TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

May 17, 1984

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

By letter dated April 25, 1984 from T. M. Novak to H. G. Parris, TVA was provided with a draft supplement to section 3.10 of the Watts Bar Nuclear Plant Safety Evaluation Report. This supplement specified additional NRC concerns related to seismic qualification of equipment. Enclosed is additional information to resolve these concerns.

If you have any questions concerning this matter, please get in touch with D. P. Ormsby at FTS 858-2682.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Licensing

Sworn to and subscribed before me
this 17th day of May 1984

Paulette H. White

Notary Public
My Commission Expires 9-5-84

Enclosure

cc: U.S. Nuclear Regulatory Commission (Enclosure)
Region II
Attn: Mr. James P. O'Reilly Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

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ENCLOSURE
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
SEISMIC AND DYNAMIC QUALIFICATION
OF SAFETY-RELATED ELECTRICAL AND MECHANICAL EQUIPMENT

Reference L. M. Mills' letters to E. Adensam dated December 1, 1982 and June 10, 1983

Generic Concern No. 1 - Single-Axis, Single-Frequency Testing

Question

TVA should verify for equipment at Watts Bar procured from Westinghouse that (1) the effect of directional coupling should be considered if applicable, (2) where applicable, verification should be provided that acceleration at each device location is less than 0.95g since the relay chatter at higher acceleration level is expected, and (3) the test response spectra (TRS) envelopes the required response spectra (RRS) for all directions since RRS for different directions can be different for buildings or cabinets.

Response

1. In order to justify the functionality of equipment using single-axis, single-frequency sine-beat testing, Westinghouse performed a supplemental seismic test program using multiple-axis, multiple-frequency excitation. This testing demonstrated that the effect of directional coupling did not adversely affect the equipment functionality.

   For the Watts Bar audit items, single-frequency, single-axis sine-beat testing was used in demonstrating seismic qualification of the three-bay solid-state protection system (SSPS), safeguards test cabinet, and main control board. For this equipment, horizontal and vertical directional coupling is not applicable because the vertical fundamental frequency of the equipment is greater than 33 Hz. Horizontal directional coupling, should it exist for the equipment, would be small. In comparing the Watts Bar requirements to the seismic qualification levels for the equipment, one notices there is sufficient margin to demonstrate the acceptability of horizontal directional coupling if it existed.

2. It is assumed that the 0.95g level mentioned is that of the eight-pole AR relays as tested during the Westinghouse high seismic test program.

   Westinghouse performed seimsic testing during their low seismic test program where relays were inputted at 0.8g acceleration (WCAP-7817, supplements 2 and 3) and no relay chatter was experienced. This low seismic documentation was reviewed at the Watts Bar audit. For the Watts Bar three-bay SSPS, the maximum postulated zero period acceleration (ZPA) is 0.45g which is approximately a factor of two less than the 0.8g level experienced during the low seismic program. Based on the above, relay chatter is not a concern for the Watts Bar plant.

3. As provided with the completed SQRT forms, TRS versus RRS comparisons were performed and demonstrated that plant-specific requirements were enveloped.

Generic Conern No. 3 - Field Mounting Versus Test Mounting

Question

A number of electrical cabinets were found to be field mounted by welding but test mounted by bolting. Demonstrate by in-situ tests on a WBN cabinet that the response of the cabinet is essentially unaffected by the difference in mounting.

Response

By the referenced letters, TVA provided the following information:

1. Discussion of TVA's program for seismic qualification of equipment including excerpts from design criteria which address the basic requirement that 'equipment being tested will be mounted to the vibration generator in a manner that simulates the intended service mounting.'

2. Engineering rationale concerning the primary sources of assembly flexibility for base-sill mounted eletrical panels. For the base-sill-mounted electrical panels inspected during the site audit, the primary sources of panel flexibility are not significantly effected by the mounting differences between the qualification test configuration and the corresponding installed configuration.

3. Analytical evaluation of the mounting difference has been provided for the main control board, which the site auditors felt represented a particular concern. Calculation results verified that the natural frequency shift due to the mounting differences was insignificant.

4. Summary discussion of Westinghouse background experience related to sill-to-floor mounting differences. This experience provides test verification that mounting differences of the type observed during the site audit are insignificant.

In summary, TVA has provided engineering rationale, analytical demonstration, and (by reference to Westinghouse documentation) test results, which verify TVA's position that the apparent differences in equipment anchorage observed during the site audit have no significant impact on the validity of equipment qualification. It is felt that the previous responses provide an adequate basis for resolution of this concern and that a further demonstration of adequacy by a program of in-situ testing is not justified.

Generic Concern No. 4 - Age Sensitivity, Surveillance, and Maintenance Program

Question

TVA should provide a detailed program of surveillance and maintenance of safety-related equipment for NRC review and approval.

Response

In response to a similar question from NRC on TVA's environmental qualification program, TVA provided a description of our maintenance and surveillance program for safety-related equipment. (Reference the response to item 20 in L. M. Mills' letter to E. Adensam dated November 7, 1983.) Please review this response.

Generic Concern No. 7 - Seismic Qualification Status - Safety-Related Equipment

Question

TVA should confirm the completion of seismic qualification of safety-related equipment in writing prior to fuel load, and maintain auditable records for NRC inspection.

Response

All safety-related mechanical and electrical equipment installed at Watts Bar has been seismically qualified by the vendor and this qualification reviewed and approved by TVA. Auditable records of seismic qualification programs for this equipment are maintained in the equipment contract files.

Specific Concern No. 1b - Reactor Trip Switch Gear

Question

TVA should conduct a walkdown audit on a sampling basis prior to fuel load to confirm that field modifications of this type have been made.

Response

TVA will conduct a walkdown inspection on a sampling basis to confirm the as-installed configuration of safety-related electrical and mechanical equipment and to assure that field modifications of this type have been completed. This inspection will be completed and results submitted by June 8, 1984.

Question

TVA should confirm that adequate clearance has been provided between the box-shaped cable tray support beam that extends downward from the ceiling and the reactor trip switchgear cabinet.

Response

The cable tray support beam has been modified to provide acceptable clearance between itself and the reactor trip switchgear cabinet for unit 1. This information was previously provided to you by L. M. Mills' letter to E. Adensam dated February 9, 1984.

Specific Concern No. 2b - Reactor Protection System Cabinet

Question

TVA should confirm that 0.5-inches clearance has been provided between the reactor protection system cabinet and engineering safeguards cabinet.

Response

The reactor protection system cabinet and engineering safeguards cabinet for unit 1 have been modified to provide 0.5-inches clearance between the cabinets. This information has previously proivded to you by L. M. Mills' letter to E. Adensam dated February 9, 1984.

Specific Concern 3a - Charging/Safety Injection Pump

Question

TVA should justify use of the Bijlaard technique for the suction nozzle geometry of the charging/safety injection pump.

Response

The suction nozzle of the charging/safety injection pump was analyzed according to the requirements of the ASME Code, Section III, Appendix A-2212, taking into account seismic loads, dead weight, and operating loads. The Bijlaard method was not used in analyzing the suction nozzle as per the design report prepared by Pacific Pump which was reviewed during the audit. This information was previously provided to you in the referenced letter dated December 1, 1982.

Specific Concern 4c - Control Rod Drive Mechanism (CRDM)

Question

TVA should provide the qualification safety margin for the CRDM.

Response

The analysis of the CRDMs, model L-106A, at Watts Bar under seismic conditions yielded first-mode frequencies of 4.3 to 6.8 Hz. Test results on the L-105 CRDM, which is shorter than the L-106 model, yielded 6.5 to 10.5 Hz for the first natural frequency. The longest CRDM has the largest seismic bending moment and lowest natural frequency of all the CRDMs. For the Watts Bar plant, the acceleration at the frequency of the longest CRDM (4.3 Hz) is lower than the peak acceleration of spectra curve. The peak horizontal acceleration occurs from 4.5 to 13 Hz. To account for any uncertainty of the seismic loading on the longest CRDM, the loading output was amplified. The amplification factor used was the ratio of the acceleration response spectra peak value to the acceleration level at the longest CRDM first frequency (4.31Hz). The entire combined response was amplified as additional conservatism, even though participation factors for modes higher than the fundamental mode are small.

For the resultant loadings of operating base earthquake (OBE) and safe shutdown earthquake (SSE) condition, the bending moment of the vertical shock was added absolutely to the bending moment of the horizontal shock. Maximum seismic bending moments at the limiting location (rod travel housing lower section) are as follows using the previous outlined procedures.

Rod Travel Housing

Condition	Maximum Bending Moment (in-lb)
OBE	80,694
SSE	98,993
LOCA	49,060
Faulted = $(SSE^2 + LOCA^2)^{1/2}$	110,483

Rod Travel Housing Allowables
(E.M. 4531, revision 2)
(Lower Joint)

Condition	Allowable Seismic Bending Moment (in-lb)
Upset (including OBE)	178,652
Faulted	232,301

From the above actual and allowable values, the following safety margins are derived:

Safey Margins

Upset = 1.21
Faulted = 1.10

where margin = $\left[\frac{\text{allowable}}{\text{actual}} - 1.0\right]$

Specific Concern 5a - Control Board

Question

TVA should provide justification for the assumption that the outside edge of the angle-shaped member is guided. Were this member more conservatively assumed to be fixed on the inside edge and free on the outside edge, the frequency calculation would yield 14.7 Hz rather than 19.7 Hz.

Note: It is assumed that the 14.7 Hz referred to in the NRC question is a typographical error. For this analysis model which is fixed on the inside edge and free on the outside edge, the frequency calculation yields 16.7 Hz.

Response

From the design configuration, there is obviously a significant amount of moment reaction capability along the outside edge of the angle-shaped member but certainly not total fixity. In the absence of other considerations, an appropriate analysis model of this configuration would, of course, lie somewhere between the fixed/guided and the conservatively flexible fixed/free boundary conditions.

For this particular analysis, with other conservative assumptions involved, it was judged appropriate to limit the compounding of conservatisms by using the fixed/guided analysis model. This engineering judgment is still considered appropriate.

As a matter of information, using a base stiffness value which is half-way between the fixed/guided and fixed/free analysis model boundary conditions (i.e., $k=7.5\ EI/L^3$), the panel assembly natural frequency would shift from 21.1 to 18.9 Hz due to the mounting configuration difference. This frequency shift would still have no significant effect on the main control board qualification.

Specific Concern 7b - 125V dc Vital Batteries

Question

TVA should confirm that battery spacers have been installed in the 125V dc vital battery assembly.

Response

The battery spacers have been installed in the 125V dc vital battery rack assembly for units 1 and 2. A problem has been encountered with excessive space between the end spacers and the end rail on the battery rack assembly. TVA has evaluated this problem with support from the manufacturer. TVA will replace the present end rails with adjustable end rails to eliminate the excessive space. This will be completed by August 31, 1984, for units 1 and 2. In the interim, plywood spacers will be utilized as additional end spacers to eliminate the excessive space in the unit 1 battery rack. The plywood spacers will be installed by June 1, 1984.

Specific Concern 8c - Diesel Generator Control and Protection Relay Panel

Question

TVA should provide justification including electrical schematics that the protective relays tested in the de-energized mode (because they do not perform any safety-related function in the energized) are not a safety concern due to a change of state from energized to de-energized while the diesel generator is providing emergency power.

Response

There will be no change of state from the energized to de-energized condition while the generator is providing emergency power because these relays will not be used. The protective relays only protect the diesel generator during testing. Once the generator is started for emergency use, a normally closed contact from the 86GA auxiliary relay opens to remove the protective relays trip contacts from the circuit (reference Watts Bar FSAR figure 8.3-28). Therefore, the only possible way for the protective relay to prevent the generator from performing its safety-related function would be for contact chatter to occur while the diesel generator is on standby and the plant is operating normally. Contact chatter could cause the auxiliary lockout relay 86GA to operate and place the generator breaker in a trip condition, and if a safety injection or under-voltage signal occurred before the lockout relay could be manually resest, the generator could not function. Therefore, these protective relays were seismically tested in the de-energized position to ensure that this contact chatter would not occur.

All the protective relays, with the exception of the 46-phase balance current relay, passed all siesmic testing with no chatter occurring. The 46-phase relay (Westinghouse type CM 290B960A21) exhibited contact chatter at 15, 16.0, and 17.5 Hz. Chatter duration was less than 3 milliseconds for all cases and did not cause a change of state in any of the other relays. Therefore, according to the seismic test reports no problem can occur due to this nominal contact chatter.

The NRC also requested justification for the 87-differential relays being tested in the de-energized state. Again, as with the other protective relays, the major danger is that the diesel generator breaker would be placed in a trip mode unnecessarily due to contact chatter, possibly energizing the 86 lockout relay. This would render the diesel generator unavailable for use during emergency situations. This differential relay is a Westinghouse SA-1 sold state relay was tested in the de-energized state and no output occurred. None of the above relays will interfere with the operation or activation of the diesel generator system.

Reference WBN FSAR Figures 8.3-4 and 8.3-25 through -29 for electrical schematics.

Specific Concern 10a - Main Steam Isolation Valve

Question

TVA should provide values for the torsional moment and shear force obtained from the piping analysis to assure that the shear stresses were enveloped by the test.

Response

As stated in our previous response provided by the referenced letters, the piping analysis loads at the main steam isolation valve (MSIV) interface are significantly less than the maximum loads which would be permitted by piping analysis stress limit criteria. The piping stress allowable criteria, is in turn significantly less than the nozzle loads criteria for MSIV qualification.

From piping analysis results, the maximum shear load imposed on the MSIV consists of a torsional moment of 93,318 ft lbs and a shear force of 48,882 lbs. The resulting shear stress in the pipe (32 in schedule 40) from these load components is approximately 2500 lb/in^2. The corresponding maximum shear load imposed on the valve during qualification was a torsional moment of 2.278x1026 ft-lbs. This qualification shear load corresponds approximately to (shear) yield stress in the pipe (i.e., in excess of 26,000 lb/in^2).

Specific Concern 13b - Barksdale Pressure Switch/Square D Relay

Question

TVA should provide justification concerning the potential for multimodel excitation and the possibility that the single frequency TRS do not adequately envelope a broadened RRS for the Barksdale pressure switch.

Response

The required response spectrum illustrated in Figure 13b (this response spectrum was previously provided as Figure 21.2-1 in the June 10, 1983, letter) should be recognized as artifically broadened to cover unknown or variable factors such as the building structural frequency, which is not precisely known. This has the effect of making the RRS artificially conservative since building resonance can occur only at specific frequencies within the band and not throughout the entire band.

For a predominately single-frequency building response spectra (Watts Bar diesel generator building), the peak acceleration will occur at a single frequency somewhere within the broadened frequency band. This condition is in turn seen by an item of equipment (Barksdale pressure switch) as a (predominately) single-frequency input. For an item of equipment, the most severe loading condition occurs when the single frequency input is applied at the natural frequency (ies) of the equipment. For this situation, in terms of response spectra, a conservative test is assured if the peak acceleration of the TRS, at the equipment natural frequency(ies), is equal to or greater than RRS acceleration value of the broadened amplication region. For this situation, there is no requirement what so ever that the single-frequency TRS envelope the broadened TRS.

The adequacy, and in fact the conservatism of the Barksdale pressure switch seismic qualification test, is clearly illustrated by the response spectra comparison of Figure 13b.

FIGURE 13b

TRS/RRS COMPARISON
BARKSDALE PRESSURE SWITCH
LATERAL (FRONT/BACK) AXIS