AP1000 Safety-Related Equipment Seismic Qualification Testing

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Overview

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- Applicable Industry Standards
- Applicable Regulatory Requirements
- AP1000 EQ Methodology
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Seismic Qualification Requirements

- Providing evidence the equipment will perform its safety-related functions during and/or after being subjected to the forces resulting from a postulated Safe Shutdown Earthquake (SSE) at the end of its qualified life
- Safety-related equipment qualified by test shall withstand the effects of five half level SSEs, prior to the SSE
- High Frequency SSE Screening Test of Safety-related equipment susceptibility to Hard Rock High Frequency (HRHF) excitation

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Applicable Industry Standards

- IEEE Std 323-1974, “IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations”
- IEEE Std 344-1987, “IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations”
- IEEE Std 382-1996, “IEEE Standard for Qualification of Actuators for Power-Operated Valve Assemblies with Safety Related Functions for Nuclear Power Plants”

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Applicable Regulatory Requirements

- Regulatory Guide 1.89 “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants,” (Rev. 1, June 1984)
- Regulatory Guide 1.100 “Seismic Qualification of Electrical and Mechanical Equipment for Nuclear Power Plants,” (Rev. 2, June 1988)
- COL/DC-ISG-1 “Interim Staff Guidance on Seismic Issues of High Frequency Ground Motion
  - Assures safety-related equipment and components which are sensitive to HRHF seismic demand are screened out or shown to be acceptable for their specific application

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AP1000 EQ Methodology

- APP-GW-G1-002, AP1000 Plant Equipment Qualification Methodology

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Seismic Qualification Testing

- Seismic Testing in compliance with IEEE Std 344-1987 is the preferred method for demonstrating functionality and structural integrity of safety-related equipment during the earthquake event
  - Multi-Frequency Random Test Inputs meeting Stationary and Coherence requirements
  - Five Half Level SSEs followed by a minimum of one SSE
- High Frequency SSE Screening Test of Safety-related equipment susceptibility to HRHF excitation

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Seismic Qualification Test Sequence

- Initial Inspection
- Baseline Functional Test
- Environmental Operational Extremes Test
- Aging (where applicable: thermal, temperature cycling, radiation, mechanical / electrical wear, vibration)
- Seismic Test
  - Half SSE Testing
  - SSE Testing
- High Frequency SSE Screening Test of safety-related equipment susceptibility to HRHF excitation
- Post-test Inspection

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Seismic Margin in Testing

- Number of seismic test runs compared to one earthquake event
- Test response spectra (TRS) and requirement response spectra comparisons
  - Enveloping
  - Zero Period Acceleration (ZPA)
- Strong motion intensity of the test levels is always greater then the earthquake demand
- Broadened spectra curves which define the RRS are developed for multiple plant locations and elevations
- Sufficient margin exist in the qualification process when demonstrating seismic qualification to in-structure response spectra based on the certified seismic design response spectra (CSDRS)

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Seismic Margin in Testing (Cont'd)

- Additional seismic margin will need to be introduced for safety-related equipment susceptibility to HRHF excitation
  - Testing performing 5% critical damping testing should use HRHF spectra SSE RRS at 3% critical damping
  - The amplitude of the HRHF RRS shape will increase by approximately 30%
  - Developing the TRS at 5% critical damping testing to envelop the amplified HRHF RRS will also cause the ZPA to increase by approximately 30%