Evaluation and Screening Process for High Frequency Sensitive Equipment

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Evaluation and Screening Process for High Frequency Sensitive Equipment

Evaluation Process to Address HRHF Seismic Response Impact on Equipment Qualification

- Comparative seismic analyses of typical structures housing safety-related electrical equipment
- Reviewed existing seismic test data for high frequency (HF) content and equipment performance
- Development of a screening process for HF sensitive equipment and components
- Development of a methodology to address equipment sensitive to high frequency seismic excitation

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Comparative Seismic Analyses

- Evaluate the effects of high frequency seismic input on typical safety-related equipment
- Conclusions:
  - Equipment exhibiting dominant natural frequencies below Hard Rock High Frequency (HRHF) exceedance range or above 50 Hz do not require any additional treatment for qualification to HF seismic requirements
  - Equipment that exhibits dominant natural frequencies which coincide with the peak spectral acceleration of the HRHF Safe Shutdown Earthquake (SSE) Required Response Spectra (RRS) will require additional evaluation to verify acceptability

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Review of Existing Seismic Test Data

- Evaluate low frequency seismic test programs to determine if high frequency excitation is exhibited in the frequency range of 25 to 50 Hz
- Conclusions:
  - Current seismic qualification test methods envelop HRHF SSE inputs up to a 2 g peak spectral acceleration (5% critical damping)
  - HF supplemental seismic testing should be conducted when all the following occur:
    - Equipment has potential high frequency failure modes
    - HRHF SSE RRS peak coincides with equipment dominant natural frequencies
    - HRHF SSE RRS peak acceleration is greater than 2 g at 5% critical damping

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Screening Process for HF Sensitive Equipment

- HF sensitive equipment are those safety-related equipment and components with potential failure modes involving change of state, chatter, signal change/drift, and connection problems
- HF sensitive equipment are screened out or found acceptable for HRHF excitation
- HF Susceptibility requires all of the following factors to be present:
  - HRHF SSE RRS exceeds the Certified Design AP1000 SSE In-Structure Response Spectra (ISRS)
  - HRHF SSE RRS peak acceleration is greater than 2 g at 5% critical damping
  - Equipment dominant natural frequencies are in the HF exceedance range

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Evaluation Methodology for HF Sensitive Equipment

Group No. 1

- Rugged equipment with dominant natural frequencies above 50 Hz
- Seismic qualification of this group based on AP1000 SSE ISRS is adequate and no additional evaluation for HRHF SSE RRS is required

Group No. 2

- Equipment which exhibit dominant natural frequencies below the HRHF exceedance range
- Seismic qualification of this group based on AP1000 SSE ISRS is adequate and no additional evaluation for HRHF SSE RRS is required

Group No. 3

- Safety-related equipment which exhibit dominant natural frequencies in HRHF exceedance range
- The safety-related equipment will be subjected to supplemental high frequency seismic evaluation to verify acceptability

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Evaluation Methodology for HF Sensitive Equipment (Cont'd)

- Evaluation of Group No. 3 Equipment
  - Perform review of equipment safety functions and potential HF failure modes for SSE event
    - Equipment whose failure modes would result in a plant safe shutdown are excluded
  - Supplemental HF seismic testing is conducted when HRHF SSE RRS peak spectral acceleration is greater than 2 g (at 5% critical damping)
  - HF sensitive components having potential failure modes associated with mounting, connections and fasteners, joints, and interface are considered to be qualified by traditional low frequency qualification testing per IEEE Std 344 and/or required quality assurance inspection and process/design controls

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Evaluation Methodology for HF Sensitive Equipment (Cont'd)

- Evaluation of Group No. 3 Equipment (Cont'd)
  - No additional seismic testing is required for previously tested equipment whose qualified level envelops the HRHF SSE RRS
  - Supplemental seismic testing is the preferred HF screening method when low frequency seismic testing does not envelop the HRHF SSE RRS
- EPRI White Paper "Seismic Screening of Components Sensitive to High Frequency Vibratory Motions" (June 2007) outlines other recommended generic screening methods

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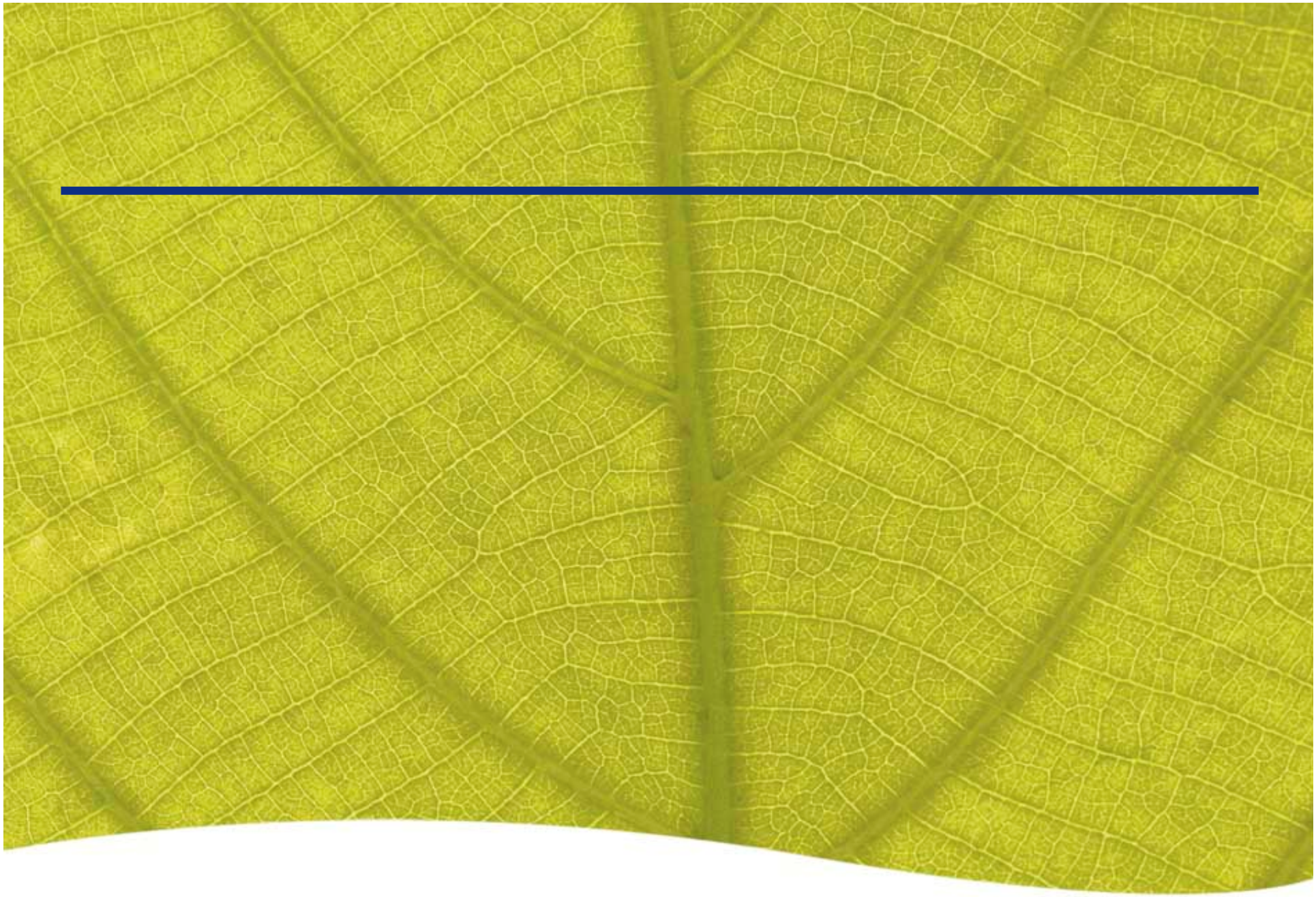

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