and maintenance of mounting and bolting details.

3.10.1 Seismic Qualification Criteria

3.10.1.1 Qualification Standards

The methods employed for seismic and dynamic qualification of mechanical and electrical equipment are described or referenced in Section 3.10.2. These methods comply with the requirements of GDC 1, GDC 2, GDC 4, GDC 14, GDC 30, and 10 CFR 50, Appendix S. The methods used to implement the requirements of 10 CFR Part 50, Appendix B are described in Chapter 17.

An acceptable method for complying with the NRC regulations on the seismic qualification of electrical and mechanical equipment is described in RG 1.100, Revision 2. This Regulatory Guide states that the procedures described in IEEE Std 344-1987 are acceptable to the NRC staff for satisfying the NRC regulations pertaining to seismic qualification of electrical and mechanical equipment. ~~Except for the use of earthquake experience,~~ AREVA NP plans to use IEEE Std 344-2004[1] (Reference 5) to provide the technical requirements for seismic qualification of components that are included in the environmental qualification (EQ) program, along with other components that are not addressed in the EQ program. Seismic qualification based on ~~earthquake experience may be performed in accordance with IEEE Std 344-2004 with suitable justification in accordance with regulatory practice.~~ experience, per Section 10 of IEEE Std 344-2004, is not utilized by AREVA NP.

The U.S. EPR design utilizes the following procedures in IEEE Std 344 for seismic qualification of electrical and mechanical equipment:

- Predicting equipment performance by analysis.
- Testing the equipment under simulated seismic conditions.
- Qualifying the equipment by a combination of analysis and testing.
- ~~Use of applicable experience data (see Appendix 3D, Attachment E)~~Use of applicable test data from previous qualification of similar equipment.

Electrical and mechanical equipment for the U.S. EPR is qualified only for the case of the SSE defined in Section 3.7.1. As described in Section 3.7, consideration of design cases for an operating basis earthquake (OBE) is not a design requirement for the U.S.

1. Section 3.11 provides the justification for the use of the latest version of the IEEE standards referenced in this section that have not been endorsed by existing Regulatory Guides. AREVA NP maintains the option to use current NRC-endorsed versions of the IEEE standards.

Testing is the preferred method for seismic equipment qualification. The type of test used to establish qualification depends on many factors, such as the type of equipment, its safety function, its location, and its flexibility.

Qualification by analysis only, can be used under the following conditions:

- Maintaining the structural and pressure boundary integrity is sufficient to perform its safety-related functions.
- The equipment is structurally simple and its behavior can be predicted by a conservative analytical approach.
- The equipment is too large or heavy to obtain a representative test input at existing test facilities. As required, the essential control devices and electrical parts of the equipment are tested separately.
- The interfaces, such as interconnecting cables to a cabinet, cannot be conservatively considered in the testing.

The loads to be considered in the analysis and the methods of combining responses are described in Section 3.9 and Attachment E to Appendix 3D.

Active valves and dampers can be qualified by a combination of analysis and testing to demonstrate operability and structural integrity. Attached appurtenances, such as operators, limit switches, and solenoid valves, can be qualified separately by testing, as recommended in IEEE Std 382 (Reference 6) and IEEE Std 344.

~~Mechanical and electrical equipment can also be seismically qualified using applicable experience data. This qualification is based on the guidelines in IEEE Std 344, supplemented with analysis as required. If experience data are used to establish equipment qualification, a COL applicant that references the U.S. EPR design certification will document the qualification methodology and supporting data.~~Mechanical and electrical equipment may also be seismically qualified using previous seismic qualification testing, subject to suitable similarity analyses, where such previous testing has been determined to meet the specified performance requirements and acceptance criteria. This qualification is based on the guidelines in IEEE Std 344-2004, supplemented with analysis as required.

3.10.2.1 Seismic Qualification of Electrical Equipment and Instrumentation

3.10.2.1.1 Seismic Qualification by Type Test

Seismic qualification by testing is performed in accordance with IEEE Std 344. Multi-frequency and multi-axis testing are the preferred method of qualification, though the standard allows alternative testing methods, such as single-frequency and single-axis testing. Regardless of which testing method is used, the test will conservatively simulate and envelop the required seismic motion at the location of the equipment.

3D Attach E Seismic Qualification Techniques

E.1 Purpose

The purpose of this attachment is to provide the methodology for establishing the seismic qualification of mechanical, electrical, and instrumentation and control (I&C) equipment. An acceptable method for complying with the NRC regulations with respect to the seismic qualification of electrical and mechanical equipment is described in RG 1.100, Revision 2. This states that the procedures described in IEEE Std 344-1987 are acceptable to the NRC staff for satisfying the NRC regulations pertaining to seismic qualification of electrical and mechanical equipment. Section 3.10 describes the methods for seismic qualification of mechanical, electrical, and instrumentation and control (I&C) equipment. ~~Except for the use of earthquake experience, AREVA NP plans to use IEEE Std 344-2004[1] (Reference 1) to provide the technical requirements for seismic qualification of components that are included in the Equipment Qualification (EQ) program, along with other components that are not addressed in the EQ program. Seismic qualification based on earthquake experience may be performed in accordance with IEEE Std 344-2004 (Reference 1) with suitable justification in accordance with regulatory practice.~~ This methodology is also based on the recommended methods and criteria in IEEE Std 382-2006[1] (Reference 2), and incorporates guidelines from Sections 3.7, 3.9, and 3.10. Table 3.10-1—List of Seismically and Dynamically Qualified Mechanical and Electrical Equipment, provides a list of mechanical equipment that is being seismically qualified in accordance with IEEE Std 344 (Reference 1). Table 3.11-1—List of Environmentally Qualified Electrical/I&C Equipment, provides a list of electrical and I&C equipment that is located in a harsh environment and is being seismically qualified in accordance with IEEE Std 344 (Reference 1). Table 3.10-1 also provides a list of electrical and I&C equipment that is not located in a harsh environment but is seismically qualified in accordance with IEEE Std 344 (Reference 1).

E.2 Definitions

This section defines the terms used in this attachment.

Operating Basis Earthquake

For the U.S. EPR, the operating basis earthquake (OBE) is defined as one-third of the safe shutdown earthquake (SSE) as detailed in Section 3.7, and within the following definition for an SSE.

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1. Section 3.11 provides the justification for the use of the latest version of the IEEE standards referenced in this section that have not been endorsed by existing Regulatory Guides. AREVA NP maintains the option to use current NRC-endorsed versions of the IEEE standards.

Similarity

Similarity is an instance in which equipment is of a type that has been previously qualified, differing only in size or in the specific qualified devices located in the assembly or structure.

~~Experience Data~~

~~As identified in IEEE Std 344 (Reference 1), experience data is evaluated data for a reference equipment class that has been exposed to earthquakes or testing, supplemented by analysis as required.~~

E.3 Seismic Qualification Methods

The scope of Seismic Category I equipment that requires seismic qualification is defined in Section 3.10. The seismic qualification is performed in accordance with IEEE Std 344 (Reference 1) and incorporates the requirements from Sections 3.7, 3.9, and 3.10. The qualification can be demonstrated through testing, analysis, a combination of testing and analysis, similarity, and by use of experience data. The method of qualification must be selected based on the appropriateness of the method for the size, type, complexity, and functional requirements of the subject equipment.

E.3.1 Qualification by Testing

Qualification by testing is the preferred qualification method for equipment that must perform an active function during and after a seismic event. The type of seismic test that is recommended depends on the type of equipment, its function, the methods of mounting, and the type of seismic motion expected according to Section 3.10.2. The different methods of qualification by testing are presented in Section E.5 of this attachment.

E.3.2 Qualification by Analysis

Qualification by analysis is selected when equipment can be accurately modeled and when it is verified that the structural integrity of the equipment sufficiently demonstrates that it will perform its design-intended function during and after a seismic event. In addition, when a complete seismic test is not practical, a combination of testing and analysis can be performed as described in Section 3.10.2. Different methods for qualification by analysis are presented in Section E.6.

E.3.3 Qualification by Similarity

Qualification by similarity is appropriate when the equipment is similar to an item previously qualified, differing only in configuration details such as size or arrangement of specific qualified devices located in the assembly or structure. The purpose of qualification by similarity is to avoid the impracticality of testing or analyzing

numerous configurations of equipment that is essentially the same. Qualification by similarity shall demonstrate the similarity of equipment (i.e., demonstrate dynamic similarity), the applicability of the previous test and analysis, and assess the need for supplemental device testing. Specific details associated with qualification by similarity are presented in Section E.7.

E.3.4 Qualification by Experience

As noted in Section 3.10, seismic qualification based on experience, per Section 10 of IEEE Std 344-2004, is not utilized by AREVA NP. This does not prevent the use of applicable test data from previous qualification of similar equipment. ~~IEEE Std 344 (Reference 1) presents requirements for the use of properly documented test experience and seismic experience data to perform the seismic qualification of mechanical and electrical equipment. Experience data may be used on a case-by-case basis and includes mechanical and electrical equipment. The use of experience data includes an assessment of the appropriateness of the application, observance of limitations on its use, and completion of documentation requirements. Documentation requirements associated with the use of experience data include the identification of the specific equipment qualified based on experience, the details of the methodology used, and the corresponding supporting experience data for each piece of equipment. Section E.8 provides further information on qualification by experience.~~

E.4 Requirements

E.4.1 Damping

Damping represents the energy dissipation within a structure while it is responding to applied seismic inertia loads. The level of damping depends on many factors including the materials used, the methods of mounting, and the type of loading as addressed in Section 3.7.1.2 and in RG 1.61, Revision 1. Typical damping values used in seismic analysis are listed in Table 3.7.1-1—Damping Values for Safe Shutdown Earthquake.

E.4.1.1 Application of Damping in Testing

Equipment is subjected to seismic inertia loads defined by the required response spectra (RRS) for qualification of equipment by testing. Any practical value of damping can be used in the RRS for testing. It is not necessary to use a predefined damping value because the comparison of the test response spectra (TRS) and the RRS is performed for a TRS damping value that is equal to or greater than that used for the RRS. Both the RRS and TRS are described further in Section E.5.1.

accounted for in the low frequency modal analysis. The effects of this missing mass are considered in the analysis as addressed in Section 3.7.3.7.

The total combined response to high frequency modes are then combined with the total combined response from lower frequency modes as described in Section 3.7.3.7.

E.6.3.2 Time History Analysis

Time history analysis is the preferred method for seismic analysis when a piece of equipment exhibits a non-linear response (e.g., changing stiffness or frequencies under increasing load). This analysis is also used to generate response spectra at a specific component location, such as an instrument inside a cabinet panel. When the maximum time history responses to the three components of earthquake motion are calculated separately, the maximum combined response is calculated as described in Sections 3.7.3.6 and E.6.2.3. When the responses to the three components of earthquake motion are statistically independent and applied simultaneously, the responses may be obtained individually for each of the three independent components and combined algebraically at each time step to obtain the total response time history. This approach is further detailed in Section 3.7.3.6, which demonstrates that the approach conforms to RG 1.92.

E.7 Qualification by Similarity

IEEE Std 344 (Reference 1) provides information about the qualification of equipment by similarity for equipment similar to a type that is previously qualified either by test or analysis, and which differs only in size or in the specific qualified devices located in the assembly or structure. In such cases, it is neither practical nor necessary to test every variation of the basic qualified configuration. For these situations, the qualification of the various configurations is demonstrated by similarity using the previous test or analysis qualification. Where qualification is achieved by extrapolation of qualification results based on test, analysis, or combination of the two, the excitation, physical system, and safety function are taken into consideration. The need for additional qualification of the specific devices located in the assembly or structure is evaluated in each instance.

Qualification by similarity is not considered to be the same process as qualification by comparison to reference equipment classes derived from either earthquake experience or test experience data addressed in IEEE Std 344 (Reference 1). The use of such experience data is presented in the following sections.

E.8 DELETED ~~Qualification by Experience~~

~~Guidelines for performing EQ by comparison to experience data are provided in this section. As described in IEEE Std 344 (Reference 1), the source for experience data may be a reference equipment class that has been exposed to either earthquakes or~~

~~testing, supplemented by an analysis, as required. Use of experience data may not be appropriate for a specific application. The following paragraphs address the limitations on the use of qualification by experience.~~

~~Test experience data is obtained from test results from previous qualifications. Test experience data is most often applicable for establishing seismic qualification for a reference equipment class based on using the test results for five or more individual items. The test experience data should meet the requirements of IEEE Std 344 (Reference 1), including the seismic aging effects. The minimum requirement for consideration of seismic aging (i.e., fatigue) is as described in Section 3.7.3.2. The use of a single test of an item to qualify a different, but similar candidate item is considered qualification by similarity and is addressed in Section E.7.~~

~~Qualification based on test experience data involves the following steps.~~

1. ~~Characterize test motions experienced by the reference equipment.~~
2. ~~Establish the test experience based seismic capacity for a reference equipment class.~~
3. ~~Characterize the test experience reference equipment class.~~
4. ~~Compare the candidate equipment to the test experience reference equipment class.~~
5. ~~Document the qualification process.~~

~~A special case for the use of experience data is established for the situation of inherently rugged equipment. Experience data shows that certain types of equipment possess high resistance to seismic inertia loads. This may be the result of inherent characteristics required to accommodate operational or shipping loads and the application of explicit design standards. Such equipment is deemed to be inherently rugged. Where inherent seismic ruggedness can be established through analysis, testing, or earthquake experience, or where the seismic loads are a small fraction of the operating loads, the rules for characterizing the reference equipment class and the procedure for defining the seismic capacity of the reference equipment class may be simplified and reduced. In this case, the characterization of the reference equipment class and the technical justification for the assigned seismic capacity level are developed and documented as the reference data for this special case.~~

~~Limitations on the use of experience data conform to IEEE Std 344 (Reference 1).~~

E.9 Performance Criteria

The performance criteria for equipment that is being seismically qualified in accordance with IEEE Std 344 (Reference 1) are as follows: