Attachments 2, 5, 6, 7, 8, 9, 12, 15, 18 and 23 are to be withheld from public disclosure under 10 CFR 2.390. When separated from these attachments, this letter is decontrolled.

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

February 25, 2011

10 CFR 50.4

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 2
NRC Docket No. 50-391

Subject: WATTS BAR NUCLEAR PLANT (WBN) UNIT 2 – INSTRUMENTATION AND CONTROLS STAFF INFORMATION REQUESTS

Reference: 1. Licensee Open Items to be Resolved for SER Approval List

The purpose of this letter is to provide TVA's responses to NRC's information requests on the referenced "Licensee Open Items to be Resolved for SER Approval List." Enclosure 1 to this letter provides TVA's responses to the information requested by NRC.

Enclosure 2 contains the attached supporting documents for TVA's responses to NRC's requests/questions provided in Enclosure 1. Enclosure 3 contains a list of references on which TVA's responses are based. Enclosure 4 provides a list of the new regulatory commitments contained in this letter.

Attachments 2, 5 through 8, and 23 contain information proprietary to General Atomics Electronic Systems Inc. (GA-ESI). TVA requests that the GA-ESI proprietary information be withheld from public disclosure in accordance with 10 CFR § 2.390. An affidavit for withholding proprietary information from public disclosure and non-proprietary versions of the documents will be submitted within two weeks of receipt from GA-ESI.

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Attachments 9, 12, 15 and 18 contain information proprietary to Westinghouse Electric Corporation (WEC). TVA requests that the WEC proprietary information be withheld from public disclosure in accordance with 10 CFR § 2.390. The corresponding affidavits for withholding proprietary information from public disclosure are contained in Attachments 11, 14, 17 and 20. Attachments 10, 13, 16 and 19 contain the corresponding non-proprietary versions of the documents.

The Attachments have been reviewed and approved by WBN Unit 2 Engineering with the exception of Attachment 8 which provides qualification information for all WBN Unit 2 replacement monitors. WBN Unit 2 Engineering has, however, reviewed and approved those portions of Attachment 8 which apply to the RM-1000 monitors.

If you have any questions, please contact William Crouch at (423) 365-2004.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 25th day of February, 2011.

Sincerely,

David Stinson
Watts Bar Unit 2 Vice President

Enclosures:

1. Responses to Licensee Open Items To Be Resolved For SER Approval
2. List of Attachments
3. List of References
4. List of New Regulatory Commitments

cc (Enclosures):

U. S. Nuclear Regulatory Commission
Region II
Marquis One Tower
245 Peachtree Center Ave., NE Suite 1200
Atlanta, Georgia 30303-1257

NRC Resident Inspector Unit 2
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Enclosure 1
TVA Letter Dated February 25, 2011
Responses to Licensee Open Items to be Resolved for SER Approval

For some NRC RAI requests, this letter provides TVA's initial response. For the other NRC RAI requests in this letter, a response has been provided in previous TVA letters to the NRC and the NRC has subsequently requested additional information. For these requests, the initial TVA response is not repeated below. The additional NRC information requests are identified as **"Follow-up NRC Requests."** TVA responses to these items are identified as **"TVA Response to Follow-up NRC Request."**

1. **NRC Request (Item Number 081)**

The Post Accident Monitoring System (PAMS) Licensing Technical Report (WNA-LI-00058-WBT Rev. 0, Dated April 2010), in Section 7, lists codes and standards applicable to the Common Q PAMS. This list contains references to old revisions of several regulatory documents, for example:

(1) RG 1.29 - September 1978 vs. March 2007
(2) RG 1.53 - June 1973 vs. November 2003
(a) IEEE 379-1994 vs. -2000
(3) RG 1.75 - September 1975 vs. February 2005
a. IEEE 384-1992 vs. -1992
(4) RG 1.100 - June 1988 vs. September 2009
a. IEEE 344-1987 vs. -2004
(5) RG 1.152 - January 1996 vs. January 2006
a. IEEE 7-4.33.2-1993 vs. -2003
(6) RG 1.168 - September 1997 vs. February 2004
a. IEEE 1012-1986 vs. -1998
b. IEEE 1028-1988 vs. -1997
(7) IEEE 279-1991 vs. 603-1991
(8) IEEE 323-1983 vs. -1974 (RG 1.89 Rev. 1 June 1984 endorses 323-1974)

However, LIC-110, "Watts Bar Unit 2 License Application Review," states: "Design features and administrative programs that are unique to Unit 2 should then be reviewed in accordance with the current staff positions." Please identify all differences between the versions referenced and the current staff positions. Please provide a justification for the acceptability PAMS with respect to these differences.

Follow-up NRC Request:

ML101600092 Item No.1: There are three sets of regulatory criteria that relate to a Common Q application (e.g. WBN2 PAMS):
(a) Common Q platform components – Common Q TR
(b) Application Development Processes – Common Q SPM
(c) Application Specific – current regulatory criteria

The Common Q Topical Report and associated appendices primarily addressed (a) and (b). The Common Q SER states:

'...Appendix 1, "Post Accident Monitoring Systems," provides the functional requirements and conceptual design approach for upgrading an existing PAMS based on Common Q components (page 58, Section 4.4.1.1, "Description")...On the basis of the above review, the staff concludes that Appendix 1 does not contain sufficient information to establish the generic acceptability of the proposed PAMS design (page 56, Section 4.4.1.3, "PAMS Evaluation")...'

The NRC did not approve the proposed PAMS design. Section 6, "References," and Section 7, "Codes and Standards Applicable to the Common Q PAMS," of the PAMS Licensing Technical Report contain items that are not the current regulatory criteria.

Please provide an explanation of how the WBN2 PAMS conforms with the application specific regulatory criteria applicable to the WBN2 PAMS design. For example IEEE Std. 603-1991 Clause 5.6.3, "Independence Between Safety Systems and Other Systems," and Clause 6.3, "Interaction Between the Sense and Command Features and Other Systems," contain application specific requirements that must be addressed by a PAMS system.

TVA Response to Follow-up NRC Request:

Attachment 4 contains the results of the TVA analysis of standards and regulatory guides applicable to the Common Q PAMS. Based on the results of the analysis, the Common Q PAMS design meets the applicable requirements and is acceptable.

2. **NRC Request (Item Number 086)**

The PAMS Licensing Technical Report (WNA-LI-00058-WBT Rev. 0, Dated April 2010), in Section 6, lists references applicable to the Common Q PAMS. This list contains references to old revisions of several regulatory documents, for example:

(1) DI&C-ISG04 - Rev. 0 (ML072540138) vs. Rev. 1 (ML083310185)

However, LIC-110, "Watts Bar Unit 2 License Application Review," states: "Design features and administrative programs that are unique to Unit 2 should then be reviewed in accordance with the current staff positions." Please identify all differences between the versions referenced and the current staff positions. Please provide a justification for the acceptability PAMS with respect to these differences.

Follow-up NRC Request:

TVA to address with Open Item 81.

TVA Response to Follow-up NRC Request:

The analysis for compliance with DI&C-ISG04, Revision 0 to Revision 1 was previously submitted as part of the Common Q PAMS Licensing Technical Report Revision 2 in TVA to NRC letter dated December 22, 2010 (Reference 1). Attachment 4 contains the results of the TVA analysis of standards and regulatory guides applicable to the Common Q PAMS. Based on the results of the analysis, the Common Q PAMS design is acceptable.

3. **NRC Request (Item Number 142)**

The applicable regulatory guidance for reviewing the WBN2 PAMS System Requirements Specification (SysRS) would be IEEE 830 as endorsed by Regulatory Guide 1.172 and BTP 7-14 Section B.3.3.1, Requirements Activities – Software Requirements Specifications." IEEE 830-1994 Section 4.3.8, "Traceable," states: "A [requirements specification] is traceable of the origin of each of its requirements is clear..."

Follow-up NRC Request:

Updated Specifications and Requirements Traceability Matrix (RTM) to be provided by TVA

TVA Response to Follow-up NRC Request:

WNA-VR-00279-WBT, Revision 4, "Watts Bar 2 NSSS Completion Program I&C Projects Requirements Traceability Matrix for the Post Accident Monitoring System" is available for NRC audit at the Westinghouse Rockville office. The document will be available at the Westinghouse Cranberry offices to support the NRC Common Q PAMS audit.

Attachment 9 contains the proprietary version of WNA-DS-01617-WBT-P, Revision 4, "Post Accident Monitoring System - System Requirements Specification," dated February 2011. Attachment 10 contains the non-proprietary version WNA-DS-01617-WBT-NP, Revision 4, "Post Accident Monitoring System - System Requirements Specification," dated February, 2011. Attachment 11 contains the Application for Withholding Proprietary Information from Public Disclosure, WNA-DS-01617-WBT-P, Revision 4, "Nuclear Automation Watts Bar 2 NSSS Completion Program I&C Projects, Post Accident Monitoring System - System Requirements Specification" (Proprietary), dated February 10, 2011.

Attachment 12 contains the proprietary version of WNA-DS-01667-WBT-P, Revision 4, "Post Accident Monitoring System – System Design Specification," dated February 2011. Attachment 13 contains the non-proprietary version WNA-DS-01667-WBT-NP, Revision 4, "Post Accident Monitoring System – System Design Specification," dated February 2011. Attachment 14 contains the Application for Withholding Proprietary Information from Public Disclosure, WNA-DS-01667-WBT-P, Revision 4, "Nuclear Automation Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System - System Design Specification" (Proprietary), dated February 11, 2011.

Attachment 15 contains the proprietary version of WNA-SD-00239-WBT-P, Revision 4, "Software Requirements Specification for the Post Accident Monitoring System," dated February 2011. Attachment 16 contains the non-proprietary version WNA-SD-00239-WBT-NP, Revision 4, "Software Requirements Specification for the Post Accident Monitoring System," dated February 2011. Attachment 17 contains the Application for Withholding Proprietary Information from Public Disclosure, WNA-SD-00239-WBT-P, Revision 4, "Nuclear Automation Watts Bar 2 NSSS Completion Program I&C Projects, Software Requirements Specification for the Post Accident Monitoring System" (Proprietary), dated February 10, 2011.

4. **NRC Request (Item Number 143)**

The WBN2 PAMS Software Requirements Specification (WBN2 PAMS Software Requirements Specification (SRS) – ML101050202) contains a table (see page iii) titled, "Document Traceability & Compliance," which states that the WBN2 PAMS SRS was created to support the three documents identified (one of which is the WBN2 PAMS SysRS). Section 1.1, "Overview," of the WBN2 PAMS SRS states: "This document describes requirements for the major software components ..."

Follow-up NRC Request:

Updated Specifications and RTMs to be provided by TVA

TVA Response to Follow-up NRC Request:

See Response to item 3 (Matrix Item Number 142)

5. **NRC Request (Item Number 145)**

The WBN2 PAMS System Design Specification (WBN2 PAMS System Design Specification(SDS)) contains a table (see page iii) titled, "Document Traceability & Compliance," which states that the WBN2 PAMS SDS was created to support the WBN2 PAMS SysRS.

(a) *Does the WBN2 PAMS SDS implement all of the hardware requirements in the WBN2 PAMS SysRS?*

(b) *Please briefly describe all of the documents that implement the hardware requirements of the WBN2 PAMS SysRS.*

Follow-up NRC Request:

To be addressed by Revision of the RTM, SRS, SysRS, and SysDS.

TVA Response to Follow-up NRC Request:

See Response to item 3 (Matrix Item Number 142)

6. **NRC Request (Item Number 202)**

The letter (ML0003740165) which transmitted the Safety Evaluation for the Common Q topical report to Westinghouse stated: "Should our criteria or regulations change so that our conclusions as to the acceptability of the report are invalidated, CE Nuclear Power and/or the applicant referencing the topical report will be expected to revise and resubmit their respective documentation, or submit justification for continued applicability of the topical report without revision of the respective documentation." Question No 81 identified many criteria changes; please revise the respective documentation or submit justification for continued applicability of the topical report.

Follow-up NRC Request:

Summary provided in Licensing Technical Report (LTR) Revision 2 has been reviewed and found to be unacceptable.

LTR Section 9 evaluates the compliance of the Software Requirements Specification (SRS) to IEEE 830-1998. There are two issues with this evaluation:

(1) IEEE 830-1998 is not the current Standard Review Plan (SRP) acceptance criteria. IEEE 830-1998 has not been formally endorsed by a regulatory guide.
(2) Westinghouse committed to evaluate the SRS against 830 when the NRC identified several inconsistencies.

Yes ISG-4 is one new criteria, and an evaluation against it has been provided.

In addition, LTR Revision. 2 Section 13 states: "The applicable NRC regulatory guides, IEEE and EPRI industry standards for the common Q PAMS are shown below. Compliance to these codes and standards are stated in Section 4 of Reference 1." Reference 1 is the common Q topical report.

Partial TVA Response to Follow-up NRC Request:

(1) and *(2)* The current version of the IEEE Standard is 830-1993. The following statement was previously added to the LTR, Revision 2:

"An analysis was performed to determine the differences between IEEE Standard 830-1993 and IEEE Standard 830-1998. It was determined that IEEE Standard 830-1998 enveloped all of the requirements in IEEE Standard 830-1993. The changes in IEEE Standard 830-1998 were to update the dates of the references, to fix minor wording and formatting, and to add an informative Annex that shows guidelines for compliance with IEEE/EIA 12207.1-1997."

Attachment 4 contains the results of the TVA analysis of standards and regulatory guides applicable to the Common Q PAMS. Based on the results of the analysis, the Common Q PAMS design is acceptable.

The final response to this item is pending submittal of the Licensing Technical Report Revision 3 scheduled for March 29, 2011.

7. **NRC Request (Item Number 244)**

Section 8.2.2 of the Common Q SPM (ML050350234) states that the Software Requirements Specification (SRS) shall be developed using IEEE 830 and RE 1.172. Clause 4.8, "Embedding project requirements in the SRS," of the IEEE 830 states that an SRS should address the software product, not the process of producing the software. In addition Section 4.3.2.1 of the SPM states "Any alternatives to the SPM processes or additional project specific information for the ...SCMP...shall be specified in the PQP.

Contrary to these two statements in the SPM, the WBN2 PAMS SRS (ML101050202) contains many process related requirements, for example all seventeen requirements in Section 2.3.2, "Configuration Control," address process requirements for configuration control.

Please explain how the above meets the intent of the approved SPM.

Follow-up NRC Request:

Issues with Common Q TR & SPM compliance were discussed in the weekly public meetings.

TVA Response to Follow-up NRC Request:

The documents discussed in Item 3 have been revised to address compliance with the Topical Report (TR) and the Software Program Manual (SPM).

8. **NRC Request (Item Number 252)**

The (Software Program Manual) SPM contain requirements for software requirements traceability analysis and associated documentation (see Section 5.4.5.3, "Requirements Traceability Analysis"). Please provide information that demonstrates that requirements traceability analysis has been successfully accomplished.

Follow-up NRC Request:

Updated Specifications and RTMs to be provided by TVA

TVA Response to Follow-up NRC Request:

See Response to item 3 (Matrix Item Number 142)

9. **NRC Request (Item Number 281)**

For FSAR Section 7.6.8 in amendment 96, redline version has completely rewritten this section of the FSAR, however, the staff is not able to determine any changes made to the section. Explain what changes have been made to this FSAR Section.

Follow-up NRC Request:

***(1)** FSAR Amendment 101 did not reflect the changes in 7.6.8 associated with implementation of the DCS. **(2)** Provide the basis for acceptance to use Foxboro I/A DCS in place of analog instrumentation and relays.*

TVA Response to Follow-up NRC Request:

(1) The underlined text from FSAR Amendment 101 Section 7.6.8 reflects the installation of the Foxboro DCS.

7.6.8 Text from FSAR Amendment 101

The wide range temperature signals, as inputs to the Protection Sets I and II, continuously monitor RCS temperature conditions. In Protection Set I, the existing RCS wide range temperature channels on RCS loops 1 and 2 provide inputs to the Eagle 21 digital process protection system. Eagle 21 provides isolated analog signals to the digital process control system. An auctioneer function selects the lowest temperature signal which is then used to calculate an acceptable reference pressure limit (PORV setpoint) considering the plant's allowable pressure and temperature Protection Set III. The calculated reference pressure is compared to the actual RCS pressure monitored by the wide range pressure channel. The auctioneered temperature signal will annunciate a main control room (MCR) alarm whenever the measured temperature approaches, within a predetermined amount, the reference temperature for arming the system. Similarly, whenever the measured pressure approaches within a predetermined amount of the programmed setpoint, another MCR alarm will be generated. When the measured RCS pressure is equal to or above the programmed setpoint (nominal values), a PORV open signal is initiated and a MCR alarm is actuated. A manually armed permissive allows this actuation signal to control the Train A PORV (PCV-68-340A). The manually armed permissive also serves to block a spurious PORV opening due to potential instrument failure whenever the RCS temperature is above the arming reference temperature.

The monitored generating station variables that generate the actuation signal for the Train B PORV (PCV-68-334) are processed in a similar manner. The RCS loops 3 and 4 wide range temperature signals and the RCS pressure signal are provided from Protection Set II. Therefore, the generating station variables used for the Train B PORV are derived from a protection set that is independent of the sets from which generating station variables used for the Train A PORV are derived. The wide range temperature auctioneer function and the programmed pressure setpoint calculation for the Train B PORV are performed in a different group of the digital process control system than those for the Train A PORV. Each of these control groups has a fault tolerant, redundant processor pair and redundant power supplies with different power sources.

(2) At the NRC public meeting, the NRC reviewer identified that the specific question was Foxboro I/A compliance with IEEE 279.

FSAR section 7.6.8.1 addresses compliance of the COMS with IEEE 279 and states:

7.6.8.1 Analysis of Interlock

Many criteria presented in IEEE 279-1971 and IEEE 338-1971 do not apply to the interlocks for RCS pressure control during low temperature operation,

because the interlocks do not perform a protective function but rather provide automatic pressure control at low temperatures as a backup to the operator. However, although IEEE 279-1971 criteria do not apply, some advantages of the dependability and benefits of an IEEE 279-1971 design have occurred by including the pressure and temperature signal elements as noted above in the protection sets and by organizing the control of the two PORVs into dual channels. Either of the two PORVs can accomplish the RCS pressure control function.

The design of the low temperature interlocks for RCS pressure control is such that pertinent features include:

(1) No credible failure at the output of the protection set racks, after the output leaves the racks to interface with the interlocks, will prevent the associated protection system channel from performing its protective function because such outputs that leave the racks go through an isolation device.

(2) Testing capability for elements of the interlocks within (not external to) the protection sets that generate the temperature and pressure process signals for the overpressure mitigation system is consistent with the testing principles and methods discussed in Section 7.2.1.1.3.

(3) A loss of offsite power will not defeat the provisions for an electrical power source for the interlocks because these provisions are through onsite power which is described in Section 8.3.

The design of the COMS as implemented in the Foxboro I/A system fully complies with FSAR section 7.6.8.1. Items (1) and (2) are implemented as part of the Eagle 21 modification. Item (3) is addressed by each processor pair having redundant power supplies with both being battery backed and ultimately backed by an ESF diesel generator.

10. NRC Request (Item Number 318)

TVA has provided the following documents for RM-1000 equipment qualification:

(i) Qualification Test Report for RM-1000 Processor Module and Current-To-Frequency Converter 04508905-QR (January 2001)

(ii) Qualification Test Report Supplement, RM-1000 Upgrades 04508905-1SP (June 2006)

(iii) Qualification Test Report Supplement, RM-1000 Upgrades 04508905-2SP (June 2008)

(iv) Qualification Test Report Supplement, RM-1000 Upgrades 04508905-3SP (May 2008)

Please clarify whether all of these are fully applicable to WBN2 or are they applicable with exceptions? If with exceptions, then please clarify what those are.

Supplement 3 was issued one month prior to supplement 2. Please explain the reason for the same.

Follow-up NRC Request:

Provide qualification reports 04038903-QSR and 04038903-7SP by the dues date of 1/22/11.

Submit a copy of any other relevant reviewed versions of the qualification reports.

Submit copies of the reviewed reports for 04508905-QR, 04508905-1SP, 04508905-2SP.

Clarification of applicability of existing reports is acceptable.

TVA Response to Follow-up NRC Request:

The following documents are the qualification documents associated with the RM-1000 radiation monitors:

- Attachment 5 contains the approved proprietary version of General Atomics Electronic Systems 04508905-1SP, "Qualification Test Report Supplement, RM-1000 Upgrade."
- Attachment 6 contains the approved proprietary version of General Atomics Electronic Systems 04508905-2SP, "Qualification Test Report Supplement, I-F Converter Upgrades."
- Attachment 7 contains the approved proprietary version of General Atomics Electronic Systems 04038903-7SP, "Qualification Basis for 04034101 (2-RE-90-271, 272, 273 & 274)."
- Attachment 8 contains the proprietary version of General Atomics Electronic Systems 04038903-QSR, "Qualification Summary Report for Watts Bar Nuclear Plant Unit 2 Replacement Radiation Monitors." WBN Unit 2 Engineering has reviewed and approved only those portions of this document applicable to the RM-1000 monitors. Engineering approval of the entire document will take place when a full review of all covered monitors is complete.
- Attachment 23 contains the approved proprietary version of General Atomics Electronic Systems 04508905-QR, "Qualification Test Report for RM-1000 Processor Module and Current-To-Frequency Converter."

11. NRC Request (Item Number 323)

WCAP-13869 revision 1 was previously reviewed under WBN Unit 1 SER SSER 13 (Reference 8). Unit 2 references revision 2. An analysis of the differences and their acceptability will be submitted to the NRC by November 15, 2010
Please clarify whether all of these are fully applicable to WBN2 or are they applicable with exceptions? If with exceptions, then please clarify what those are.

Follow-up NRC Request:

The staff is confused with the response since both units have reference leg not insulated. Rev 2 should apply to Unit 1 also and there should be no difference between Unit 1 and 2

TVA Response to Follow-up NRC Request:

A FSAR change will be submitted in a future FSAR amendment to change the revision level back to revision 1 for WBN Unit 2.

12. NRC Request (Item Number 335)

LPMS: Reference to OI-331, sub item 2.

Provide analysis, test, or combined analysis and test for normal operating radiation, temperature, and humidity environment per regulatory position C.1.g of RG 1.133. As an alternate TVA may confirm that the required equipment has been qualified for the environments stated in RG 1.133, position C.1.g and that TVA has reviewed the test report and found it acceptable.

TVA Response to NRC Request:

Partial Response included in TVA to NRC letter dated December 22, 2010 (Reference 1).

Attachment 18 contains the proprietary version of EQ-EV-71-WBT-P, Revision 1, "Environmental Evaluation and Operating History of the Westinghouse DMIMS-DX Preamplifier and Softline Cable Used at Watts Bar 2" dated February 2011 (Proprietary). Attachment 19 contains the non-proprietary version EQ-EV-71-WBT-NP, Revision 1, "Environmental Evaluation and Operating History of the Westinghouse DMIMS-DX Preamplifier and Softline Cable Used at Watts Bar 2," dated February 2011. Attachment 20 contains the Application for Withholding Proprietary Information from Public Disclosure, EQ-EV-71-WBT-P, Revision 1, "Environmental Evaluation and Operating History of the Westinghouse DMIMS-DX Preamplifier and Softline Cable Used at Watts Bar 2," (Proprietary) dated February 18, 2011.

13. NRC Request (Item Number 338)

In page 3-15 and appendix B of Qualification Test Report 04508905-QR, licensee described the selection of seismic required response spectra (RRS) and indicated Figure 3-2 (page 3-17), Figure 3-3 (page 3-18) are the RRSs used. The RRS curves used for actual testing are lower than the RRS curves that are shown on Figures 3-2 and 3-3. The RRS curves used for testing are shown in Figure 4-5, 4-6, 4-7, 4-8, 4-11, 4-12, 4-13, and 4-14 (pages 4-25, 4-26, 4-28, 4-29, 4-37, 4-38, 4-40, 4-41). Please clarify and justify why the RRS curves used in actual tests are lower than the RRS curves determined in Figures 3-2 and 3-3.

In addition please justify that the RRS used for testing envelopes the RRS required for WBN-2 application specific seismic conditions.

TVA Response:

04508905-QR, "Qualification Test Report for RM-1000 Processor Module and Current-To-Frequency Converter," (Attachment 23) documents the original baseline testing of the RM-1000 and current-to-frequency converter. The document has been revised to discuss the actual test spectra versus the required WBN spectra and how the WBN requirements were satisfied (Reference 22). 04508905-QR serves as a reference document for the WBN Unit 2 specific seismic qualification of the RM-1000 radiation monitors and current-to-frequency converters documented in 04038903-7SP, "Qualification Basis for 04034101 (2-RE-90-271, 272, 273 & 274)," (Attachment 7) and 04038903-QSR, "Qualification Summary Report for Watts Bar Nuclear Plant Unit 2 Replacement Radiation Monitors," (Attachment 8).

14. **NRC Request (Item Number 339)**

In the Qualification Test Report 04508905-QR, the licensee provided only eight Safe Shutdown Earthquake (SSE) Test Response Spectra (TRS) as mentioned in the previous open item (OI-338). Please provide all SSE and Operating Basis Earthquake (OBE) TRS plots for NRC review.

TVA Response:

As agreed to with the reviewer, Attachment 1 contains the applicable ARS plots for Elevation 755 where the TRS does not envelope the RRS. Attachment 2 contains the applicable Wyle Test Report 41991 SSE TRS plots.

15. **NRC Request (Item Number 340)**

Provide test result curves for all Electro Magnetic Interference and Radio Frequency Interference (EMI/RFI) tests listed in Table 3.2.3 (page 3-8) of the Qualification Test Report 04508905-QR. In addition, please provide the standards or the guidance documents used as the source for ENV 50140, ENV 55011 Class A, and EN 55022 Class B.

Follow-up NRC Request:

Provide the qualification reports by 1/28/11 per TVA letter of 12/22/10.

TVA Response to Follow-up NRC Request:

The total EMI/RFI testing of the RM-1000 and current-to-frequency converter is documented in the following reports:

- Attachment 5 contains the proprietary version of General Atomics Electronic Systems 04508905-1SP, "Qualification Test Report Supplement, RM-1000 Upgrade." See sections 5.1.1, 5.1.2 and 5.1.4 for EMI/RFI.
- Attachment 7 contains the proprietary version of General Atomics Electronic Systems 04038903-7SP, "Qualification Basis for 04034101 (2-RE-90-271, 272, 273 & 274)." See section 5 for EMC qualification basis.

- Attachment 8 contains the proprietary version of General Atomics Electronic Systems 04038903-QSR, "Qualification Summary Report for Watts Bar Nuclear Plant Unit 2 Replacement Radiation Monitors." See section 3.4 for electromagnetic compatability qualification requirements.
- Attachment 23 contains the proprietary version of General Atomics Electronic Systems 04508905-QR, "Qualification Test Report for RM-1000 Processor Module and Current-To-Frequency Converter." See sections 3.2.1 through 3.2.5 and 6.2 for EMI/RFI.

Attachments 7 and 8 document the EMI/RFI testing specific to the WBN Unit 2 RM-1000 monitors and current-to-frequency converters.

16. NRC Request (Item Number 341)

FSAR Table 3.10 list seismically qualified equipment. However, these tables do not list the containment high range radiation monitors. Please add them to the appropriate FSAR table(s) or justify why they should not be included in the FSAR 3.10 series of tables.

TVA Response:

A review of WBN Unit 2 FSAR Amendment 102 sections 3.10, 11 and 12 was performed. The reviewer was unable to locate seismic qualification information for the radiation monitoring system in those sections. A review of Chapter 3.11 confirmed that radiation monitoring is included in the environmentally qualified systems.

It appears that seismic qualification of the radiation monitoring equipment was unintentionally omitted from FSAR section 3.10. FSAR section 3.10 will be updated to include the qualified radiation monitoring equipment in FSAR Amendment 103.

17. NRC Request (Item Number 344)

Unit 1 SE discussed in Section 7.6.5, "Valve Power Lockout". There is no section in FSAR which provides discussion on this subject. SE section discusses compliance with PSB-18. ***(a)*** *Provide a discussion which can be used by the staff to determine similar conclusion as Unit 1 and if the design is similar to Unit 1 then make a statement to that effect.* ***(b)*** *Also provide the list of the valves where power lockout during normal reactor operation is utilized for valves whose inadvertent operation could affect plant safety.*

TVA Response:

(a) In accordance with 0PDP-6, "Locked Valve/Breaker Program," Revision 1 (Attachment 25), valves locked by design are shown on design output documents (flow diagrams, system descriptions, etc.). As documented in 0PDP-6, valves are locked for multiple reasons. It is anticipated that many of the valves that were locked to provide positive isolation between Unit 1 and Unit 2 will not be locked when Unit 2 becomes operational and will be removed from the locked valve program. At the same time, Unit 1 valves locked for operational/Appendix R/Single Failure criteria will result in the corresponding Unit 2 valves being locked.

(b) The list of valves locked by design is contained in 0-PI-OPS-17.0, "18 Month Locked Valve Verification," Revision 44 (Attachment 21). Valves locked out by opening the associated circuit breaker are listed in 0-PI-OPS-17.1, "18 Month Locked Breaker Verification," Revision 14 (Attachment 24).

18. NRC Request (Item Number 345)

Provide the normal temperatures and expected periods of high/low temperature excursions to assess aging requirements. TVA to further clarify if 86°F for 40 years was used as the qualification requirement for aging tests. This has been stated in some of the subsections under section 4.2 of the 04508905-QR report but the rationale for using 86°F (includes an internal temperature rise of 18°F) for 40 years has not been justified in the 04508905-QR report or the supplement reports. TVA to provide the rationale for this acceptance criteria for WBN-2.

TVA Response:

RM-1000 in a NIM Bin was tested at 39° F for 72 Hrs and tested at 131° F for 72 Hrs per Section 4.2.6 of 04508905-QR (Attachment 23). This is stated in document 04038903-7SP, Section 2.1 (Attachment 7). The ambient temperature used for aging was 86° F (30°C). The NIM Bin has perforated holes in top and bottom covers and has an average internal temperature rise of approximately 18° F due to natural air convection. So the average internal temperature used for aging was 104° F (40° C).

In accordance with Attachment 8, 04038903-QSR, "Qualification Summary Report for Watts Bar Nuclear Plant Unit 2 Replacement Radiation Monitors," Section 3.2, the aging is to an ambient equivalent condition of 104° F which is based on an 86° F average ambient temperature of the environment and an enclosure temperature rise of 18° F. IEEE Std 1205-2000, Table D.8 shows that the upper bounding temperature is 104° F for all plant areas except the reactor building. The intent in qualifying the part for 40 years is to identify each component's failure mechanisms and to determine whether 40 years[1] of aging has a significant effect of these failure mechanisms.

[1]The design life goal for most Class 1E equipment is 40 years, but for most electronic assemblies 20 years, or less, is more realistic. Because of rapidly changing technologies, replacement components sometimes become unavailable in a relatively short period of time.

19. NRC Request (Item Number 346)

TVA has previously stated in response to open item 319 that RM-1000 System Verification Test Results report, 04507007-1TR is not applicable to WBN-2. However, TVA has not provided a WBN-2 specific test results report. Please identify and provide the appropriate test results reports to complete the review.

TVA Response:

Document 04507007-1TR is the RM-1000 System Verification Test Results. 04038903-QSR, "Qualification Summary Report for Watts Bar Nuclear Plant Unit 2 Replacement Radiation Monitors" (Attachment 8) and 04038903-7SP, "Qualification Basis for 04034101

(2-RE-90-271, 272, 273 & 274) (Attachment 7) are the WBN Unit 2 equipment specific qualification reports.

20. NRC Request (Item Number 347)

Qualification report 04508905-1SP does not address EMI/RFI qualification for the new RM-1000 modules. TVA to provide the updated qualification or explain the basis for not addressing the EMI/RFI qualification.

TVA Response:

Qualification report 04038903-7SP, Qualification Basis for 04034101-001 (2-RE-90-271, -272, -273, & -274) (Attachment 7), addresses the EMI/RFI qualifications for the entire loop including the RM-1000 and current to frequency (I/F) converter. This report references 04038800, "RM-1000 EMC Test Report, TVA," and 04509050, "RM-1000 EMC Test Report." The results are summarized in 04038903-7SP.

21. NRC Request (Item Number 348)

Qualification report 04508905-2SP does not address EMI/RFI qualification for the new I/F converters. TVA to provide the updated qualification or explain the basis for not addressing the EMI/RFI qualification.

TVA Response:

Qualification report 04038903-7SP, Qualification Basis for 04034101-001 (2-RE-90-271, -272, -273, & -274), (Attachment 7) addresses the EMI/RFI qualifications for the entire loop including the RM-1000 and I/F converter. This report references 04038800, "RM-1000 EMC Test Report, TVA," and 04509050, "RM-1000 EMC Test Report." The results are summarized in 04038903-7SP.

22. NRC Request (Item Number 349)

Radiation testing was not considered in any of the test reports as all the equipment has been assumed to be located in nuclear power plant areas with mild environments and radiation dosages less than 1 x 10^3 rads for total integrated dose (TID). However, the radiation monitors and the I/F converters are located in the main control room which is defined as mild environment. For WBN-2 mild environment is defined as room or building zone where (1) the temperature, pressure, or relative humidity resulting from the direct effects of a design basis event (DBE) (e.g., temperature rise due to steam release) are no more severe than those which would occur during an abnormal plant operational condition, (2) the temperature will not exceed 130°F due to indirect effects of a DBE, (3) the event radiation dose is less than or equal to 1 x 10^4 rads, and (4) the total event plus the 40 year TID (total integrated dose) is less than or equal to 5 x 10^4 rads (reference WB-DC-40-54). TVA to address lack of radiation qualification for WBN-2.

TVA Response:

The design criteria provides the criteria for determining what is a mild environment at WBN Unit 2. Calculation WBNAPS4004, "Summary of Mild Environment Conditions for Watts Bar Nuclear Plant," provides the actual values for each area of the plant. In accordance with Table 1, the Control Room has a 40 year maximum TID of $3.5x10^2$ RAD and a maximum integrated accident dose of 710.5 RAD for a maximum TID of 1060.5 RAD.

The accident dose of 710.5 RAD is the dose for a 100 day LOCA at the surface of the HEPA filter in the Mechanical Equipment Room. This is documented in TVA calculation WBNTSR-005, "Dose Due to the Control Building Emergency Air Cleanup Filters," Revision 3. However, on page 25 of WBNTSR-005, the shine from this source into the control room is negligible and is not considered in the dose calculation for the control room.

Calculation WBNAPS3-126, "EQ Dose in the U1/U2 Auxiliary Instrument Rooms and the Computer Room in the Control Building," Revision 0 documents the environmental qualification (EQ) radiation dose in the control building. Considering that the dose from the HEPA filter is negligible to the control room (as discussed above), a review of the WBNAPS3-126 calculation determined that the TID including the normal and accident dose values for the control room is actually less than $1x10^3$ RAD. Calculation WBNAPS3-126 will be revised to add the control room to the calculation with a dose of less than $1x10^3$ RAD by July 1, 2011. Since the control room TID will be documented in calculation WBNAPS3-126 to be less than $1x10^3$ RAD, radiation qualification of the RM-1000 is not required.

23. NRC Request (Item Number 350)

The seismic required response spectra (RRS) is shown in Figures 3-1 of 04508905-1SP and Figure 3-1 of 0458905-2SP report. The actual test response spectra are shown in Figures 4-5 and 4-6 of 04508905-QR report. The actual test response spectra does not seem to fully envelope the RRS. However, this statement is based on visual reading of unidentified numbers. TVA to provide clarification to the values at the inflection point of all lines on the RRS and the actual test response spectra. The seismic qualification issue is open till further clarification is received from TVA.

TVA Response:

The RM-1000 was seismically tested in a NIM Bin, and the actual test response spectra fully envelopes the RRS of TVA Standard Specification CEB-SS-5.10, "For Seismic Qualification of Electrical, Mechanical and I&C Devices," Revision 3, (Attachment 3) Figure 3-1 as shown in Section 3.0, Figures 3-4 and 3-5 of 04038903-7SP, "Qualification Basis for 04034101 (2-RE-90-271, 272, 273 & 274)," (Attachment 7). Seismic qualification of the WBN Unit 2 RM-1000 monitors is summarized in 04038903-QSR, "Qualification Summary Report for Watts Bar Nuclear Plant Unit 2 Replacement Radiation Monitors" (Attachment 8).

24. NRC Request (Item Number 351)

The replacement schedule for the components that have a qualified life of less than 40 years is noted in Table 6-1 of the supplemental qualification report 04508905-1SP. It is not clear if the components identified for replacement in this report are the only components or if the components which are in addition to the components previously identified in qualification report 04508905-QR.

Are there any age sensitive components for the I/F converter used for WBN-2? (Note: Report 04508905-2SP does not state any age sensitive components that require replacement during the qualified life).

TVA Response:

The replacement schedules stated in 04508905-1SP, "Qualification Test Report Supplement, RM-1000 Upgrade," (Attachment 5) and 04508905-2SP, "Qualification Test Report Supplement, I-F Converter Upgrades," (Attachment 6) should be used. 04508905-2SP states in Section 6: "None of the Current-to-Frequency converter modules qualified by this supplement contain parts that have significant age related failure mechanisms."

25. NRC Request (Item Number 352)

Please clarify how many RM-1000 radiation monitors are being procured for WBN-2, is the quantity 2 or four. MR 25402-011-MRA-HARA-00002, R4 under Item 1.6 indicates that the quantity is 2. If so, is WBN-2 using dual channel indication on each RM-1000 unit. TVA to clarify.

TVA Response:

The total number of RM-1000 units procured under Material Requisition (MR) 25402-011-MRA-HARA-00002 is four. The MR on line item 1.6 is stating the purchase of 2 sets of 2 RM-1000s and I/F Converters making a total of 4 for each type of component.

Each monitor utilizes a single channel display for the 2-RM-90-271, -272, -273 and -274 monitors.

Enclosure 2
TVA Letter Dated February 25, 2011
Responses to Licensee Open Items to be Resolved for SER Approval

List of Attachments

1. Acceleration Response Spectra (ARS) for the El. 755 Auxiliary Control Building
2. Wyle Test Report 41991 Safe Shutdown Earthquake (SSE) Test Response Spectra (TRS) Plots
3. TVA Standard Specification - "CEB-SS-5.10, for Seismic Qualification Of Electrical, Mechanical, and I&C Devices," Revision 3, dated Feberuary 1, 2008
4. Common Q PAMS Regulatory Guide and IEEE Standard Analysis
5. General Atomics Electronic Systems 04508905-1SP, "Qualification Test Report Supplement, RM-1000 Upgrade," Revision B, dated February 10, 2011 (Proprietary)
6. General Atomics Electronic Systems 04508905-2SP, "Qualification Test Report Supplement, I-F Converter Upgrades" Revision A, (Proprietary), dated June 23, 2008
7. General Atomics Electronic Systems 04038903-7SP, "Qualification Basis for 04034101 (2-RE-90-271, 272, 273 & 274)," Revision C, (Proprietary), dated February 22, 2011
8. General Atomics Electronic Systems 04038903-QSR, "Qualification Summary Report for Watts Bar Nuclear Plant Unit 2 Replacement Radiation Monitors," Revision B, (Proprietary), dated February 10, 2011
9. Westinghouse Electric Company WNA-DS-01617-WBT-P, Revision 4, "Post Accident Monitoring System - System Requirements Specification, " (Proprietary), dated February, 2011
10. Westinghouse Electric Company WNA-DS-01617-WBT-NP, Revision 4, "Post Accident Monitoring System - System Requirements Specification," dated February, 2011
11. Westinghouse Electric Company CAW-11-3107, Application for Withholding Proprietary Information from Public Disclosure, WNA-DS-01617-WBT-P, Revision 4, "Nuclear Automation Watts Bar 2 NSSS Completion Program I&C Projects, Post Accident Monitoring System - System Requirements Specification," (Proprietary), dated February 10, 2011
12. Westinghouse Electric Company WNA-DS-01667-WBT-P, Revision 4, "Post Accident Monitoring System – System Design Specification," (Proprietary), dated February 2011
13. Westinghouse Electric Company WNA-DS-01667-WBT-NP, Revision 4, "Post Accident Monitoring System – System Design Specification," dated February 2011
14. Westinghouse Electric Company CAW-11-3108, Application for Withholding Proprietary Information from Public Disclosure, WNA-DS-01667-WBT-P, Revision 4, "Nuclear Automation Watts Bar 2 NSSS Completion Program I&C Projects Post Accident Monitoring System - System Design Specification" (Proprietary), dated February 11, 2011
15. Westinghouse Electric Company WNA-SD-00239-WBT-P, Revision 4, "Software Requirements Specification for the Post Accident Monitoring System," (Proprietary), dated February 2011

16. Westinghouse Electric Company WNA-SD-00239-WBT-NP, Revision 4, "Software Requirements Specification for the Post Accident Monitoring System," dated February 2011

17. Westinghouse Electric Company CAW-11-3102, Application for Withholding Proprietary Information from Public Disclosure, WNA-SD-00239-WBT-P, Revision 4, "Nuclear Automation Watts Bar 2 NSSS Completion Program I&C Projects, Software Requirements Specification for the Post Accident Monitoring System," (Proprietary), dated February 10, 2011

18. Westinghouse Electric Company EQ-EV-71-WBT-P, Revision 1, "Environmental Evaluation and Operating History of the Westinghouse DMIMS-DX Preamplifier and Softline Cable Used at Watts Bar 2," (Proprietary), dated February 2011

19. Westinghouse Electric Company EQ-EV-71-WBT-NP, Revision 1, "Environmental Evaluation and Operating History of the Westinghouse DMIMS-DX Preamplifier and Softline Cable Used at Watts Bar 2," dated February 2011

20. Westinghouse Electric Company CAW-11-3115, Application for Withholding Proprietary Information from Public Disclosure, EQ-EV-71-WBT-P, Revision 1, "Environmental Evaluation and Operating History of the Westinghouse DMIMS-DX Preamplifier and Softline Cable Used at Watts Bar 2," (Proprietary), dated February 18, 2011

21. TVA procedure 0-PI-OPS-17.0, "18 Month Locked Valve Verification," Revision 44

22. White paper on Sorrento/GA qualification reports

23. General Atomics Electronic Systems 04508905-QR, "Qualification Test Report for RM-1000 Processor Module and Current-To-Frequency Converter," Revision A, (Proprietary), dated February 10, 2011

24. TVA procedure 0-PI-OPS-17.1, "18 Month Locked Breaker Verification," Revision 14

25. TVA procedure 0PDP-6, "Locked Valve/Breaker Program," Revision 1

Enclosure 3
TVA Letter Dated February 25, 2011
Responses to Licensee Open Items to be Resolved for SER Approval

List of References

1. TVA to NRC letter dated December 22, 2011, "Watts Bar Nuclear Plant (WBN) Unit 2 – Instrumentation and Controls Staff Information Requests"

Enclosure 4
TVA Letter Dated February 25, 2011
Responses to Licensee Open Items to be Resolved for SER Approval

List of New Regulatory Commitments

1. FSAR Section 3.10 will be updated to include the qualified radiation monitoring equipment in FSAR Amendment 103. [Item 14, (Matrix Item 341)]

2. The General Atomics Electronics Systems Inc. (GA-ESI) affidavits for withholding and non-proprietary versions of attachments 5, 6, 7, 8 and 23 will be submitted within two weeks of receipt from GA-ESI. [Cover Letter]

3. Calculation WBNAPS3-126 will be revised to include the control room by July 1, 2011. [Item 22, (Matrix Item 349)]

4. A FSAR change will be submitted in a future FSAR amendment to change the revision level for WCAP-13869 from 2 back to 1. [Item 11, (Matrix Item 323)]

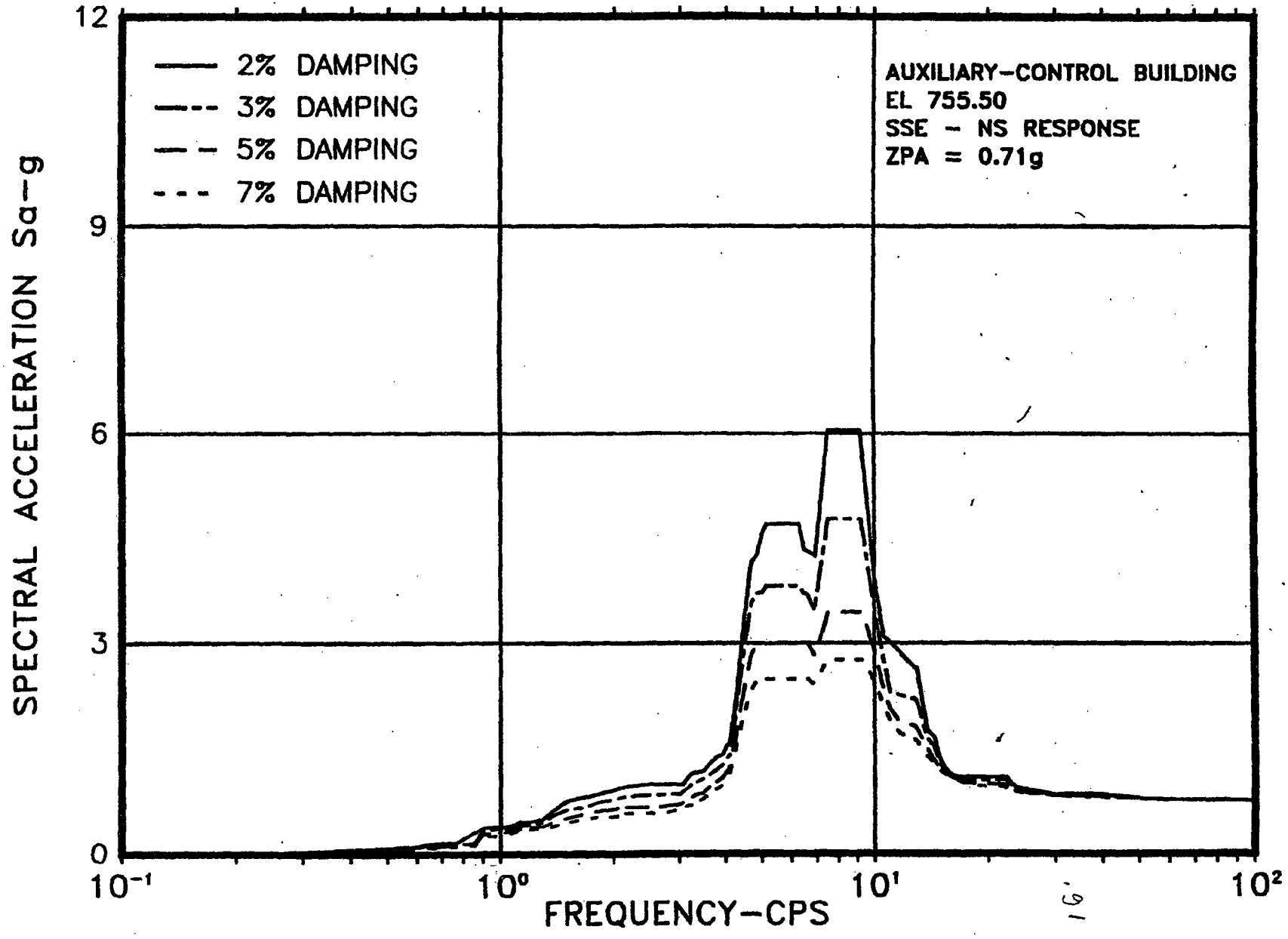
TVA Letter Dated February 25, 2011

Attachment 1

Acceleration Response Spectra (ARS) for the El. 755 Auxiliary Control Building

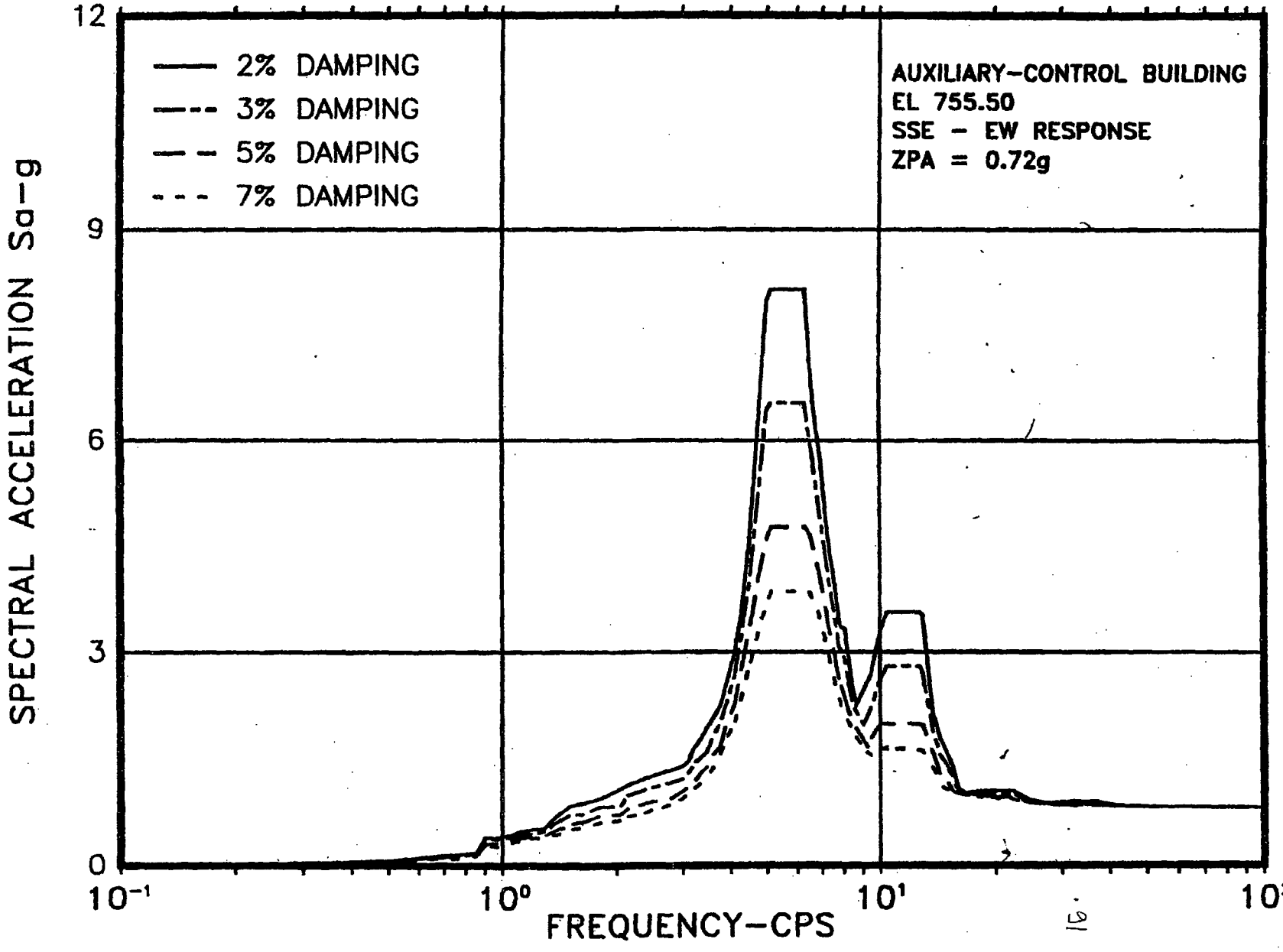
TVA WATTS BAR ~~UNIT 1~~ NEW-DESIGN/MODIFICATION ARS

R5



TVA WATTS BAR ~~UNIT 1~~ NEW-DESIGN/MODIFICATION ARS

R5



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TVA WATTS BAR ~~UNIT 1~~ NEW-DESIGN/MODIFICATION ARS

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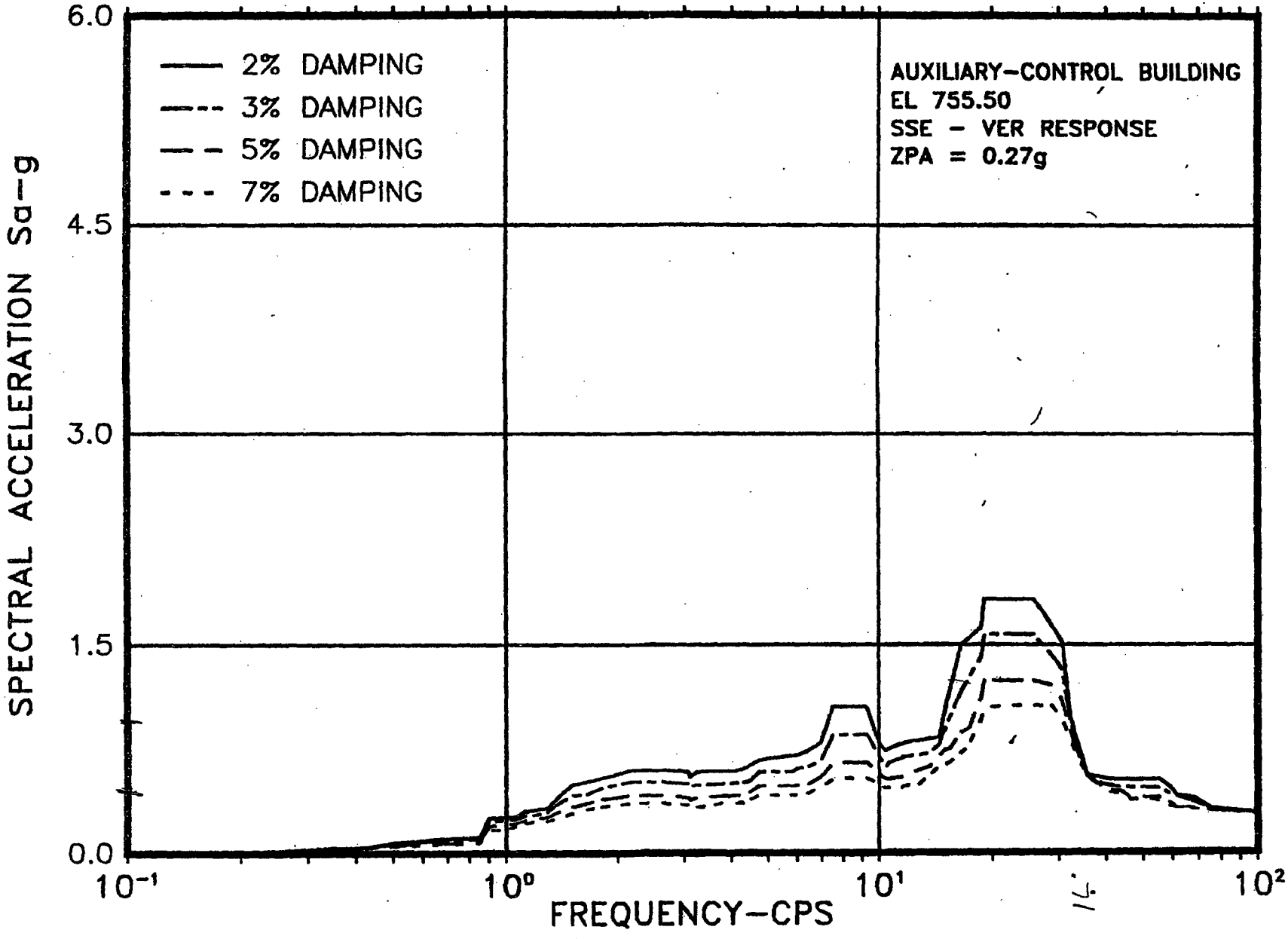

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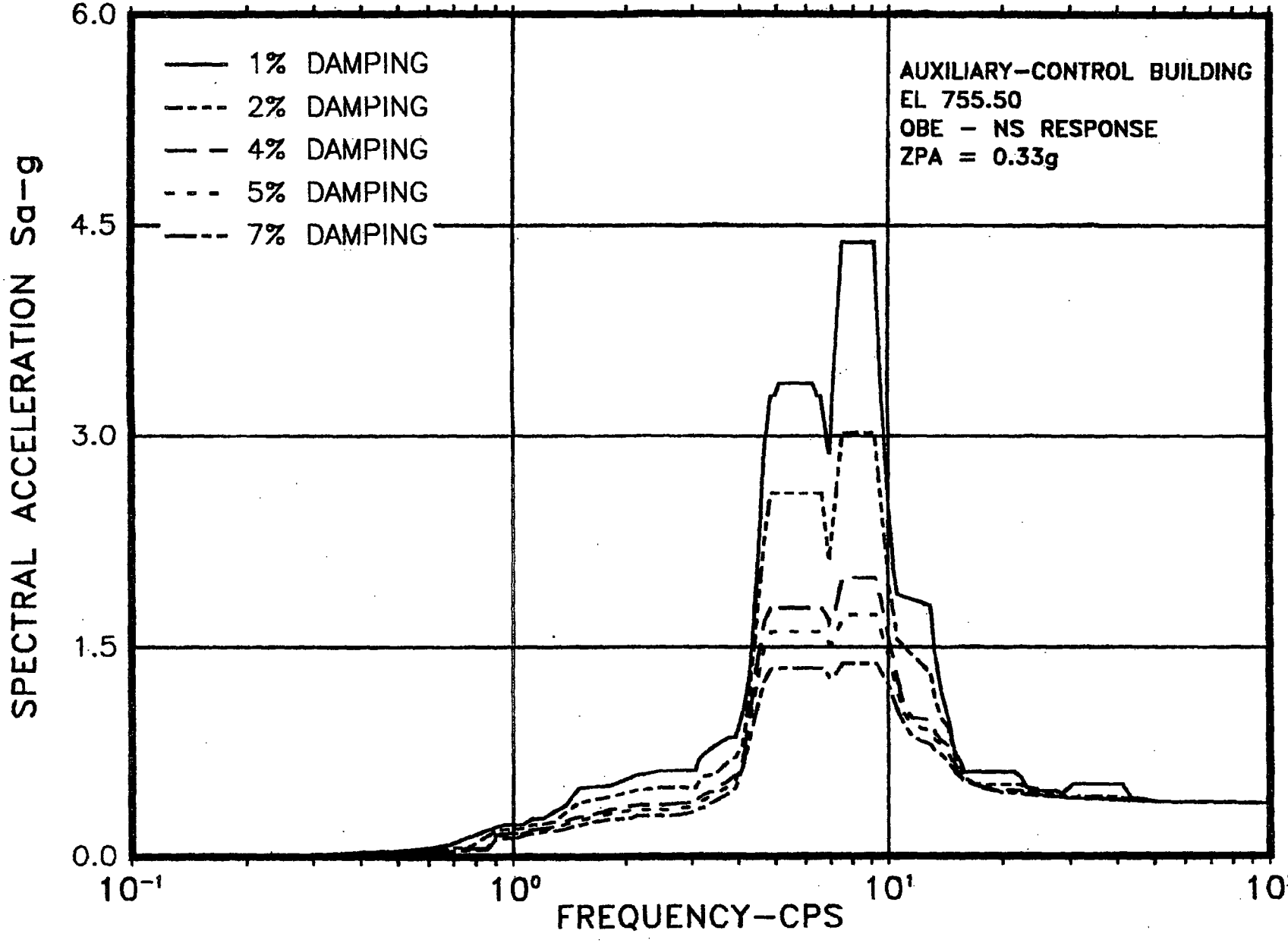

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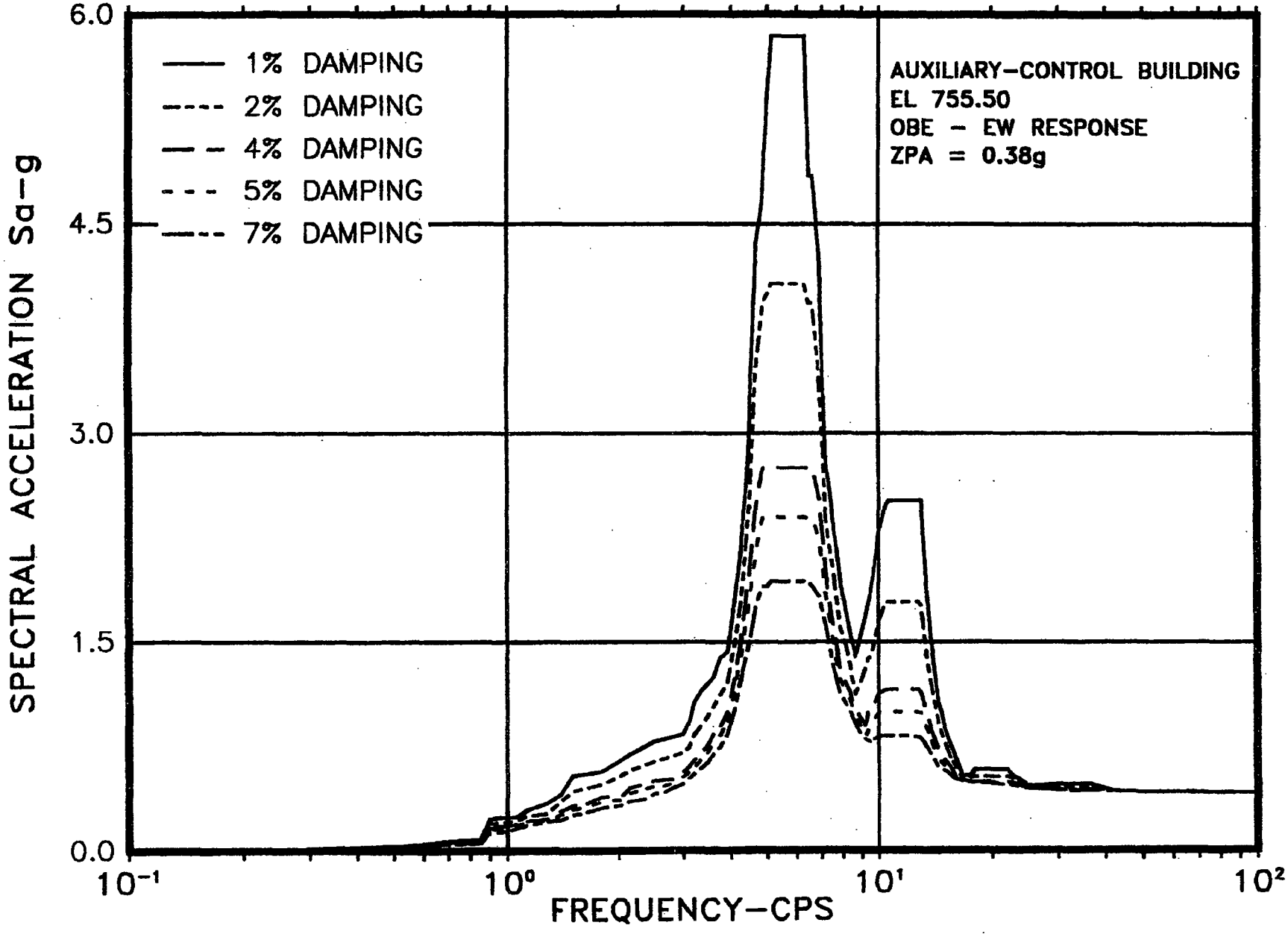

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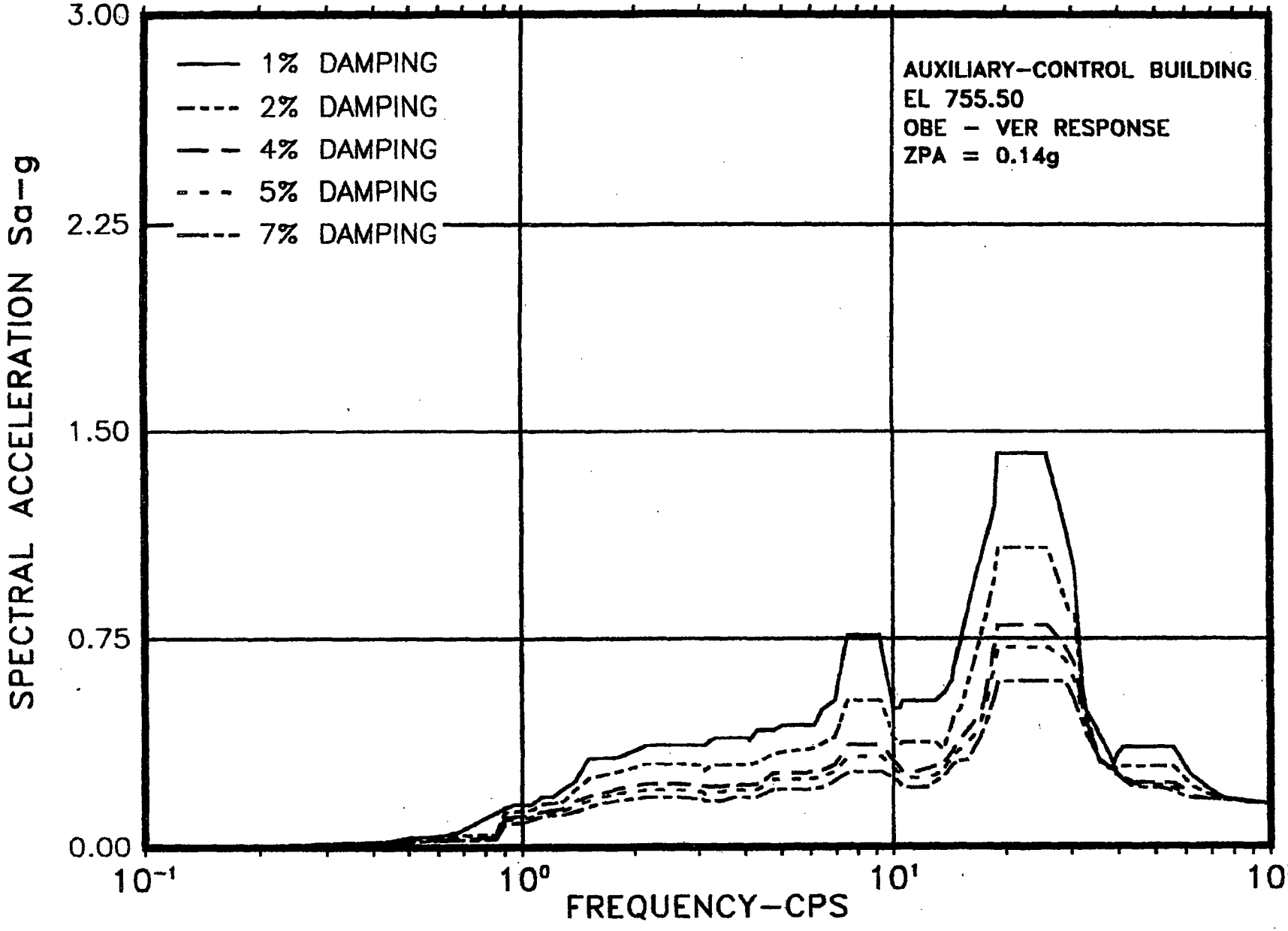
R5



Attachment 3

TVA Standard Specification "CEB-SS-5.10, for Seismic Qualification Of Electrical, Mechanical, and I&C Devices," Revision 3, Dated February 1, 2008

TENNESSEE VALLEY AUTHORITY

NUCLEAR POWER GROUP

B41 080118 003

STANDARD SPECIFICATION

CEB-SS-5.10
FOR
SEISMIC QUALIFICATION OF
ELECTRICAL, MECHANICAL, AND I&C DEVICES

Revision 3 Effective Date = 02/01/08

	REVISION R0	R1	R2	R3
PREPARED	L. C. Rinaca	L. C. Rinaca	J. K. Rochelle	J. K. Rochelle
CHECKED	K. R. Spates	K. R. Spates	L. C. Rinaca	P. B. Selman
VERIFIED	J. K. Rochelle	J. K. Rochelle	L. C. Rinaca	L. C. Rinaca
APPROVED	H. L. Williams	R. D. Cutsinger	K. R. Spates	K. R. Spates
DATE	3/17/94	4/25/96	6/17/05	1-18-08

Revision No.	DESCRIPTION OF REVISION	Approved Date
0	Original Issue - 24 pages following plus Attachment 1 (3 pages)	3/17/94
1	Revised to reflect revision of reference 2.1 (f) which alters the shape of the standard device required response spectra and adds slow sine sweep as an acceptable method for required input motion testing. Also, the specification is updated to reflect current TVA organization and other minor editorial changes are incorporated. Three pages are added to Attachment 1 (A4 - A6) to provide log-log graph forms for specific case device required response spectra in each orthogonal direction. Repagination results in the addition of one page (page 25). Pages 5-25 are affected by repagination. Specific changes are reflected with revision bars on the following pages: i, 1-13, 15, 16, 18-20, 23 and 24. Revision 1 of CEB-SS-5.10 contains 33 total pages.	4/25/96
2	Document converted to current WORD processing format and then revised to: 1) Add definitions for Contact Chatter Fragility Level, Dedication, Operability, Functionality, Potentially Operability Sensitive Device, and Seismically Sensitive Item; 2) Add CGI and CCASSI abbreviations; 3) Add reference to 50.59 Screening review and three EPRI industry consensus documents for device dedication; 4) Add default requirements for generic device qualification (in Attachment 1); 5) Encourage equal inputs in all three axes for most devices; 6) Clarify requirements for monitoring and reporting device operability sensitivities; 7) Add requirements for qualification and dedication of potentially operability sensitive devices based on similarity to test specimen; 8) Add requirements for determining contact chatter fragility levels based on multi-frequency RRS testing; 9) Clarify requirements for biaxial tests with phase dependent input; 10) Remove considerations for Bellefonte Nuclear Plant; 11) Clarify design data requirements; 12) Adjust headings to add revision number to all pages; 13) Make other minor editorial improvements: and 14) Replace the cover sheet per NEDP-10, latest revision. Specific changes are reflected with revision bars on all pages. Five pages added due to revisions, reformatting, and pagination. Revision 2 of CEB-SS-5.10 contains 38 total pages.	6/17/05

3	Revised to: 1) Reflect changes due to replacement of interim design criteria in BFN-50-C-7105 with long-term design criteria in BFN-50-C-7106; 2) Change TVAN to TVA NPG (Nuclear Power Group); 3) Update definition of Seismic/Structural Qualification (S/SQ). 4) Add needed acronyms and make needed clarifications; 5) Utilize electronic cross-referencing. Significant changes are marked with revision bars. One page added due to pagination. Revision 3 of CEB-SS-5.10 contains 39 total pages.	01/18/08

TABLE OF CONTENTS

1.0 SCOPE

This specification compiles the requirements, design data and direction for verifying compliance with TVA Nuclear Power Group (NPG) seismic/structural design criteria (Reference 2.1) for Seismic Category I (BFN Class I) and Class 1E electrical, mechanical and I&C devices to be qualified separately from their host assemblies. This specification supplements the governing design or procurement specification and is intended to serve as an aid to equipment Vendors and Third Party Qualifiers (TPQs) (including consultants and test laboratories) in demonstrating compliance with TVA NPG design criteria for Seismic/Structural Qualification (S/SQ) of devices. Any conflicts between this specification and the design or procurement specification shall be brought to TVA NPG's attention for resolution.

Although it is desirable that devices be qualified as an integral part of their host assemblies, this approach is not always practical during initial qualification and is seldom practical during qualification of modifications or alternate replacement items for operating plants. In those cases, devices may be qualified as separate entities for the seismic/structural loading environment consistent with their installed location and configuration. The content of this specification was developed to ensure that a procured Seismic Category I (BFN Class I) component, when qualified as a device, will perform its safety function during and following design basis loading conditions. Typically, the primary design basis load conditions to be addressed include pressure, weight, thermal and the plant Safe Shutdown Earthquake (SSE) (alternately called the DBE at BFN) but other coincident static or dynamic loading events shall be addressed if defined by the governing design/procurement specification for the device.

For some devices, qualification requirements associated with normal, abnormal and accident environmental conditions and/or mechanical or fluid induced vibration conditions may be stipulated by the governing design or procurement specification. Data and direction for addressing these considerations either separately or in conjunction with the structural loading conditions addressed herein is outside the scope of this standard specification; however, it should be noted that S/SQ is generally, but not always, required for the end of design life (i.e., after exposure to all specified service related degradation mechanisms).

Compliance with this standard does not by itself ensure S/SQ of the equipment assembly of which the device is a part nor does it provide verification for other design requirements such as environmental qualification of non-metallic materials. In general, if the procured device to be qualified separately is furnished as a component of an assembly, responsibility for qualification of the assembly rests with TVA NPG or the assembly Vendor / TPQ. If the device is procured and qualified as a separate entity (e.g., for use in one or more previously qualified assemblies), then responsibility for qualification of the assembly (or assemblies) rests with TVA NPG. In-line fluid components (e.g., valves), even when furnished as a part of an assembly, are not within the scope of this specification; however, electrical, mechanical or I&C components (e.g., limit switches, position indicators, solenoid valves, actuators, etc.) furnished as appurtenances to in-line fluid components may be qualified as devices in accordance with this specification.

1.1 APPLICABILITY

This specification shall be used by equipment Vendors or TPQs (including their consultants and/or test laboratories) to satisfy contractual obligations associated with seismic/structural qualification of Seismic Category I (BFN Class I) devices for TVA NPG Browns Ferry (BFN), Sequoyah (SQN), and Watts Bar (WBN) nuclear plants. Depending on design or procurement specification requirements, qualification in accordance with this specification may be performed either on a plant specific or generic (applicable to all TVA NPG plants) basis. Unless otherwise noted, the approaches and requirements delineated envelop TVA NPG's plant specific design criteria requirements (i.e., are generic) with regard to seismic design basis.

1.2 DEFINITIONS

In general, terminology used in this specification is consistent with IEEE 344-1975 (Reference 2.2). TVA NPG specific definitions used herein are as follows:

Active Component - A component that performs or causes the performance of a mechanical motion during the course of accomplishing a safety function.

Assembly - Any integrated system complete with all appendages such as motors, fans, racks, piping systems, panels or consoles that is supported as a unit from a surface having a defined dynamic motion. When all the components of a system are mounted on a support structure, the unit becomes an assembly. Seismic/structural qualification requirements for assemblies are typically specified in terms of floor acceleration response spectra. The term "host assembly" as used in this specification refers to the particular assembly in which the device of interest is installed.

Contact Chatter Fragility Level – The maximum device Required Response Spectra (RRS) for which its electrical contacts do not change state (open if normally closed or close if normally open) for a duration of more than 0.002 seconds (2 milliseconds). The RRS is typically a standard shape curve (e.g. Figure 3.1) with acceleration magnitude adjusted to fragility level.

Dedication – An acceptance process undertaken to provide reasonable assurance that a Commercial Grade Item (CGI) to be used as a basic component will perform its intended safety function, and in this respect, is deemed equivalent to an item designed and manufactured under a 10CFR50 Appendix B QA program.

Device - Any component (such as a motor, fan, transmitter, switch, relay, sensor, recorder, etc.) that is intended for inclusion in an assembly but whose safety function can be verified independent of the assembly given an appropriate level of dynamic loading at the component's installed location.

Equipment Damping - The energy dissipation within equipment due to material and structural damping while it is responding to an earthquake or other dynamic loading event. Damping depends on such factors as type of joints or connections within the structure, material, and strain magnitude.

Functionality - The ability of Seismic Category I (BFN Class I) plant features to perform their safety functions when subject to design basis loads.

In-line Fluid System Component - Valves, strainers, filters, regulators, etc., that are mounted in pressure retaining members such as pipes or tubes.

Location Specific Required Response Spectrum (RRS) - A response spectrum that defines that seismic/dynamic loading environment at a particular location on an assembly considering response of the assembly to the floor design RRS.

Non-active Component - Those components that are not required to perform or cause the performance of a mechanical motion during the course of accomplishing a safety function.

Operability - In the context of this specification, operability is defined as the ability of active components to perform a mechanical motion or change of state to accomplish a safety function, in accordance with the plant design basis criteria, and to avoid spurious behavior that would result in an unintended mechanical motion or change of state.

Potentially Operability Sensitive Device - A device (or class of devices) that has generally shown a potential to affect the required seismic adequacy for operability of the device itself or its host. The most common examples of device operability sensitivities are unacceptable electrical contact chatter, breaker tripping, loss of electrical continuity, loss of calibration, and fluid sloshing.

Rigid - Equipment is considered rigid if it, at all points, follows the motion of its foundation without amplification or attenuation. For TVA NPG plants, rigidity is assured if all natural frequencies of the equipment exceed 33 Hz.

Safety Function - That function of a structure, system or component which is necessary to assure: (1) integrity of the reactor coolant pressure boundary, (2) capability to shutdown the reactor and maintain it in a safe shutdown condition, or (3) capability to mitigate or prevent the consequences of accidents which could result in potential off site exposures to a significant fraction of the guideline exposures of 10 CFR Part 100.

Seismic Category I - Classification given to those plant features that perform or ensure the performance of safety functions. Seismic Category I features are designed and constructed to assure achievement of their safety functions at all times including a concurrent SSE. At BFN this classification is alternately called Seismic Class I.)

Seismically Sensitive Item - An item (or class of items) which has the potential to affect the seismic adequacy of the item itself or its host.

Seismic/Structural Qualification - The process of verifying and documenting that Seismic Category I (BFN Class I) and Seismic Category I(L) (BFN Class II) plant features are capable of withstanding design basis loading conditions in conformance with applicable plant design criteria. Qualification is by analysis, test, experience, or a combination thereof in accordance with plant design basis commitments.

Snug Tight - Snug tight defines a condition where mating parts are in firm contact with each other and the bolt or nut cannot be loosened by hand. For typical devices, snug tightness is attained by a qualified person using less than full physical effort with an unmodified commercial open-end wrench or sprocket type rachet of proper size. For small threaded fasteners less than about 1/4 inch diameter, commercial type screw or nut drivers (including socket or hex key heads) may be used as long as the snug tight condition is attained.

Vendor - Organization, firm, company, etc., that is contractually obligated to furnish seismic/structural qualified assemblies and/or devices for use at TVA NPG facilities.

1.3 ABBREVIATIONS

AISC - American Institute of Steel Construction
ASME - American Society of Mechanical Engineers
ASTM - American Society for Testing Materials
BFN - Browns Ferry Nuclear Plant
CGI - Commercial Grade Items
CCASSI - Critical Characteristics for Acceptance of Seismically Sensitive Items
CFR - Code of Federal Regulations
DBE - Design Basis Earthquake
I&C - Instrumentation and Control
IEEE - Institute of Electrical and Electronics Engineers
NPG - Nuclear Power Group
NRC - Nuclear Regulatory Commission
OBE - Operating Basis Earthquake
RRS - Required Response Spectrum
SQN - Sequoyah Nuclear Plant
SRSS - Square Root Sum of Squares
SSE - Safe Shutdown Earthquake
TPQ - Third Party Qualifier
TRS - Test Response Spectrum
TVA - Tennessee Valley Authority
WBN - Watts Bar Nuclear Plant
ZPA - Zero Period Acceleration

1.4 UNITS

g - acceleration in units of gravity (1 g = 32.2 feet/second/second)
Hz - Hertz (cycles per second)

2.0 REFERENCES

2.1 TVA NPG DESIGN DOCUMENTS

a. WB-DC-40-31.2, Design Criteria "Seismic Qualification of Category I Fluid System and Electrical or Mechanical Equipment," (Latest Revision), Watts Bar Nuclear Plant (WBN).

b. SQN-DC-V-40.0, Design Criteria, "Seismic Qualification of Category I Fluid System and Electrical or Mechanical Equipment," (Latest Revision), Sequoyah Nuclear Plant (SQN).

c. BFN-50-C-7106, Design Criteria, "Equipment Seismic/Structural Qualification," (Latest Revision), Browns Ferry Nuclear Plant (BFN).

d. CEB-CQS-447, Engineering Calculation, "Standard Equipment Seismic Qualification Test Methods for Devices," (Latest Revision), All NPG Plants.

2.2 IEEE, Standard 344-1975, "Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."

2.3 NRC Regulatory Guide 1.100 Revision 1, "Seismic Qualification of Electrical Equipment for Nuclear Power Plants," August 1977.

2.4 AISC, Manual of Steel Construction, 7th Edition.

2.5 EPRI, NP-5652, "Guideline for the Utilization of Commercial Grade Items in Nuclear Safety Related Applications (NCIG-07)", June 1988

2.6 EPRI, TR-102260, "Supplemental Guidance for the Application of EPRI NP-5652 on the Utilization of Commercial Grade Items", March 1994

2.7 EPRI, TR-112579, "Critical Characteristics for Acceptance of Seismically Sensitive Items", September 2000

2.8 10CFR50.59 Screening Review for CEB-SS-5.10 Revision 3 (RIMS# B41 080118 002)

3.0 GENERAL REQUIREMENTS

The Vendor's or TPQ's program for S/SQ of Class 1E electrical/I&C and/or Seismic Category I mechanical devices shall demonstrate the component's capability to perform its intended safety function during and after the SSE (BFN DBE) and/or other specified design basis loading conditions. In accordance with regulatory guidance provided in Reference 2.3, the relevant TVA NPG design documents (Reference 2.1) typically[1] utilize Reference 2.2 as the governing industry standard for seismic qualification. Therefore, the Seismic Category I (BFN Class I) device qualification program shall typically comply with the recommended practices per References 2.2 and 2.3 supplemented by the design data and direction delineated herein.

Attachment 1 identifies device specific S/SQ requirements (including safety function) and load data. The attachment is repeated as necessary to address multiple unique devices under the governing design or procurement specification. Default requirements are established in Attachment 1 for each topic. The default requirements apply unless requirements are marked (i.e., filled-in) for the specific device to be qualified.

3.1 APPROACH

S/SQ of devices is generally accomplished by one or a combination of the following two approaches:

a. Testing under simulated load conditions

b. Prediction of structural/mechanical performance by analysis

The permissible qualification approach for the device in question is identified by Attachment 1. If either test or analysis are permissible per Attachment 1, selection of the actual approach is a Vendor / TPQ responsibility; however, for qualification of active and/or potentially operability sensitive Seismic Category I (BFN Class I) and Class IE devices, purely analytical approaches are seldom applied. Therefore, it is recommended and encouraged that the Vendor or TPQ obtain TVA NPG concurrence prior to proceeding with a purely analytical qualification of an active or potentially operability sensitive device. In general, analysis without testing is acceptable only if structural integrity alone can ensure the required safety function and this aspect shall be fully justified in the qualification report. In some cases, a combination of test and analysis may be the best approach for qualification of a particular device. Acceptable methods for implementation of analysis and test qualification approaches are outlined in Section 4.0.

3.2 ACCELERATION DESIGN DATA

Qualification of devices may be performed using either Required Input Motion (RIM) or Required Response Spectrum (RRS) techniques. The RRS technique generally allows a reduced degree of conservatism in exchange for increased analytical or test complexity. RRS tests are also typically less time consuming and less costly than RIM tests. For qualification by test, use of the RRS

[1]The BFN design criteria (Ref. 2.1 c) includes an alternative approach for qualification of some Seismic Class I devices, which is not addressed herein.

technique is encouraged in all cases and required when contact chatter fragility level must be determined (see Section 4.1.1 e). Otherwise, unless RIM is specifically designated as not applicable by Attachment 1, selection of the technique for qualification is a Vendor / TPQ option. In all cases, adequacy of implementation is subject to TVA NPG approval.

3.2.1 Required Input Motion (RIM)

Dynamic loading for device qualification may be simulated by input accelerations Ax horizontal and Ay vertical as defined by Attachment 1. The input acceleration is considered to act as a set of single frequency waveforms over the frequency range from 1 to 33 Hz. Specific waveforms for RIM tests are discussed in Section 4.1.3.1. The input accelerations Ax and Ay correspond to the maximum acceleration of the host assembly at the device installed location considering all modes of vibration within the frequency range defined above and all dynamic load combinations. If not explicitly defined by Attachment 1, Ax and Ay shall be no less than 3 g and 3 g, respectively. For most devices, it is appropriate and desirable to apply equal inputs in all three orthogonal directions. That allows the device to be used in multiple applications without placing special restrictions on orientation. Orientation restrictions and different inputs in the 3 orthogonal directions are typically used to qualify devices for a specific application when the seismic margins relative to functional (e.g. contact chatter) fragility are small and multi-frequency RRS testing is applied.

If the Vendor or TPQ is responsible for qualification of both the device and the host assembly under the same design or procurement specification and the host assembly response (based on quantifiable analysis or test results) is significantly less than the RIM defined by Attachment 1, the Vendor may apply RIM appropriate for the device installed location. If the host assembly response at the device location is greater than the RIM defined by Attachment 1, the Vendor / TPQ shall appropriately increase the RIM applied for device qualification. In either of these cases the Vendor's / TPQ's qualification report shall include verification that the peak assembly response at the device location is enveloped by the input acceleration magnitudes used for device qualification. This requirement does not apply when TVA NPG is responsible for host assembly qualification and definition of device RIM.

3.2.2 Required Response Spectrum (RRS)

Dynamic loading for device qualification may also be simulated by one or more RRS as defined by Attachment 1. If so designated by Attachment 1, dynamic loading for device qualification may be simulated by the standard RRS included as Figure 3.1. Figure 3.1 is equivalent to the 3 g RIM described in Section 3.2.1. If Ax or Ay (defined in Section 3.2.1) is specified to be different from 3 g (e.g., 2 g, 4 g, etc.), an appropriate 5% damped RRS can be defined as follows:

1. ZPA = Ax, Ay = acceleration at frequencies $\geq$ 33 Hz (g)

2. $A_{P5\%}$ = 5 x ZPA = peak acceleration (g)

3. Linear (on log - log scale) ramp up from 0.45 g @ 1 Hz to A_p @ low end frequency of peak band. Low end frequency of peak acceleration band is given by:
   $f = (A_{P5\%}/ C)^m$; where C = 0.45 and m = 0.42893.

4. Linear (on log - log scale) ramp down from $A_{P5\%}$ @ 16 Hz to 2 x ZPA @ 33 Hz

In cases where the Vendor or TPQ is responsible for qualification of both the device and the host assembly under the same design or procurement specification and the host assembly response at the device location (based on quantifiable analysis or test for the governing floor response spectra input) is significantly less than the Figure 3.1 RRS adjusted to the value of Ax and/or Ay defined by Attachment 1, the Vendor or TPQ may adjust the Figure 3.1 RRS to a lower level ZPA. Alternatively, the Vendor or TPQ may develop more specific RRS that are appropriate for the device location. The specific device RRS shall consider host assembly response to the governing floor response spectra and all potential response modes of the device itself when subjected to assembly motion. If the assembly response at the device location is greater than the RRS defined by Attachment 1, then the RRS used for device qualification shall be appropriately increased. In either case, the Vendor's or TPQ's qualification report shall include verification that the RRS used for device qualification envelopes the seismic demand imposed by the host assembly at the device location. This requirement does not apply when TVA NPG is responsible for host assembly qualification and definition of the device RRS.

RRS for use in qualification by multi-frequency tests (see Section 4.1) are typically based on 5% damped response although any practical value of damping may be utilized as long as the test response spectra and RRS reflect equal damping. However, RRS for qualification by analysis (see Sections 3.4 and 4.2) shall be based on 3% damping. Figure 3.2 reflects a standard 3% damped response spectrum for 3 g ZPA that corresponds to the 5% spectra given by Figure 3.1. For ZPA values different from 3 g, conversion of a standard 5% damped response spectra shape (as defined above) to 3% damping is as follows:

1. $ZPA_{3\%} = ZPA_{5\%}$ = acceleration at frequencies $\geq$ 33 Hz.

2. $A_{P3\%}$ = 5 x 1.3 x ZPA = peak acceleration (g). Note that 1.3 factor bounds 5% to 3% amplification ratio for both random motion and 5 to 10 cycle per beat sine beat motion.

3. Calculate low end frequency (Hz) of constant peak acceleration band:
   $f = (A/C)^m$; where $A = A_{P5\%}$ = 5 x ZPA, C = 0.45 and m = 0.42893.
   Note that f is the same frequency calculated in step 3 of the 5% RRS definition given above.

4. Linear (on log-log scale) ramp up from Ac @ 1 Hz to A_p @ f Hz. A_c (g) is given by: $A_c = A_{p3\%}/(f)^r$;where $A_{p3\%}$ and f are from steps 2 and 3, respectively and r = 2.33138.

5. Linear (on log-log scale) ramp down from $A_{p3\%}$ @ 16 Hz to 2 x 1.3 x ZPA @ 33 Hz

3.3 DEVICE CONFIGURATION

The device qualification configuration shall represent, to the extent practical, the installed configuration. Deviations shall be identified and justified in the qualification report. Items of consideration include:

a. Mounting - Unless specific mounting requirements are defined by TVA NPG, the qualified device configuration shall be in accordance with its standard installation instructions and mounting provisions including furnished or recommended hardware (brackets, supports, fasteners, etc.). As a design objective, high strength fasteners with associated preload requirements should be avoided. Snug tightening (see definition in Section 1.2) of threaded mounting fasteners should be utilized unless specific preload is required to ensure structural integrity or safety function.

b. Orientation - If the device orientation is not specified by TVA NPG, the qualification shall define, justify and address the worst case orientation with respect to the gravity vector. Determination of worst case orientation shall include both structural and functional considerations. Orientation limitations, if any, shall be clearly identified (see Section 6.3).

c. Mass and Pressure Characteristics - Devices shall be qualified in the operational configuration including internal fluids at service temperatures and pressures.

d. Fluid and Electrical Interface - Device qualification shall include application or simulation of interface loads and/or added mass from attached pipe, tube, conduit, etc. Specific interface requirements are identified by Attachment 1. In the absence of specific interface requirements per Attachment 1, it is the Vendor's / TPQ's responsibility to define appropriate interface limitations (see Section 6.3).

e. Functionality and Operability - Devices qualified by test shall be operational to the extent necessary to verify required safety function as defined by Attachment 1 via monitoring before, during and after the test. Electromagnetic relays, motor starters, and similar potentially operability sensitive devices shall be monitored for contact chatter in the normally open, normally closed and transition states unless otherwise specified by TVA NPG. Chatter in excess of 0.002 seconds (2 milliseconds) duration shall be identified as a test anomaly to be resolved by TVA NPG, unless otherwise specified.

3.4 DAMPING

The design value of damping for use in qualification of devices by analysis is 3% of critical. Damping for qualification by test is discussed in Section 3.2.2. If the Vendor derives RIM or RRS accelerations based on host assembly dynamic response (Section 3.2), the derivation shall be based on the design value of damping as defined by the governing design or procurement specification for the assembly.

3.5 CODES AND STANDARDS

Devices shall be designed in accordance with specified industry codes and standards. Any structural design calculations required by the governing code or standard shall be included in the device qualification report.

3.6 SIMILARITY, SAMPLE SIZE AND DEDICATION CONSIDERATIONS

Qualification of a particular device may be based on equivalence of that device to one or more similar devices that are qualified in accordance with this specification. The qualification and/or dedication report shall fully document a similarity verification and address those structural and functional attributes that are sensitive to seismic loading. For qualification by test, one fully representative specimen is generally satisfactory; however, if one specimen is not fully representative, a selection of test specimens may be used to capture structural and functional differences. The specimen selection shall be justified and the results obtained from all specimen tests included in the qualification report.

If testing of multiple specimens is required by NPG, this requirement will be identified by Attachment 1 to this specification.

Qualification of a particular device may also be based on existing qualifications that were performed to similar (or more conservative) requirements and methods. The Vendor/ TPQ is encouraged to utilize existing qualifications wherever possible; however, where differences in requirements and methods exist, the relative conservatism shall be justified in the qualification and/or dedication report.

General industry guidance on dedication of CGI for safety related service is provided in References 2.5 and 2.6. Vendors / TPQs shall comply with applicable portions of that general guidance (or equal) when providing dedicated devices for NPG. In addition, for potentially operability sensitive devices which are seismically sensitive CGI, dedication of the devices for safety-related service (i.e., as a basic component) shall be based on the guidance in EPRI TR-112579 (Reference 2.7), or equal, to ensure that the dedicated device is sufficiently similar to the seismic test specimen. Seismic testing of a device from the same lot as a dedicated device is often, but not always, an acceptable alternative. Upon request, TVA NPG will provide Vendors / TPGs with a copy of these three EPRI guidance documents and other EPRI documents on dedication, to allow compliance with this specification.

4.0 QUALIFICATION METHODS

4.1 QUALIFICATION BY TEST

4.1.1 General Requirements

Devices are preferably qualified by test in which they are subjected to vibratory motion that conservatively simulates the specified full level (maximum or worst case) load environment (normally SSE but may include other dynamic load sources) at the device mounting location.

To account for multiple dynamic events, all full level qualification tests shall be run a minimum of two times. For qualification by multi-frequency RRS testing (Section 4.1.3.2), 5 tests at 70% of the full level RRS defined in Section 3.2.2 followed by one full level test is an acceptable alternative to two full level tests.

All qualification tests shall satisfy the following general requirements unless otherwise specified by TVA NPG:

a. All test specimens shall be operative before, during and after the test to the extent required to verify safety function. Device baseline performance shall be established prior to dynamic testing.

b. Sufficient monitoring shall be incorporated for the test specimen to verify safety function before, during and after the test or as permitted by the design/procurement specification.

c. Sufficient dynamic data shall be collected for each test to verify satisfaction of input/response acceleration requirements per this specification.

d. Any structural resonance frequencies and operability sensitivities (e.g., contact chatter or trip exceeding 0.002 seconds duration) detected during either full level, part level or exploratory tests shall be identified.

e. If contact chatter or trip, exceeding 2 milliseconds duration, occurs at the defined RRS or RIM a contact chatter fragility level shall be determined for each operating state and for the transition condition, when applicable. Transition testing is required for electromagnetic relays and motor starters but not required for switches and circuit breakers. Contact chatter fragility level shall be determined based on the standard device RRS shape per Figure 3.1 with input level adjusted until the chatter fragility level is determined.

4.1.2 Multi-Axis Versus Single Axis Considerations

Unless explicitly justified in the qualification report, biaxial testing with acceleration input in each of two (one horizontal and one vertical) orthogonal axes is required. Tri-axial testing is encouraged for multi-frequency tests but is not required for TVA NPG plants. Single axis testing may be justified under the circumstances described in section 6.6.6 of Reference 2.2.

4.1.3 Test Methods

In this specification, several alternative device test qualification methods are presented; however, utilization of other methods is not precluded. Selection of the best method for a particular device is a Vendor / TPQ responsibility. If the Vendor or TPQ prefers to utilize other methods or deviations from the methods presented, to minimize risk relative to final NPG approval, concurrence should be obtained before proceeding.

Either single frequency or multi-frequency tests are permissible, as follows.

4.1.3.1 Single Frequency Tests

Devices may be qualified by a series of tests with Required Input Motion (RIM) applied at discrete frequencies over the range from 1 to 33 Hz. The test frequency interval shall be no more than 1/3 octave (as defined in Reference 2.2) and all known device, assembly or building natural frequencies shall be included as discrete test frequencies; however, the highest test frequency shall be no less than 25.4 Hz. If building frequencies are unknown or varied (as in the case of generic qualification for multiple locations), the test frequencies shall be spaced at no more than 1/4 octave intervals in the range from 4 to 16 Hz) Note that the ratio of adjacent frequencies is $2^{1/3} = 1.26$ for 1/3 octave intervals and $2^{1/4} = 1.19$ for 1/4 octave intervals. To determine device natural frequencies, the application of a low level exploratory test to determine resonant frequencies and transmissibility's within the plant flexible range (1 to 33 Hz) is suggested; however, unless the device configuration with its mounting arrangement indicates a potential for non-rigid response that is detectable by external instrumentation, exploratory tests for compact devices typically do not result in useful dynamic response data.

As described below, single frequency tests utilizing either sine beat, continuous sine or slow sine sweep waveforms are acceptable to TVA NPG. These methods generally introduce conservative structural demand when compared to the multi-frequency test method discussed in Section 4.1.3.2. As such, multi-frequency RRS testing is the preferred method for qualification of operability sensitive devices (e.g., electro-magnetic

relays, motor starters, circuit breakers, and switches).

Sine Beat — This test involves the application of sine beats with peak input acceleration corresponding to the desired full level qualification. The beats shall consist of a sinusoid at the frequency of interest and amplitude as shown in Figure 4.1. The duration of the beat shall be a minimum of 10 cycles unless it is shown that a lower number of cycles is sufficient to duplicate or exceed the response of the equipment at the appropriate location. 5 cycle per beat input is acceptable in the frequency range above 16 Hz. The time of the pause between beats shall be long enough to allow the device to come to rest. A minimum of 5 beats is required to complete one test cycle.

Continuous — This test involves the application of fixed frequency, constant amplitude sinusoidal motion with peak input acceleration corresponding to the desired full level qualification. The duration of each continuous test shall be a minimum of 50 cycles (25 cycles for test frequencies above 16 Hz).

Slow Sine Sweep — Although not a true discrete frequency waveform, the slow sine sweep test is similar to the continuous sine method except the constant amplitude input is applied in a slow frequency sweep (1 octave per minute or slower sweep rate) in the range of 1 to 33 Hz).

If single axis testing is not justified per Section 4.1.2, simultaneous biaxial RIM shall be applied in a horizontal and the vertical axis as follows

1. Inputs in phase

2. Inputs 180° out of phase (requires rotating specimen 180° if table input motion is phase dependent)

3. Device rotated 90° relative to horizontal acceleration input (about the vertical axis) and inputs in phase

4. Same orientation as 3 with inputs 180° out of phase (requires rotating specimen 180° if table input motion is phase dependent)

If single axis testing is applicable, RIM may be applied in the vertical and two perpendicular horizontal axes separately.

Input acceleration levels shall be in accordance with Section 3.2.1 above. It is recognized that test laboratory capabilities may be limited to less than the required full level acceleration input at the lower end of the frequency range of concern (below ≈ 5 Hz). In this case it is permissible to test with acceleration input at the test table limits; however, the test table shall provide at least ±2 inches of displacement input. If the Vendor or TPQ is responsible for qualification of both the device and its host assembly, the device qualification report shall include verification that the table limited acceleration inputs exceed the assembly response levels at these frequencies. Otherwise, this is a TVA NPG responsibility.

4.1.3.2 Multi-frequency Test

Devices may be qualified by multi-frequency tests using RRS per Section 3.2.2. Random motion as described by Reference 2.2 is the preferred waveform for qualification by multi-frequency test; however, use of other appropriate waveforms described by Reference 2.2 is permissible. Selection of the best waveform is a Vendor / TPQ responsibility. Regardless of the waveform selected, the derivation and application of the test input motion shall be in compliance with the practices delineated by References 2.2 and 2.3. The response spectrum of the actual test input motion (based on mathematical reduction of test table instrumentation data) shall envelop the required response spectrum and the peak input acceleration must be greater than or equal to the ZPA of the required response spectrum. Utilization of waveforms other than as described by Reference 2.2 is not absolutely precluded; however, concurrence from TVA NPG shall be obtained before proceeding. In all cases, compliance with the intent of References 2.2 and 2.3 is required.

If single axis testing is not justified per Section 4.1.2, multi-frequency device qualification tests shall be performed with either biaxial or tri-axial input in the vertical and horizontal directions coincident with the appropriate RRS for each axis. Tri-axial phase independent motion is preferred, but not required. The biaxial tests shall be repeated for the perpendicular horizontal direction. If the table input motion is phase dependent, the specimen must also be rotated 180° to account for out of phase motion as described in Section 4.1.3.1. If only one horizontal RRS is defined per Section 3.2.2, that spectra may be considered to act in both horizontal directions.

If single axis testing is justified per Section 4.1.2, multi-frequency input may be applied in the vertical and two perpendicular horizontal axes separately to satisfy the appropriate RRS for each axis.

4.2 QUALIFICATION BY ANALYSIS

Use of the analysis method alone for device qualification is usually not appropriate for complex components, components containing structural nonlinearities or active components whose safety function involves electrically or mechanically induced motion (i.e., potentially operability sensitive devices). In these cases the Vendor / TPQ shall obtain concurrence from TVA NPG before proceeding. The analysis must address all critical details or components and potential failure modes (e.g., overstress, excessive deflection, interference, etc.) of the device when subjected to seismic and other inertial loading in combination with normal service loads. The Vendor or TPQ shall select critical details or components and failure modes based on the particular device's safety function. Analysis methods are often used in combination with test as discussed in Section 3.1.

The analysis guidelines presented in Reference 2.2 are applicable. The basic process and TVA NPG specific requirements are as follows:

4.2.1 Mathematical Model

Develop a mathematical model of the device of sufficient detail to conservatively predict structural response of all critical components.

4.2.2 Dynamic Characteristics

Determine natural frequencies and mode shapes with sufficient accuracy to reflect the dynamic behavior of the device in its installed configuration.

4.2.3 Rigid Devices

Devices with a first natural frequency equal to or greater than 33 Hz can be termed rigid and analyzed statically using input accelerations Ax and Ay defined in Section 3.2.1. Axis combinations shall be as follows:

Apply constant accelerations Ax and Ay to the device center(s) of mass in the worst case (weakest) horizontal direction and vertical direction, respectively. If the device has no definite orientation, the orthogonal Ax and Ay components shall be applied in a manner that results in the maximum state of stress and/or deflection or be repeated in each of three orthogonal axis. The effects of Ax and Ay (including sign) shall be combined in the most conservative manner (i.e., absolute summation of effects) and the resulting effect combined with sustained loads such as deadweight, maximum operating pressure and other operating loads for evaluation against acceptance criteria (see Section 5.2).

4.2.4 Flexible Devices

Devices with one or more natural frequencies less than 33 Hz shall be considered flexible and analyzed dynamically considering the device RRS as defined by Section 3.2.2 (considering damping equal to 3% of critical). If only one horizontal RRS is defined per Section 3.2.2, that spectra shall be considered to act in both horizontal axis. Axis combinations shall be as follows:

Apply spectral accelerations in a modal analysis for each of the three mutually perpendicular directions over the range from 1 to 33 Hz. For each direction, individual modal responses shall be combined by the square root sum of the squares except that responses for closely spaced modes (frequency within 10 percent of the adjacent mode) shall be combined by absolute summation and treated as a pseudo mode for the square root sum of the squares combination.

The analysis of flexible devices shall include contributions from higher frequencies to account for inertial effects on portions of the device that do not participate in flexible modes (≤ 33 Hz). This is commonly referred to as "missing mass". To account for missing mass, the procedure outlined below is recommended. Other approaches may be acceptable; however, the underlying requirement is to ensure that all device mass is subjected to acceleration loading no less than the RRS ZPA

1. For each degree of freedom (DOF) included in the dynamic analysis, determine the fraction of DOF mass included in the summation of all modes less than 33 Hz. The fraction d_i for each DOF i is:

$$d_i = \sum_{n=1}^{N} \Gamma_n x\, \phi_{n,i}$$

where:
n = order of mode under consideration N = number of modes ≤ 33 Hz
$\phi_{n,i}$ = mode shape of the nth natural mode of the system
Γ_n = modal participation factor for the nth mode given by:

$$\Gamma_n = \frac{\{\phi_n\}^T \{1\}}{\{\phi_n\}^T [m] \{\phi_n\}}$$

where:
{1} = unity column matrix
$\{\phi_n\}$ = mode shape column matrix
[m] = square mass matrix

2. The fraction of DOF mass <u>not</u> included in the dynamic analysis is:

   $e_i = d_i - \delta_{ij}$

   where:
   δ_{ij} is the Kronecker delta, which is equal to one if DOF i is translational displacement in the direction of earthquake motion and is equal to zero if DOF i is either a rotational displacement or is not in the direction of earthquake motion. Note that since there are three directions of earthquake motion, there will be three sets of e_i.

3. For each earthquake direction, perform a pseudo static analysis of the device with input as follows:

   $P_i = ZPA \times M_i \times e_i$

   where:
   P_i = force or moment applied at DOF i
   M_i = mass or mass moment of inertia associated with DOF i

4. The total earthquake response in a given direction is determined by combining the pseudo static analysis results with the dynamic analysis ($\leq$ 33 Hz modes) results for that direction by SRSS.

The total responses for each orthogonal horizontal direction shall be assumed to act simultaneously with the vertical direction (2 cases) in the most conservative manner (i.e., absolute summation of effects). Stress/deflections from the worst of the two cases shall be combined with corresponding results from a sustained loads analysis for evaluation against acceptance criteria (see Section 5.2).

<u>Alternatives</u>

Alternatives to the general approach for flexible device analysis outlined above may be acceptable and shall be fully justified in the qualification report. For example, one relatively common practice is to forego a frequency extraction analysis for the device (assume non-rigid) and apply acceleration magnitudes equal to 1.5 times the peak of the device RRS to all mass points in a static stress analysis consistent with the approach described in Section 4.2.3. It is recommended that other alternative approaches receive concurrence from TVA NPG before proceeding.

5.0 ACCEPTANCE CRITERIA

5.1 QUALIFICATION BY TEST

The acceptance criteria for S/SQ of devices by test is that the device must not indicate a loss of safety function when subjected to all relevant dynamic and static loads. Required safety function and relevant loads are defined by Attachment 1. Due to the wide variety of devices covered by the scope of this specification, particular safety functions are not defined herein; however, the required safety function for a given device is typically defined by the governing design or procurement specification. Safety function must be demonstrated both before and after the test.

Unless explicitly excused by the governing design or procurement specification, demonstration of safety function during the test is also required. In no case is spurious function (e.g., contact chatter or loss of electrical continuity more than 0.002 seconds duration) permissible unless specifically allowed by the design or procurement specification. Such spurious functions shall be identified as test anomalies. Also contact chatter fragility levels shall be determined when unacceptable chatter or tripping occurs at the specified RIM or RRS (see Section 4.1.1 e). Any uncertainty regarding required safety function and/or operability requirements shall be brought to the attention of TVA NPG for disposition.

5.2 QUALIFICATION BY ANALYSIS

The general acceptance criteria for S/SQ of devices by analysis is that, under the influence of load conditions identified by Attachment 1, all critical components shall retain structural and functional integrity with sufficient margin to assure that the device's safety function is not compromised. Required safety function is identified by Attachment 1.

Considering the loads defined by Attachment 1 and other functional loads defined by the Vendor / TPQ, maximum stress and deflection shall be calculated for the following combination as appropriate for the particular device in question:

LTOT = DW + PR + TM ± TD ± IF± SSE ± DBA, where:

LTOT = Combined Effect
DW = Deadweight
PR = Maximum Operating Pressure
TM = Sustained Mechanical Load (e.g., shaft thrust or torque, etc.)
TD = Dynamic Mechanical Load (e.g., blowdown, water hammer, etc.)
IF = Interface Load (e.g., attached pipe, tube, conduit, etc.)
SSE = Safe Shutdown Earthquake Inertial Loads
DBA = Other Design Basis Inertial Loads
+ = Algebraic Summation
± = Absolute Summation (assume reversing signs and worst case phasing relationship)

Calculated stresses and deflections for critical components shall satisfy the

requirements defined by Sections 5.2.1, 5.2.2, and 5.2.3 as appropriate.

5.2.1 Structural Integrity - Ductile Metals

The stress limits per Sections 5.2.1.1 and 5.2.1.2 shall be satisfied. These stress limits only apply for **ductile** metals (including ferritic and austenitic steels, nickel and nickel alloys, copper and copper alloys, aluminum and aluminum alloys or titanium) with minimum inelastic elongation ≥ 15% under standard tensile tests conducted at or below the minimum device service temperature. Metals procured to ASTM specifications that satisfy the elongation requirement are preferred.

5.2.1.1 Pressure Boundary Materials

For pressure boundary materials subjected to concurrent earthquake loading, total applied stresses shall not exceed the following values.

PRIMARY STRESS ALLOWABLE	
MEMBRANE	MEMBRANE + BENDING
1.1 Sh	1.65 Sh

For standard pressure boundary materials (ASME or corresponding ASTM specifications), Sh is the basic allowable stress at the design temperature as specified by the ASME B&PV Code. If not specified by the device design or procurement specification, the latest Code edition or addenda on the contract date shall be utilized. For non-ASME/ASTM materials, Sh shall be derived in accordance with the basis for determining allowable stress given in the ASME B&PV Code.

5.2.1.2 Non-pressure Boundary Members, Welds and Threaded Fasteners

Non-pressure retaining members, welds and threaded fasteners shall satisfy AISC Manual of Steel Construction (Reference 2.4) or equivalent allowables for tension shear and buckling failure modes. Application of the 1.33 factor on allowable stress is permissible. For threaded fastener materials not explicitly included in Reference 2.4, the following equivalent stress allowable criteria shall be applied:

Pure Shear: $\tau \leq Su / 9$

Pure Tension: $\sigma \leq 4\ Su / 9$

Combined Shear and Tension: $\sigma \leq 0.573\ Su - 1.8\ \tau$;
$\sigma \leq 4\ Su/9$ and $\tau \leq Su / 9$

where: Su = minimum ultimate tensile strength
τ = applied shear stress
σ = applied tensile stress

5.2.2 Structural Integrity - Other Materials

Non-ductile materials such as gray cast iron are not considered suitable structural materials for safety-related components subjected to pressure and/or dynamic loading. Use of non-ductile materials shall be explicitly justified (e.g., no appropriate alternatives), approved by TVA NPG, and analytical qualification shall demonstrate a minimum factor of safety of 5 relative to the probable failure mode. Stress calculations addressing these materials shall include consideration of local stress concentrations and discontinuities. Analytical qualification of non-metallic materials in critical load bearing applications is discouraged; however, if such materials are utilized in an analytical qualification, the Vendor / TPQ shall justify that the resulting margins against failure are equivalent to those provided by Reference 2.4. This justification shall be based on test derived property or performance data for the material in question.

5.2.3 Mechanical Function - All Materials

In cases where mechanical function can be reliably demonstrated by analysis, deflection/clearance limitations shall be established by the Vendor / TPQ based on functional design requirements. Evaluations relative to Vendor or TPQ established limitations shall comply with the following general criteria:

a. Calculated clearances under load shall include the effect of manufacturing tolerances.

b. Evaluation relative to a minimum or maximum allowable clearance shall include justification of uncertainty on load induced deflection.

6.0 DOCUMENTATION REQUIREMENTS

A qualification report and associated design data is required for all devices furnished in accordance with this specification. The qualification report must be approved by TVA NPG before the devices addressed therein can be received at the TVA shipping destination. Any exceptions will require that TVA NPG place a HOLD on the devices so that they cannot be installed in the plant. This is undesirable and seldom used. The goal of the qualification report is to demonstrate, in an auditable form, the structural and functional adequacy of the device being evaluated under the seismic, operating and external loads/load combinations as defined by the design or procurement specification. The documentation must include clearly defined failure criteria, functional as well as structural. Any deviation from nominal, whether or not it constitutes a failure of the device to meet its specification requirements, must be included in the qualification report to allow evaluation by TVA NPG.

Specific documentation requirements for test and/or analysis based qualifications and the associated structural design data to be provided are as follows.

6.1 QUALIFICATION BY TEST

6.1.1 Test Procedure - Required Prior to Test

A detailed test procedure shall be submitted to and approved by TVA NPG before the test is performed. As a minimum, the test procedure shall include the following:

a. Test scope including purpose and extent.

b. Device description including manufacturer, model, rating, etc.

c. Description of seismic simulation to be applied (address wave form, required response spectra, axis combinations, test frequencies (if applicable), etc.)

d. Test matrix to be executed.

e. Required function to be demonstrated.

f. Functional verification procedure.

g. Description of data to be acquired before (baseline performance), during and after test.

h. Test data sheets and log forms.

6.1.2 Test Report

Approval of the test report by TVA NPG is required before devices procured in accordance with this specification can be received by TVA. A single test report may address more than one device. The test report

shall include but is not limited to the following:

a. A title page identifying the test laboratory, device manufacturer, device model/description, applicable TVA NPG plant(s), mark number, and all pertinent contract numbers.

b. A certification page signed by the responsible test laboratory engineer performing the test, the report author (if different from the responsible test engineer), the responsible Vendor / TPQ engineer, a responsible officer of the Vendor / TPQ company and a registered professional engineer (may be one of the above individuals). In cases where TVA NPG has contracted directly with a test laboratory to qualify or furnish qualified devices, Vendor signatures are not required.

c. Detailed device description including function, performance, arrangement (e.g., left hand, right hand, etc.), size, material, action (e.g., open/close), model number, serial number of test specimen(s), etc.

d. Test specimen weight.

e. Test procedure.

f. Certification of calibration and workability for each item of test equipment.

g. Test specimen mounting description including orientation, attachment method (welding, bolting, etc.) and attachment pattern.

h. Description and disposition of test anomalies or performance deviations relative to baseline data.

i. Test results and conclusions including all required information per Section 4.1.

j. Reduced test data.

k. Raw test data in an auditable form including title, date and signature by test personnel, the Vendor / TPQ representative and the test inspector.

6.2 QUALIFICATION BY ANALYSIS

Analytical qualifications shall be presented in a step-by-step form that is readily auditable by persons skilled in such analysis. The analysis report shall be signed by both the preparer and an independent reviewer/verifier. Independent review/verification shall be in accordance with ANSI N45.2.11 - 1974 or other equivalent quality assurance requirements in the design or procurement specification. The analysis report shall be certified by a registered professional engineer cognizant in the field of equipment S/SQ. From the standpoint of S/SQ, the certification shall state compliance with the TVA NPG design or procurement

specification and any other TVA NPG or industry specifications and standards delineated therein.

A suggested report format is presented by the following. As a minimum the analysis report shall address each format item, as appropriate:

6.2.1 Scope

Identify and describe equipment, define purpose and discuss overall analytical problem to be solved.

6.2.2 Summary of Results and Conclusions

Present a brief summary of results and provide a concise conclusion statement that relates directly to the results and the stated purpose of the calculations.

6.2.3 Assumptions

Identify and justify all assumptions. Assumptions associated with conservative analytical simplifications are acceptable; however, assumptions intended to resolve configuration, material or load uncertainties are not permissible unless the associated limitations are identified with the design data per Section 6.3.

6.2.4 Load Criteria

Define loads and load combination to be applied by the analysis.

6.2.5 Acceptance Criteria

Identify failure modes and define applicable acceptance criteria (i.e., stress, deflection, deformation limits, etc.). Identify sources and/or document basis for material allowable stresses, deflection limits, etc. Acceptance criteria shall be in accordance with applicable codes, standards and this specification.

6.2.6 Method of Analysis

Describe in detail the analytical methods, procedures and approaches to be applied. Include development of analytical equations from basic principals or provide direct reference to the source of the development. Technical references shall be available in open literature such as text books or industry papers or, if company proprietary, shall be made available for review by TVA NPG. All computer programs used in the analysis shall be identified and documentation that establishes the programs' reliability must be referenced. Computer programs written specifically for analysis of the device being addressed (i.e., one time use) shall be fully documented and verified within the qualification report. General use programs shall fully comply with Appendix B of 10 CFR Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel

Reprocessing Plants."

6.2.7 Calculations

Present all calculations and results with supporting figures, sketches and mathematical models. Mathematical models shall identify and/or depict members (elements), mass points (nodes), restraint points (boundary conditions) and applied loads. For computer aided analysis, sufficient input and output shall be included to allow a skilled person to review and, if necessary, recreate the analysis without assistance from the original analyst.

6.2.8 References

Identify all sources of input information or supporting documentation including but not limited to:

a. Technical references (textbooks, industry papers, EPRI reports, etc.)

b. Industry codes and standards (e.g., ASME B&PV Code, IEEE 344-1975, etc.)

c. Regulatory documents (i.e., guides, bulletins, information notices, etc.)

d. Design or procurement specification

e. Test reports

f. Commercial computer codes

g. Design drawings

6.3 DESIGN DATA

As a minimum, the Vendor / TPQ shall furnish an outline drawing or sketch of each device (a more detailed engineering drawing is preferred) that depicts significant features, dimensions and structural materials. The following seismic/structural design data is also required and should be included either on the drawing/sketch or an installation/operation Vendor manual:

a. Maximum Operating Conditions - pressure, temperature, etc. (as applicable)

b. Center of Gravity Location

c. Total Weight

d. Any Orientation Limitations

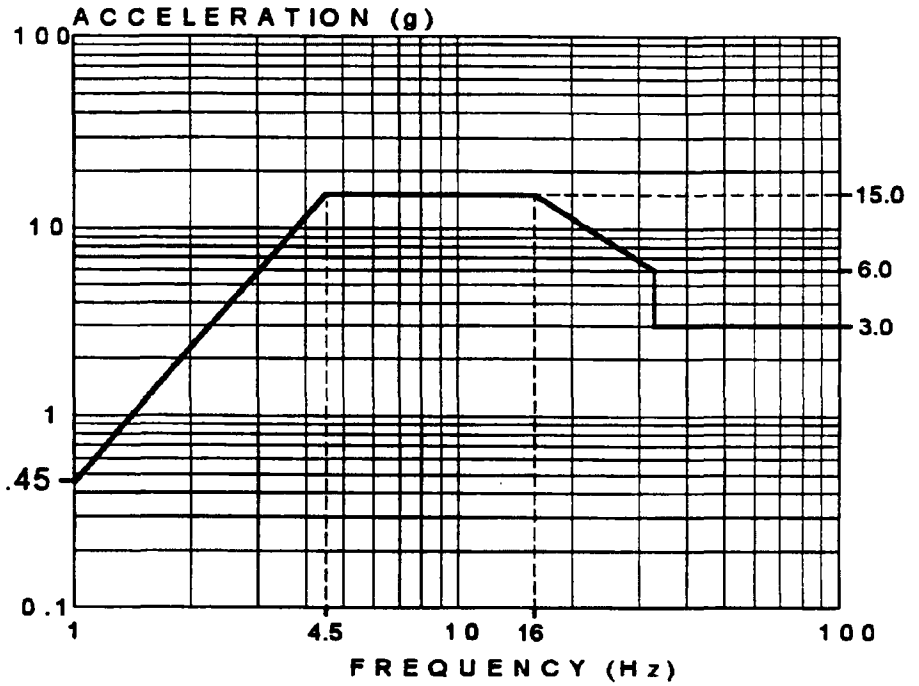
e. Mounting Details - Welding or fastener pattern, size, material or strength requirements; fastener torque with tolerance (snug tight should be specified if preload is not required for structural or functional considerations); etc.

f. Interface Limitations - Define load, configuration and/or attached weight limitation for all fluid or conduit connections. Limits may be specified in terms of pipe, tube or conduit length (of a particular size) from the device to the 1st support furnished by TVA NPG or in terms of allowable forces and moments acting at the interface point under the worst case qualification load combination.

g. Any other data that is pertinent to correct installation and maintenance of S/SQ for the device's design life.

Figure 3.1 – REQUIRED RESPONSE SPECTRA FOR DEVICES

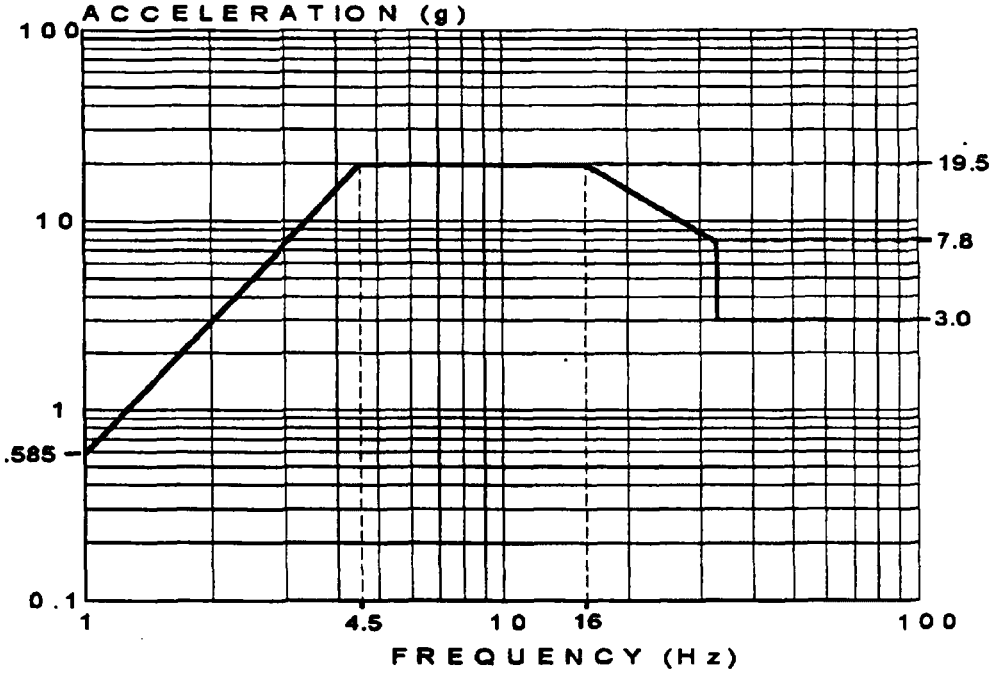
3g EQUIVALENT @ 5% DAMPING



Note: Line Segments are Straight Lines on Log/Log Scale Only

Figure 3.2 – REQUIRED RESPONSE SPECTRA FOR DEVICES

3g EQUIVALENT @ 3% DAMPING



Note: Line Segments are Straight Lines on Log/Log Scale Only

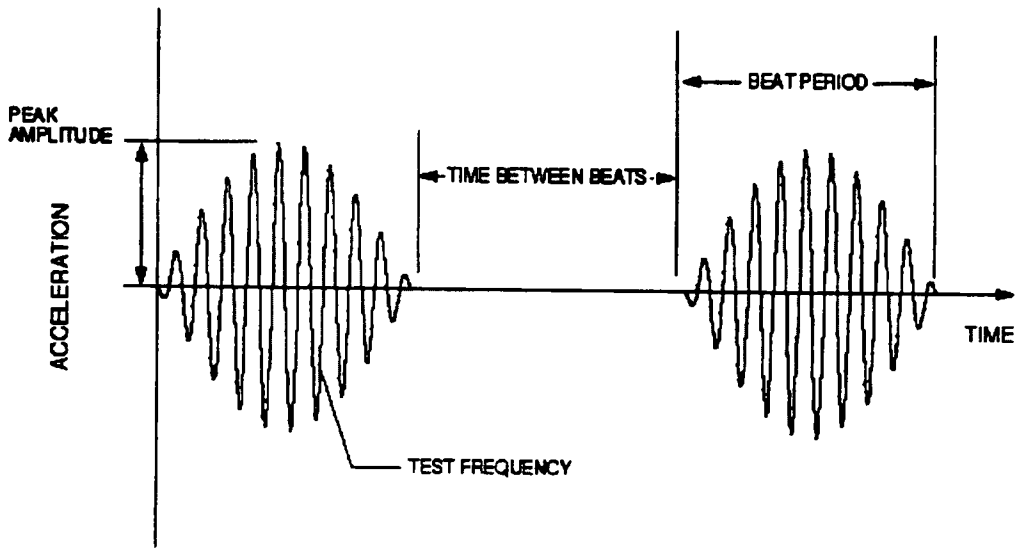


Figure 4.1 - SINE BEAT INPUT MOTION

Attachment 1 - CEB-SS-5.10 S/SQ DATA

COMPONENT IDENTIFICATION

ITEM DESCRIPTION

_____

_____

Default (if not marked) is See Procurement Specification.

PLANT APPLICABILITY:

☐Browns Ferry ☐Sequoyah ☐Watts Bar ☐All

Default (if not marked) is All.

CLASSIFICATIONS:

☐Active ☐Non-active ☐Class 1E

Default (if not marked) is Active and Class 1E (if Electrical/I&C Device).

QUALIFICATION APPROACH:

☐By Test or Test/Analysis ☐Either Test or Analysis Permissible

Default (if not marked) is By Test or Test/Analysis.

REQUIRED NUMBER OF TEST SPECIMENS:

☐One Minimum ☐ _____

Default (if not marked) is One Minimum.

Attachment 1 - CEB-SS-5.10 S/SQ DATA

SAFETY FUNCTION AND FUNCTIONAL PARAMETERS (e.g., time limits, positions, etc.):

☐See Below ☐See Separate Specification

_____

_____

_____

_____

_____

_____

_____

_____

Default (if not marked) is See Below. Full Functionality and Operability per manufacturer catalog data before, during and after seismic event.

SEISMIC LOAD:

REQUIRED INPUT MOTION:

☐ Not Applicable (Qualify to Required Response Spectra Below)

☐ Use Minimum Accelerations per Section 3.2.1

☐ Use Accelerations: Ax = _____ g

Ay = _____ g

Default (if not marked) is Use Minimum Accelerations (Ax = Ay = 3g) per Section 3.2.1.

REQUIRED RESPONSE SPECTRA:

☐ Use Standard 3 g Spectra per Section 3.2.2.

☐ Derive Spectra per Section 3.2.2 Using the Following Zero Period Accelerations:

Ax = _____ g

Ay = _____ g

☐ Use Spectra defined by the sheets A5 - A7

Default (if not marked) is Use Standard 3g Spectra per Section 3.2.2.

Attachment 1 - CEB-SS-5.10 S/SQ DATA

OTHER SPECIFIED LOADS AND CONDITIONS:

☐ See Below ☐ See Separate Specification

INTERNAL PRESSURE _____ psi

TEMPERATURE _____°F

DBA INERTIAL LOADS:

☐ Not Applicable ☐ Described Below ☐ Included in Seismic Load

_____

_____

_____

_____

_____

Default (if not marked) is See Separate Specification. If not in separate specification, use Vendor pressure and temperature ratings, and DBA Inertial Loads are Not Applicable.

INTERFACE LOADS:

☐ Not Applicable ☐ Described Below

_____

_____

_____

_____

_____

Default (if not marked) is Described Below. See Section 3.3 for Device Configuration. Simulate electrical and mechanical attachments to device. Simulation to be described in in Test Procedure or Analysis Report.

Attachment 1 - CEB-SS-5.10 S/SQ DATA

OTHER LOADS:

☐ Not Applicable ☐ Described Below

_____

_____

_____

_____

_____

Default (if not marked) is Not Applicable.

INSTALLATION ORIENTATION:

☐ Not Specified ☐ See Separate Specification ☐ See Sketch Below

Default (if not marked) is Not Specified. Orientation is per any applicable manufacturer requirements or recommendations.

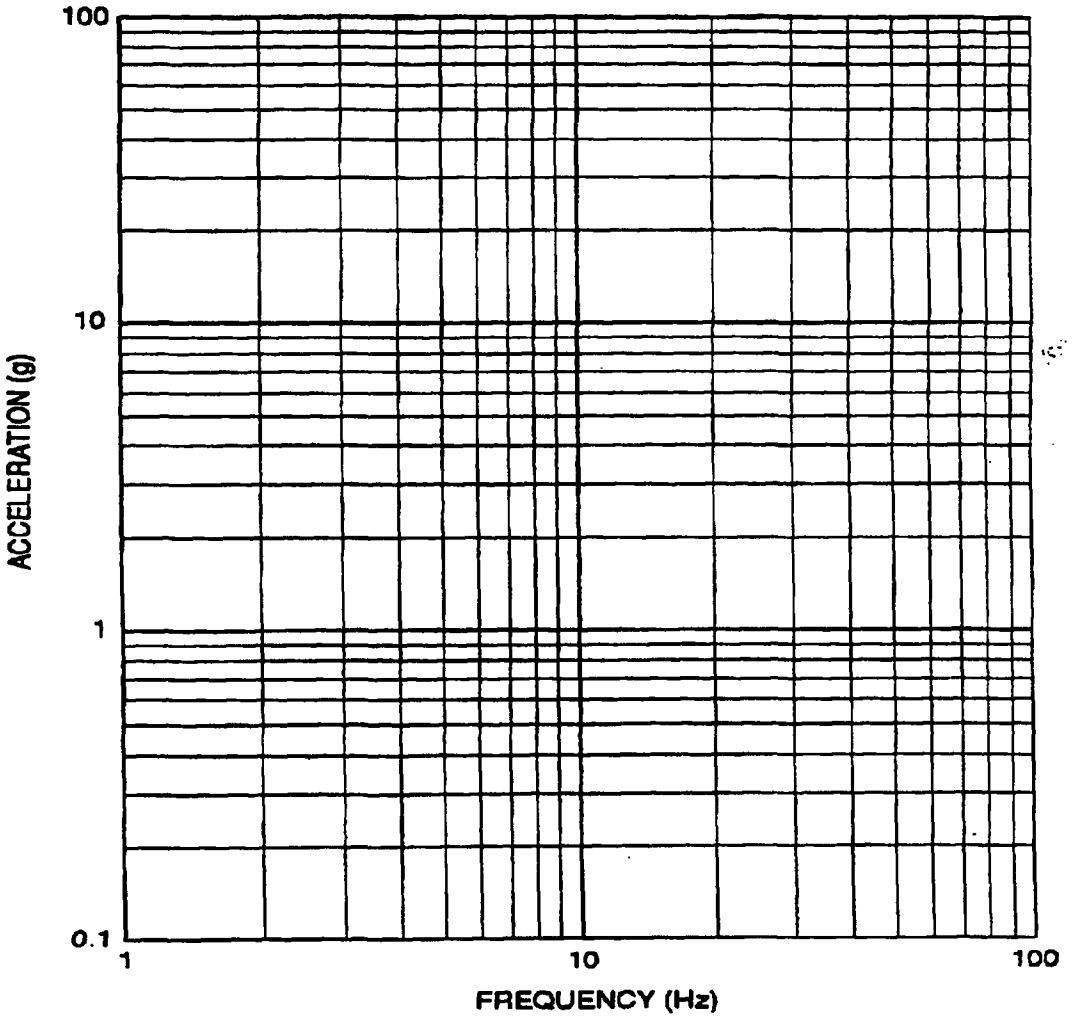
Attachment 1 - CEB-SS-5.10 S/SQ DATA

DEVICE REQUIRED RESPONSE SPECTRA:

EXCITATION DIRECTION WITH RESPECT TO DEVICE: _____

_____

_____



Default (if not marked) is Use Standard 3g Spectra per Section 3.2.2 for all 3 orthogonal directions.

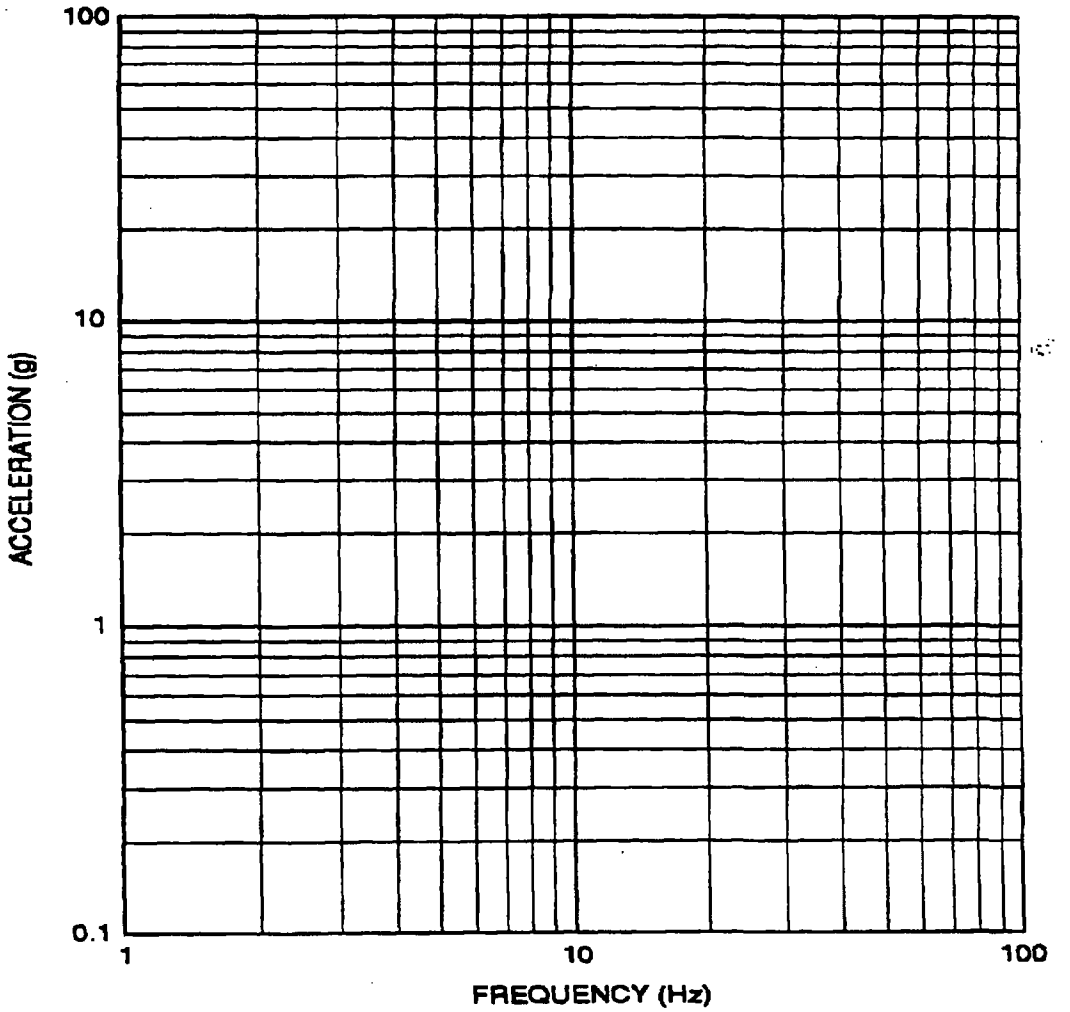
Attachment 1 - CEB-SS-5.10 S/SQ DATA

DEVICE REQUIRED RESPONSE SPECTRA:

EXCITATION DIRECTION WITH RESPECT TO DEVICE: _____

_____

_____



Default (if not marked) is Use Standard 3g Spectra per Section 3.2.2 for all 3 orthogonal directions.

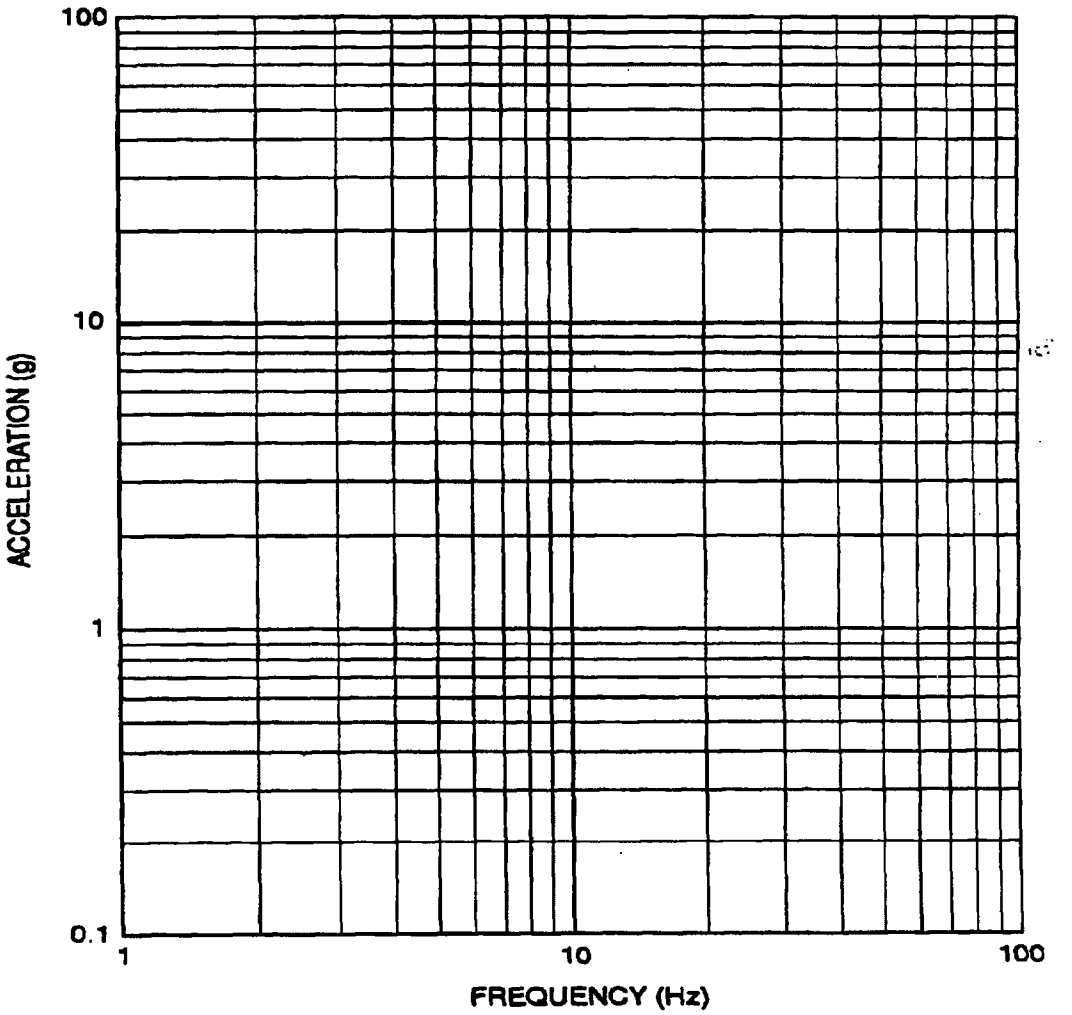
Attachment 1 - CEB-SS-5.10 S/SQ DATA

DEVICE REQUIRED RESPONSE SPECTRA:

EXCITATION DIRECTION WITH RESPECT TO DEVICE: _____

_____

_____



Default (if not marked) is Use Standard 3g spectra per Section 3.2.2 for all 3 orthogonal directions.

TVA Letter Dated February 25, 2011

Attachment 4

**Common Q PAMS Regulatory Guide and IEEE Standard Analysis,
Dated February 18, 2011**

TVA Letter Dated February 25, 2011

Attachment 4

**Common Q PAMS Regulatory Guide and IEEE Standard Analysis,
Dated February 18, 2011**

Attachment 4
Common Q PAMS Regulatory Guide and IEEE Standard Analysis
February 18, 2011

This attachment contains the following TVA review and analysis of changes in the revision level of the various Regulatory Guides and IEEE Standards referenced in the design of the Common Q PAMS.

1. Westinghouse Common Q Post Accident Monitoring System (PAMS) RG 1.29 Revision 3 to Revision 4 Comparison

2. Westinghouse Common Q Post Accident Monitoring System (PAMS) RG 1.53 Revision 0 to Revision 2 Comparison

3. Westinghouse Common Q Post Accident Monitoring System (PAMS) IEEE-279-1971 to IEEE-603-1991 Comparison

4. Westinghouse Common Q Post Accident Monitoring System (PAMS) IEEE-379 Rev 1988 to Rev 1994 to Rev 2000 Comparison

5. Westinghouse Common Q Post Accident Monitoring System (PAMS) Regulatory Guide 1.75 Rev 2 IEEE 384-1981 to 1992 Comparison

6. Westinghouse Common Q Post Accident Monitoring System (PAMS) Regulatory Guide 1.89 Rev. 0 to Rev. 1 Comparison

7. Westinghouse Common Q Post Accident Monitoring System (PAMS) Regulatory Guide 1.100 Rev 2 to Rev 0 and Rev 3 Comparison

8. Westinghouse Common Q Post Accident Monitoring System (PAMS) Regulatory Guide 1.153 to Rev. 0 to Rev. 1 Comparison

9. Westinghouse Common Q Post Accident Monitoring System (PAMS) Regulatory Guide 1.152 Rev 0 to Rev 1 to Rev 2 Comparison

10. Westinghouse Common Q Post Accident Monitoring System (PAMS) IEEE 7-4.3.2™ 1993 to 2003 Comparison

11. Westinghouse Common Q Post Accident Monitoring System (PAMS) RG 1.168 Sep 1997 to Feb 2004 Comparison, Including Related IEEE Standards

12. Westinghouse Common Q Post Accident Monitoring System (PAMS) IEEE-323 Rev. 1974 to Rev. 1983

13. Common Q PAMS Evaluation for IEEE 344 Revision Differences

14. Common Q PAMS Evaluation for ANSI/ISA 67.04 Revision Differences

Westinghouse Common Q Post Accident Monitoring System (PAMS)
RG 1.29 Revision 3 to Revision 4 Comparison

Background

The Watts Bar Project licensing basis is Regulatory Guide 1.29 rev 3[1]. The Westinghouse Common Q PAMS was designed to meet the requirements of Reg. Guide 1.29 rev 3. The current regulatory guidance is Reg. Guide 1.29 rev 4. The NRC questioned whether the Westinghouse Common Q PAMS equipment meets the requirements of current regulations. This is a comparison of the requirements of the design basis of Common Q PAMS and current regulation.

Discussion

An analysis was performed to identify the requirements of Reg. Guide 1.29 Revision 3 to identify those that are applicable to the Common Q PAMS variables. Those requirements were then compared to the corresponding requirements in Revision 4.

Table 1 contains the results of the preceding analysis and demonstrates that there are no differences between the Revision 3 and Revision 4 requirements for the Common Q PAMS equipment.

Conclusions

The Common Q PAMS equipment fully meets Reg, Guide 1.29 Revision 3 and 4 requirements.

No further action is necessary.

References

a) Regulatory Guide 1.29 rev. 3
b) Regulatory Guide 1.29 rev. 4

M. Merten, PE / 1/31/11
Prepared by / Date

D.F. Faulkner / 1/31/11
Reviewed by / Date

[1] The WBN2 FSAR in-process change package for Amendment 103 is changing this to revision 3.

Table 1

No.	R3 Location	R4 Location	R3 Statement (WBN2 & CQ design)	R4 Statement (new revision)	Analysis
1	A - Intro	A - Intro	Introductory remarks	Introductory remarks	Differences are non-technical
2	B / discussion	B / discussion	"Those structures, systems, and components that should be designed to remain functional if the SSE occurs have been designated as Seismic Category I."	"In so doing, the staff designated as Seismic Category I those SSCs that must be designed to remain functional if the SSE occurs."	Editorial change, Common Q PAMS meets all requirements
3	C.1	C.1	The pertinent quality assurance requirements of Appendix B to 10 CFR Part 50 should be applied to all activities affecting the safety-related functions of these structures, systems, and components.	"The titles and functions of these Seismic Category I SSCs for LWR designs are based on existing technology from prior applications. Certain SSCs previously considered Seismic Category I may no longer have a safety-related function requiring Seismic Category I classification, and certain passive SSCs in new LWR designs may be titled differently. The pertinent quality assurance requirements of Appendix B to 10 CFR Part 50 shall apply to all activities affecting the safety-related functions of these SSCs:"	Later revision offers more explanation only. Common Q PAMS meets all requirements.
4	C.1.E	C.1.E	n/a	Added note for size in cm and added parentheses.	Editorial change, Common Q PAMS meets the rev 3 requirement.
5	C.1	C.1	n/a	General - added sizes in cm throughout	Editorial change, Common Q PAMS meets the rev 3 requirement.

Table 1

No.	R3 Location	R4 Location	R3 Statement (WBN2 & CQ design)	R4 Statement (new revision)	Analysis
6	C.1.P	C.1.P	"p. Systems other than radioactive waste management systems, not covered by items 1.a through 1.o above that contain or may contain radioactive material and whose postulated failure would result in conservatively calculated potential offsite doses (using meteorology as recommended in Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors," and Regulatory Guide 1,4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors") that are more than 0.5 rem to the whole body or its equivalent to any part of the body."	"p. systems other than radioactive waste management systems, not covered by items 1.a through 1.o above that contain or may contain radioactive material and of which postulated failure would result in conservatively calculated potential offsite doses [using meteorology as recommended in the latest editions of Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling-Water Reactors" (Ref. 6), Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Pressurized Water Reactors" (Ref. 7), and Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design-Basis Accidents at Nuclear Power Reactors" (Ref. 3)] that are more than 0.005 Sievert (0.5 rem) to the whole body or its equivalent to any part of the body or total effective dose equivalent (TEDE), as applicable."	Stronger requirement in later revisions is not relevant to Common Q PAMS.
7	C.2	C.2	"2. Those portions of structures, systems, or components whose continued function is not required but whose failure could reduce the functioning of any plant feature included in items I .a through I.q above to an unacceptable safety level or could result in incapacitating injury to occupants of the control room should be designed and constructed so that the SSE would not cause such failure."	"2. Those portions of SSCs of which continued function is not required but of which failure could reduce the functioning of any plant feature included in items 1.a through 1.q above to an unacceptable safety level or could result in incapacitating injury to occupants of the control room should be designed and constructed so that the SSE would not cause such failure."	There is no postulated failure of Common Q PAMS that would result in the failure of other systems. Common Q PAMS meets the rev 3 requirement.

Table 1

No.	R3 Location	R4 Location	R3 Statement (WBN2 & CQ design)	R4 Statement (new revision)	Analysis
8	C.3	C.3	"3. Seismic Category I design requirements should extend to the first seismic restraint beyond the defined boundaries. Those portions of structures, systems, or components that form interfaces between Seismic Category I and non-Seismic Category I features should be designed to Seismic Category I requirements."	"3. At the interface between Seismic Category I and non-Seismic Category I SSCs, the Seismic. Category I dynamic analysis requirements should be extended to either the first anchor point in the non-seismic system or a sufficient distance into the non-Seismic Category I system so that the Seismic Category I analysis remains valid."	Rewording only, Common Q PAMS meets the rev 3 requirement.
9	C.4	C.4	"4. The pertinent quality assurance requirements of Appendix B to 10 CFR Part 50 should be applied to all activities affecting the safety-related functions of those portions of structures, systems, and components covered under Regulatory Positions 2 and 3 above. "	"4. The pertinent quality assurance requirements of Appendix B to 10 CFR Part 50 should be applied to all activities affecting the safety-related functions of those portions of SSCs covered under Regulatory Positions 2 and 3 above."	Rewording only, Common Q PAMS meets the rev 3 requirement.
10	n/a	C.5	n/a	"5. Regulatory Guide 1.189, "Fire Protection for Operating Nuclear Power Plants" (Ref. 8), provides guidance used to establish the design requirements for portions of fire protection SSCs to meet the requirements of GDC 2, as they relate to designing those SSCs to withstand the effects of the SSE."	Stronger requirement in later revision is not relevant to Common Q PAMS.

Westinghouse Common Q Post Accident Monitoring System (PAMS)
RG 1.53 Revision 0 to Revision 2 Comparison

Background

The Watts Bar Project licensing basis is Regulatory Guide 1.53 rev 0. The Westinghouse Common Q PAMS was designed to meet the requirements of RG 1.53 rev 0. The current revision is rev 2. The NRC questioned whether the Westinghouse Common Q PAMS equipment meets the newest requirements. This is a comparison of the requirements of the design of Common Q to the most recent guidance.

Discussion

See table 1

Conclusions

The Common Q PAMS equipment fully meets RG 1.53 revision 0 and revision 2 requirements.

No further action is necessary.

References

a) Regulatory Guide 1.53 rev. 0
b) Regulatory Guide 1.53 rev. 2

M. A. Merten, PE / 1/19/11
Prepared by / Date

D.F. Faulkner / 1/24/11
Reviewed by / Date

Table 1

No.	R0 Location	R2 Location	R0 Statement (design basis)	R2 Statement (CQ design)	Analysis
1	A - Intro	A - intro	Introductory remarks	Introductory remarks	Differences are non technical and/or will be incorporated within the comparison on IEEE 279-1971 and IEEE 603-1991
2	B - Overview	B - Overview	general discussion	general discussion	Differences in section are non-technical
3	C - regulatory position	C - regulatory position	See analysis	See analysis	Rev 0 discusses IEEE 379-1972 which is in trial status and thus it supplements different sections. Rev 2 endorses IEEE 379-2000. Thus the technical differences between the two IEEE standards will be discussed in another comparison document.
4	n/a	D - implementation	n/a	General implementation instructions.	New paragraph contains no technical requirements.

Westinghouse Common Q Post Accident Monitoring System (PAMS)
IEEE-279-1971 to IEEE-603-1991 Comparison

Background

The Watts Bar Project licensing basis is IEEE-279-1971. The Westinghouse Common Q PAMS was designed to meet the requirements of IEEE-603-1991. The NRC questioned whether the Westinghouse Common Q PAMS equipment meets the requirements of the design basis. This is a comparison of the requirements of the design basis of WBN2 and Common Q PAMS.

Note that IEEE-279-1971 *Criteria for **Protection Systems** for Nuclear Power Generating Stations* has been superseded by the IEEE-603 series *Criteria for **Safety Systems** for Nuclear Power Generating Stations.*

Discussion

Since these are completely different, but related standards, a line by line comparison will not be performed.

The first question is whether or not IEEE-279 would be an applicable standard for Common Q PAMS. The answer depends on whether or not Common Q PAMS is a **protection system.** Common Q performs no automatic function (beyond alarms), but it does provide information to the operators which are used to make decisions in post-accident environments.

The definition of **protective function** in IEEE-279 is not definitive as to whether the initiation of an action is done automatically or by the hands of an operator. However upon review of the definition of **protective action**, it is clear the intent of IEEE-279 is that the standard applies to automatic protective actions only. Therefore, **Common Q PAMS is not a protection system,** and therefore **IEEE-279 does not apply to Common Q PAMS**. Note that IEEE-279-1971 is referenced by Westinghouse in reference (c), but based on the definition of **protection systems**, it has no relevance.

The second question is whether or not IEEE-603 forms part of the design basis for WBN2. It does, but only for Eagle 21, see reference (d).

Conclusions

The first of the two standards, IEEE-279, is part of the design basis of WBN2 but is not relevant to Common Q PAMS. The second standard, IEEE-603-1991 is not part of the design basis for the Common Q PAMS system for WBN2.

No further action is necessary.

References

a) IEEE-279-1971
b) IEEE-603-1991
c) Licensing Technical Report - rev 2
d) FSAR section table 7.1-1

M. A. Merten, PE / 1/19/11
Prepared by / Date

D. F. Faulkner / 1/24/11
Reviewed by / Date

Westinghouse Common Q Post Accident Monitoring System (PAMS)
IEEE-379 Rev 1988 to Rev 1994 to Rev 2000 Comparison

Background

The Watts Bar Project licensing basis is IEEE-379-1988. The Westinghouse Common Q PAMS was designed to meet the requirements of IEEE-379-1994. The NRC questioned whether the Westinghouse Common Q PAMS equipment meets the requirements of the design basis. This is a comparison of the requirements of the design basis of WBN2 and Common Q PAMS.

Additionally, IEEE-379-2000 is the current revision of this standard and is endorsed by the NRC. A comparison will be made to this revision as well. This comparison is made for informational purposes only since this is not the design basis of Watts Bar Unit 2.

Discussion

Since these IEEE standards have a summary of changes section, a line by line comparison will not be performed.

There are three changes between 1988 and 1994 revisions.

1. Clarification that safety systems shall be capable of performing their safety functions with the single failure occurring prior to or during the design basis event
2. Revise definitions
3. Update the references.

Of these three the first is the only one of consequence. Since this is more restrictive in the later revisions, Common Q PAMS meets the design basis of WBN2.

The comparison to revision 2000 has the major difference of providing clarification of single-failure criterion as applied to shared systems of multi-unit stations. As Common Q PAMS is not a shared system this is not applicable. Additionally, this revision addresses regulatory positions and issues as identified in Reg Guide 1.53 rev 0 (issued June 1973) in which the Reg Guide clarified or supplemented some of these requirements. Since Common Q PAMS is in compliance with Reg Guide 1.53 rev 0 (June 1973), this difference is not applicable.

Conclusions

The Common Q PAMS equipment fully meets the WBN2 design basis requirement of IEEE-379-1988. Additionally, the differences to IEEE-379-2000 are not applicable to Common Q PAMS.

No further action is necessary.

References

a) IEEE-379-1988
b) IEEE-379-1994
c) IEEE-379-2000

M. A. Merten, PE / 1/19/11
Prepared by / Date

D.F. Faulkner / 1/24/11
Reviewed by / Date

Westinghouse Common Q Post Accident Monitoring System (PAMS)
Regulatory Guide 1.75 Rev 2
IEEE 384-1981 to 1992 Comparison

Background

The Watts Bar Project licensing basis is Regulatory Guide 1.75 rev 2 (Sep 1978) and IEEE-384-1981 - but this **only applies to the Eagle 21** Reactor Protection System. The Westinghouse Common Q PAMS was designed to meet the requirements of Reg. Guide 1.75 rev 2 (Sep 1978) and IEEE-384-1992[1].

Note that WBN2 is not committed in complying with Reg. Guide 1.75. See reference (e).

Discussion

Since WBN2 is not committed to Reg. Guide 1.75 or IEEE-384, no comparison is required.

Conclusions

No further action is necessary.

References

a) RG 1.75 rev 2 (Sep 1978)
b) RG 1.75 rev 3 (Feb 2005)
c) IEEE-384-1981
d) IEEE-384-1992
e) WB-DC-30-4 - *Separation Isolation*

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[1] RG 1.75 rev 2 endorses IEEE-384-1974 trail version with 16 notes. It was done this way because when the Topical Report was written, Westinghouse wanted to go to IEEE 384-1992, but RG 1.75 had not been revised to update the 1992 IEEE standard, which would eventually happen in RG 1.75 rev 3.

Westinghouse Common Q Post Accident Monitoring System (PAMS)
Regulatory Guide 1.89 Rev. 0 to Rev. 1 Comparison

Background

The Watts Bar Project licensing basis is Regulatory Guide 1.89 rev. 1 (June 1984). The Westinghouse Common Q PAMS was designed to meet the requirements of Regulatory Guide 1.89 rev. 1, which is also the current regulation.

The NRC questioned whether the Westinghouse Common Q PAMS equipment meets the requirements of the WBN2 design basis. This question was asked probably because the WBN1 FSAR references Reg. Guide 1.89 rev 0 (Nov 1974). The WBN2 FSAR in-process change package for Amendment 103 is changing this to revision 1.

Discussion

See background

Conclusions

Common Q PAMS is in compliance with both the WBN2 design basis and current regulation as related to Reg. Guide 1.89.

References

a) Reg. Guide 1.89 rev. 0 (Nov 1974) - *Qualification of Class 1E Equipment for Nuclear Power Plants*
b) Reg. Guide 1.89 rev. 1 (June 1984) - *Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants*
c) IEEE-323-1974 - *IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations*
d) FSAR section table 7.1-1

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Reviewed by / Date

Westinghouse Common Q Post Accident Monitoring System (PAMS)
Regulatory Guide 1.100 Rev 2 to Rev 0 and Rev 3 Comparison

Background

The Watts Bar Project licensing basis is Regulatory Guide 1.100 rev 0 (March 1976). The Westinghouse Common Q PAMS was designed to meet the requirements of RG 1.100 rev 2 (Jan 1996). The NRC questioned whether the Westinghouse Common Q PAMS equipment meets the requirements of the design basis. This is a comparison of the requirements of the design basis of WBN2 and Common Q PAMS.

Additionally, RG 1.100 rev 3 (Sept 2009) is the current revision of this guide and is endorsed by the NRC. A comparison will be made to this revision as well. This comparison is made for informational purposes only since this is not the design basis of Watts Bar Unit 2.

Discussion

Regulatory

Regulatory Guide 1.100 Revision 0 endorses IEEE 344-1975 for electrical equipment only and in addition provides 4 regulatory positions. Revision 1 of the regulatory guide endorsed the 1975 IEEE standard for use with mechanical equipment. Revision 2 of the regulatory guide endorsed IEEE 344, 1987 and eliminated the 4 regulatory positions in R0 and R1, since they were incorporated into IEEE 344, 1987. Revision 3 of the regulatory guide endorsed IEEE 344, 2004 and ASME QME-1-2007, Qualification of Active Mechanical Equipment Used in Nuclear Power Plants. Since the Common Q is electric equipment, ASME QME-1-2007 is not applicable to Common Q PAMs.

The Revision 2 of the Regulatory guide provides additional general staff positions. Position a. discusses acceptance of clauses 7, 8 and 9 in IEEE 1987. b thru d addresses experience data use for qualification. e and g address testing above 33 hz

The Regulatory guide also provides 9 specific regulatory positions. a thru g address experience data. h and i address testing above 33 Hz.

Experience data is not used in the Common Q qualification. Testing above 33 Hz is not a part of the Regulatory Basis for WBN Common Q and is therefore not applicable.

IEEE 344, 1987 provided additional techniques for testing and incorporated previous NRC Staff positions into the standard. It did not invalidate the previous guidance in the 1975 version. The 2004 version added additional guidance on the use of experience data.

Conclusions

The Common Q PAMS equipment fully meets the WBN2 design basis requirement of RG 1.100 rev 0 and is compliant with revision 3, with exception of testing above 33 Hz, which is not applicable to the Basis of Watts Bar.

No further action is necessary.

References

a) RG 1.100 rev 0
b) RG 1.100 rev 2
c) RG 1.100 rev 3

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Westinghouse Common Q Post Accident Monitoring System (PAMS)
Regulatory Guide 1.153 to Rev. 0 to Rev. 1 Comparison

Background

The Watts Bar Project licensing basis is Regulatory Guide 1.153 Rev. 0. The Westinghouse Common Q PAMS was designed to meet the requirements of Regulatory Guide 1.153 Rev. 1. The NRC questioned whether the Westinghouse Common Q PAMS equipment meets the requirements of the design basis. This is a comparison of the requirements of the design basis of WBN2 and Common Q PAMS.

Discussion

The subject regulatory guides', both Rev. 0 and 1, purpose is to endorse references (a) IEEE-603-1980 and (b) IEEE-603-1991. These documents provide methodology for satisfying regulations associated with specified aspects of the power, instrumentation, and control portions of the safety systems of nuclear power plants. Note that Common Q PAMS is a safety system, but is not a control system since it performs no automatic action.

Within IEEE-603 there are standards that it endorses itself. But Reg. Guide 1.153 rev 1 clearly states the endorsement of these referenced standards will (or could) occur under alternative regulations. Therefore this analysis on Reg. Guide 1.153 does not include these sub-referenced standards.

Regulatory Guide 1.153 rev 0 endorses IEEE-603-1980 with supplements. The only relevant supplement is that section 5.8.1 of reference (a) states Reg. Guide 1.97 should be used vice IEEE-497-1977. Reg. Guide 1.97 rev 3 is the design basis of Common Q PAMS and rev 2 is the design basis of WBN2 (the differences between these were analyzed and previously submitted to the NRC in reference (e)). Lastly, as stated previously, the design basis of WBN2 is IEEE-603-1980, but this is only applied to Eagle 21, see reference (c).

Conclusions

The subject Regulatory Guides endorse and reference other standards. Common Q PAMS has been evaluated to comply with the requirements of these other endorsed standards (see reference (d)). Therefore no additional analysis needs to be performed and no further action is necessary.

References

a) IEEE-603-1980 - *Criteria for Safety Systems for Nuclear Power Generating Stations*
b) IEEE-603-1991 - *Criteria for Safety Systems for Nuclear Power Generating Stations*
c) FSAR section table 7.1-1
d) Comparison report in this letter titled *IEEE-279-1971 to IEEE-603-1991 Comparison*
e) Comparison report titled *Reg. Guide 1.97 Revision 3 to Revision 2 Comparison* - letter dated July 30, 2010

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Westinghouse Common Q Post Accident Monitoring System (PAMS)
Regulatory Guide 1.152 Rev 0 to Rev 1 to Rev 2 Comparison

Background

The Watts Bar Project licensing basis is Regulatory Guide 1.152 rev 0 (Nov 1985). The Westinghouse Common Q PAMS was designed to meet the requirements of RG 1.75 rev 1 (Jan 1996). The NRC questioned whether the Westinghouse Common Q PAMS equipment meets the requirements of the design basis. This is a comparison of the requirements of the design basis of WBN2 and Common Q PAMS.

Additionally, RG 1.152 rev 2 (Jan 2006) is the current revision of this guide and is endorsed by the NRC. A comparison will be made to this revision as well. This comparison is made for informational purposes only since this is not the design basis of Watts Bar Unit 2.

Discussion

The first two regulatory guides (rev 0 and 1) are simple endorsements of another standard ANSI/IEEE-ANS-7-4.3.2. Reg Guide 1.152 rev 0 endorses the 1982 revision and Reg Guide 1.152 rev 1 endorses the 1993 edition (with one exception concerning quantitative reliability goals).

RG 1.152 rev 2 endorses ANSI/IEEE-ANS-7-4.3.2-2003, but also provides extra regulatory guidance concerning computer based cyber security. Since this revision was not part of the design basis of WBN2 or Common Q PAMS, the project makes no commitment to the compliance of RG 1.152 rev 2.

The technical differences in the endorsed standards will be discussed separately.

Conclusions

The Common Q PAMS equipment fully meets the WBN2 design basis requirement of RG 1.152 rev 0.

No further action is necessary.

References

a) RG 1.152 rev 0
b) RG 1.152 rev 1
c) RG 1.152 rev 2

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Westinghouse Common Q Post Accident Monitoring System (PAMS)
IEEE 7-4.3.2™ 1993 to 2003 Comparison

Background

Watts Bar Unit 2 is committed IEEE 7-4.3.2-1982, "IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations" as endorsed by Regulatory Guide (RG) 1.152, "Criteria for Use of Computers in Safety Systems of Nuclear Power Plants," Revision 0 for the Eagle 21 system. All references to RG 1.152 in the UFSAR are specific to the Eagle 21 hardware. As such, there is not an overall WBN Unit 2 commitment to a specific revision of RG 1.152 or IEEE 7-4.3.2 in the existing WBN Unit 2 licensing bases. Because the Eagle 21 system is a legacy system, no update of the system to meet later revisions of RG 1.152 or IEEE 7-4.3.2 is required. Therefore, this analysis focuses on the installation of the Common Q PAMS and how it meets current regulatory requirements.

The Westinghouse Common Q PAMS was designed to meet the requirements of IEEE 7-4.3.2 1993 as endorsed by RG 1.152, Revision 1. The NRC questioned whether the Westinghouse Common Q PAMS meets the requirements of IEEE 7-4.3.2 2003 as endorsed by Regulatory Guide 1.152, Revision 2. This is a comparison of the requirements of the design basis Common Q PAMS against current regulatory guidance.

The scope of this review is limited based on Regulatory Guide 1.152, Revision 2 which specifically does not endorse Annexes B through F of IEEE 7-4.3.2-2003.

Portions of the evaluation of the Common Q PAMS to meet the requirements of IEEE 7-4.3.2-2003 were performed in response to NRC RAI Matrix Item 212, as documented in TVA letter to NRC dated December 22, 2010.

Discussion

Software development for the Common Q PAMS applications is governed by WCAP-16096-NP-1A "Software Program Manual." This document was approved by the NRC via Final Safety Evaluation For Topical Report WCAP-16096-NP-A, Revision 1, "Software Program Manual For Common Q Systems" (TAC NO. MC2294) dated September 28, 2004. WCAP-16096-NP-A references IEEE 7-4.3.2 1993. In Exhibit 4-1 (page 10-6) the WCAP classifies the Common Q PAMS software as "Important-To-Safety" for the Kernel, Flat Panel Display and Inter-System Communication Software. All other software and development tools are classified as "General Purpose." The Important-To-Safety classification is based on the fact the PAMS performs no actuation functions.

IEEE 7-4.3.2 references IEEE 603 "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations" and provides guidance beyond IEEE 603. While both of these standards are specific to safety systems, selected principles can be applied to the Common Q PAMS and are included in the Common Q PAMS design.

IEEE 7-4.3.2 2003 contains the following safety system criteria sections:

5.1 Single-failure criterion

TVA Evaluation:

No evaluation necessary. PAMS performs no protective actions.

5.2 Completion of protective action

TVA Evaluation:

No evaluation necessary. PAMS performs no protective actions.

5.3 Quality
- 5.3.1 Software development
- 5.3.2 Software tools
- 5.3.3 Verification and validation
- 5.3.4 Independent V&V (IV&V) requirements
- 5.3.5 Software configuration management
- 5.3.6 Software project risk management

TVA Evaluation:

The Common Q PAMS Quality Program is in compliance with the NRC approved WCAP-16096-NP-1A "Software Program Manual (SPM). The following table lists the SPM sections that correspond to the quality sections in IEEE 7-4.3.2 2003 listed above.

IEEE 7-4.3.2 2003 section	Corresponding SPM section
5.3.1	3.3.5.6 and 4.1.3
5.3.2	4.9
5.3.3	3.3.5.8 and 4.6.2.4
5.3.4	2
5.3.5	3.3.5.2 and 4.6.2.9
5.3.6	4.15

5.4 Equipment qualification
- 5.4.1 Computer system testing
- 5.4.2 Qualification of existing commercial computers

TVA Evaluation:

Common Q PAMS complies with the requirements of the Westinghouse commercial item dedication program. Equipment qualification is addressed in EQ-QR-68-WBT, "Qualification Summary Report for Post-Accident Monitoring System (PAMS)." This report is due to be submitted to the NRC on March 25, 2011. The draft report was submitted to the NRC in TVA to NRC letter dated December 22, 2010. Qualification of existing commercial computers is addressed in the Westinghouse Commercial Item Dedication program as described in WNA-LI-00058-WBT-P, Revision 2, "Post-Accident

Monitoring System (PAMS) Licensing Technical Report", Section 7, Commercial Grade Dedication Process.

5.5 System integrity
5.5.1 Design for computer integrity
5.5.2 Design for test and calibration
5.5.3 Fault detection and self-diagnostics

TVA Evaluation:

5.5.1 Common Q PAMS complies with these requirements. See response to NRC Matrix Item 212, Item 1 IEEE 603 1991, 5.5 System Integrity and Item 2 IEEE 7.4.3.2-2003, 5.5 System Integrity in TVA to NRC letter dated December 22, 2010.
5.5.2 Common Q PAMS complies with these requirements. See response to NRC Matrix Item 212, Item 1 IEEE 603 1991, 5.7 Capability for Test and Calibration and Item 2 IEEE 7.4.3.2-2003, 5.5.2 Design for test and calibration in TVA to NRC letter dated December 22, 2010.
5.5.3 Common Q PAMS complies with these requirements. See response to NRC Matrix Item 212, Item 2 IEEE 7.4.3.2-2003, 5.5.3 Fault detection and self diagnostics in TVA to NRC letter dated December 22, 2010.

5.6 Independence

TVA Evaluation:

Common Q PAMS complies with these requirements. The external connection from the MTP to the Plant Computer is via a software restricted TCP/IP connection that limits processing of data from the plant computer to only those TCP/IP protocols necessary to support the communication link. This is described in WNA-LI-00058-WBT-P, Revision 2, "Post-Accident Monitoring System (PAMS) Licensing Technical Report", Section 2.2 System Description. This feature passed the data storm test performed in December 2010.

5.7 Capability for test and calibration

TVA Evaluation:

Common Q PAMS complies with these requirements. See response to NRC Matrix Item 212, Item 1 IEEE 603 1991, 5.7 Capability for Test and Calibration and Item 2 IEEE 7.4.3.2-2003, 5.5.2 Design for test and calibration in TVA to NRC letter dated December 22, 2010.

5.8 Information displays

TVA Evaluation:

Common Q PAMS complies with these requirements. The specific requirements are addressed in WNA-LI-00058-WBT-P, Revision 2, "Post-Accident Monitoring System (PAMS) Licensing Technical Report", Section 11, TVA Contract Compliance Matrix items:

- 10, display of sensor diagnostic information
- 311 system status displays
- 341 alarms

5.9 Control of access

TVA Evaluation:

Common Q PAMS complies with these requirements. The Common Q PAMS hardware is located within a vital area that has restricted access. The Common Q PAMS cabinets, located in the Aux Instrument Room, have doors that are locked. Access to features for changing values, software load etc. is controlled either the Function Enable (FE) keyswitch or Software Enable (SLE) keyswitch. The keys to the switches are controlled in accordance with TVA procedures. The system trouble alarm actuates if any keyswitch is taken to the "ENABLE" position.

5.10 Repair

TVA Evaluation:

Common Q PAMS complies with these requirements. See response to NRC Matrix Item 212, Item 1 IEEE 603-1991, 5.10 Repair in TVA to NRC letter dated December 22, 2010.

5.11 Identification

TVA Evaluation:

Common Q PAMS complies with these requirements. Hardware is identified in accordance with TVA standards. Software is identified in accordance with WCAP-16096-NP-1A "Software Program Manual."

5.12 Auxiliary features

TVA Evaluation:

Not applicable to Common Q PAMS

5.13 Multi-unit stations

TVA Evaluation:

Not applicable to Common Q PAMS

5.14 Human factor considerations

TVA Evaluation:

Common Q PAMS complies with these requirements. Human factors are addressed in WNA-LI-00058-WBT-P, Revision 2, "Post-Accident Monitoring System (PAMS) Licensing Technical Report", TVA Response to PSAI 6.7 and TVA Response to PSAI 6.14.

5.15 Reliability

TVA Evaluation:

Common Q PAMS complies with these requirements. Reliability requirements are identified in WNA-LI-00058-WBT-P, Revision 2, Post-Accident Monitoring System (PAMS) Licensing Technical Report, Section 11, TVA Contract Compliance Matrix items 178, 179, 246, 300 and 407 submitted in TVA to NRC letter dated December 3, 2010 . Reliability is evaluated in WNA-AR-00180-WBT, Revision 0 Failure Modes and Effects Analysis (FMEA) for the Post Accident Monitoring System and WNA-AR-00189-WBT Revision 0 Post Accident Monitoring System Reliability Analysis submitted in TVA to NRC letter dated October 5, 2010.

6. Sense and command features—functional and design requirements

TVA Evaluation:

Not applicable to Common Q PAMS. PAMS performs no sense and command functions.

7. Execute features—functional and design requirements

TVA Evaluation:

Not applicable to Common Q PAMS. PAMS performs no execute functions.

8. Power source requirements

TVA Evaluation:

Common Q PAMS design meets this requirement. One channel is powered from train A vital power and the other train is powered from train B vital power.

Conclusions

As described above, the Common Q PAMS meets the applicable requirements of IEEE 7-4.3.2-2003 except as noted below:

- The quality program which is in accordance with WCAP-16096-NP-1A "Software Program Manual" (SPM) which does address the same quality requirements as IEEE 7-4.3.2-2003.
- The commercial item dedication program which is in accordance with the Westinghouse 10CFR50.54 Appendix B program.

No further action is necessary.

References

a) WBN Unit 2 FSAR Section 7.1 and Table 7.1-1.
b) RG 1.152 Revision 1 "Criteria for Use of Computers in Safety Systems of Nuclear Power Plants"

c) RG 1.152 Revision 2 "Criteria for Use of Computers in Safety Systems of Nuclear Power Plants"
d) IEEE 603-1991 "Criteria for Safety Systems for Nuclear Power Generating Stations"
e) IEEE 603-1998 "Criteria for Safety Systems for Nuclear Power Generating Stations"
f) TVA letter to NRC "Watts Bar Nuclear Plant (WBN) Unit 2 – Instrumentation and Controls Staff Information Requests," dated December 22, 2010
g) Final Safety Evaluation For Topical Report WCAP-16096-NP-A, Revision 1, "Software Program Manual For Common Q Systems" (TAC NO. MC2294)
h) WCAP-16096-NP-A, Revision 1, "Software Program Manual For Common Q Systems"

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Westinghouse Common Q Post Accident Monitoring System (PAMS)
RG 1.168 Sep 1997 to Feb 2004 Comparison, Including Related IEEE Standards

Background

The Westinghouse Common Q PAMS was designed to meet the requirements of Regulatory Guide 1.168 rev 1 (Feb 2004), IEEE-1012-1998, and IEEE-1028-1997. See references (d) and (e).

However, revision 0 of reference (e) incorrectly stated Regulatory Guide 1.168 rev 0 (Sep 1997) and the incorrect related IEEE standards. The NRC had revision 0 of reference (e) and asked the question to compare the difference between rev 0 and rev 1 of the regulatory guide and its two IEEE standards.

Conclusions

Since revision 0 or reference (e) was in error, this question is no longer applicable.

No further action is necessary.

References

a) RG 1.168 Revision 1 - *Verification, Validation, Reviews, and Audits for Digital Computer Software used in Safety Systems of Nuclear Power Plants*
b) IEEE 1012-1998, *IEEE Standard for Software Verification and Validation*
c) IEEE-1028-1997 - *IEEE Standard for Software Reviews and Audits*
d) WCAP-16096-NP-A, *Software Program Manual For Common Q Systems* - Revision 1
e) WNA-LI-00058-WBT-P - *Post Accident Monitoring System PAMS Licensing Technical Report* - rev 2

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Westinghouse Common Q Post Accident Monitoring System (PAMS)
IEEE-323 Rev. 1974 to Rev. 1983

Background

The Watts Bar Project licensing basis for ICCM-86 is IEEE-323-1974. The Westinghouse Common Q PAMS system was designed to meet the requirements of IEEE-323-1983. The version approved by the NRC within Regulatory Guide 1.89 Rev 1 is IEEE-323-1974. The NRC questioned whether the Westinghouse Common Q PAMS equipment meets the requirements of the older endorsed standard. This is a comparison of the requirements of the WBN2 PAM design basis, the design of Common Q PAMS, and the most recent endorsed guidance.

Note, according to references (e), (f), (g), and (h), the design basis for WBN1 is both IEEE-323-1971 and 1974, depending on when the individual item was procured. According to reference (d), the unit 1's ICCM-86 Design Specifications, the basis of ICCM-86 is IEEE-323-1974.

Discussion

Within IEEE-323-1983 in the Forward, there is a statement "this revision to IEEE Std 323-1974 was made to clarify its requirements and imposes no additional requirements for qualifying Class 1E equipment".

Conclusions

From the above quoted statement, the project concludes that since Common Q PAMS is designed to the 1983 version, it is also compliant with the 1974 (the NRC endorsed version). Additionally, this matches the design basis of the plant.

No further action is necessary.

References

a) IEEE-323-1971, "IEEE Standard for Qualifying Class 1E Equipment for nuclear Power Generating Stations"
b) IEEE-323-1974, "IEEE Standard for Qualifying Class 1E Equipment for nuclear Power Generating Stations"
c) IEEE-323-1983, "IEEE Standard for Qualifying Class 1E Equipment for nuclear Power Generating Stations"
d) Design Specification 956080 - Inadequate Core Cooling Monitor (ICCM-86)
e) FSAR table 3.11-2 - Compliance With NRC Criteria and Standards
f) FSAR Section 7.1.1 – Identification of Safety-Related Systems
g) FSAR Section 7.1.2 – Identification of Safety Criteria
h) FSAR TABLE 7.1-1 Watts Bar Nuclear Plant NRC Regulatory Guide Conformance
i) Reg. Guide 1.89 rev 1 (June 1984) - "Qualification of Class 1E Equipment for Nuclear Power Plants"

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Common Q PAMS Evaluation for IEEE 344 Revision Differences

The licensing basis for WBN Unit 2 is IEEE 344-1975, "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations" for equipment procured after 1975. Equipment procured prior to 1975 was procured to IEEE 344-1971. The Common Q PAMS qualification is to IEEE 344-1987. The current version endorsed by the NRC is 2004.

Document Comparison

1975 to 1987 Comparison	**Qualification Impact**
Nonlinear equipment response during analysis is not included in 1975	1987 more restrictive
Maintenance and repair are not included in 1975	1987 more restrictive
Exploratory test methods are expanded in 1987, provides additional information on types of tests	no change
Vibration aging is expanded in 1987 to include normal and transient plant vibration effects	1987 more restrictive
Aging from Nonseismic Vibration Conditions is not included in 1975	1987 more restrictive
Effects of cabinet doors/panels rattling and banging not included in 1975	1987 more restrictive
Test Response Spectrum Analysis expanded in 1987	1987 more restrictive
Test motion revised in 1987	1987 more restrictive
Derivation of input motion for multifrequency tests is expanded in 1987	1987 more restrictive
Triaxial tests added in 1987	Triaxial test beds were not available in 1975
Pipe mounted equipment testing added in 1987	unknown
Transfer-Function Modal Test Method added in 1987	Equipment for this test was not available in 1975
Extrapolation for Similar Seismic Conditions deleted in 1987	1987 more restrictive
Extrapolation for Multicabinet Assemblies added in 1987	No change
Qualification by experience added in 1987	Not allowed in 1975
Informative annexes added in 1987	No change
1987 to 2004 Comparison	**Qualification Impact**
Earthquake experience added in 2004	2004 less restrictive
Non linear equipment response revised in 2004 to allow methods other than testing if the equipment cannot be adequately modeled.	2004 less restrictive
OBE & SSE analysis revised in 2004 to allow methods other than testing for complex equipment.	2004 less restrictive
Qualification by Experience expanded in 2004	2004 less restrictive
Documentation requirements for seismic reports expanded in 2004	No change

Analysis

The Common Q PAMS is being qualified by the use of test and analysis to IEEE 344-1987. As shown in the document comparison, IEEE 344-1987 is more restrictive than the plant design bases. It is also more restrictive than IEEE 344-2004 in that it limits the use of experience in qualification. The only more restrictive requirement in IEEE 344-2004 is the documentation required in the qualification report. This change does not impact the ability of the equipment to perform its design function and is not considered a critical aspect for this analysis.

The only unknown is the potential impact of pipe mounted equipment. However, none of the Common Q PAMS equipment is pipe mounted. Therefore this change has no impact.

Conclusion

Based on the analysis, seismic qualification of the Common Q PAMS meets the plant design bases and IEEE 344-2004 requirements.

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Common Q PAMS Evaluation for ANSI/ISA 67.04 Revision Differences

ISA 67.04-1994 is utilized by Westinghouse to calculate the typical alarm setpoints in the PAMS generic documents.

As part of the Eagle 21 and Common Q project scope Westinghouse is developing the calculation notes for each loop. Westinghouse is developing the calculation notes in accordance with "Westinghouse Setpoint Methodology for Protection Systems, Watts Bar Unit 2 WCAP-17044." This document is specific to WBN Unit 2. The Common Q alarm setpoint calculation notes are developed using the same methodology.

The WBN Unit 2 Licensing Bases is ISA 67.04-1982 as documented in TVA procedure EEB-TI-28 Branch Technical Instruction Setpoint Calculations, Revision 7. This procedure is used to calculate the reactor protection actuation setpoints. The differences between the ISA 67.04-1982 and 2000 along with the justification for continuing to use ISA 67.04-1982 is documented in EEB-TI-28. The Common Q PAMS alarm setpoint calculations are developed using the same process.

As previously discussed, the Common Q PAMS alarm setpoint calculation notes, and calculations are developed using the same methodology as the reactor protection system setpoints. Since the PAMS is an alarm and indication system, no further analysis is required.

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