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Docket Nos: 50-390
and 50-391

SEP 2 3 1982

Mr. H. G. Parris
Manager of Power
Tennessee Valley Authority
500A Chestnut Street, Tower II
Chattanooga, Tennessee 37401

Dear Mr. Parris:

Subject: Seismic and Dynamic Qualification Review of Safety Related Equipment for Unit 1 of the Watts Bar Nuclear Plant

Attached is the staff's evaluation of the April 1982 site audit of safety related electric and mechanical equipment for Unit 1 of the Watts Bar Nuclear Plant. A number of specific as well as generic concerns are listed in the attached evaluation. We request that resolution of the specific concerns be addressed in a single submittal rather than in piecemeal fashion.

The generic concerns are applicable to the implementation of your entire program, and therefore should be addressed for the entire plant. These concerns are as follows:

1. Single axis and single frequency tests were performed to qualify equipment. For equipment in the flexible range (below 33 Hz) these tests may not challenge the multi-frequency and multi-axis response of the equipment. This issue should be reviewed for all safety related equipment and the final resolution should be implemented for the entire list of such equipment.

2. In numerous cases the Required Response Spectra (RRS) were not broadened at the peaks to account for the uncertainty in the prediction of natural frequencies of the supporting structures. Also, sufficient margins must be included in the Test Response Spectra (TRS) to account for the uncertainty in manufacturing process and the testing apparatus. A review of all safety related equipment must be performed to address and resolve this issue.

3. In numerous cases the field mounting of equipment is by welding of various lengths whereas the mounting for the qualification testing is by bolting. All such differences must be identified and justified. The staff may require the results of purely analytical predictions to be verified by in-situ testing.

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DATE ▶							

4. Much safety related equipment is age sensitive with respect to seismic performance, for example the insulation of motors, transformers, and other electric devices. In order to assure that seismic resistance of safety related equipment is available throughout the plant life, a detailed program of surveillance and maintenance including the rationale applicable to each equipment type must be submitted for staff review and approval.

We request that your staff submit a report addressing resolution of all the generic concerns upon completion of this work.

We request your responses to our concerns be received by November 30, 1982, in order to support the licensing schedule for Unit 1. If you have any questions concerning this matter, please contact the Project Manager, T. J. Kenyon, at (301) 492-7266.

The reporting and/or recordkeeping requirements contained in this letter affect fewer than ten respondents; therefore, OMB clearance is not required under P.L. 96-511.

Sincerely,

Original signed by:
Thomas M. Novak

Thomas M. Novak, Assistant Director
for Licensing
Division of Licensing

Enclosure:
As stated

cc: See next page

OFFICE	DL:LB #4	LA:DL:LB #4	DL:LB #4	AD:L:DL			
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DATE	9/21/82	9/21/82	9/22/82	9/23/82			

WATTS BAR

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SEISMIC QUALIFICATION REVIEW TEAM REPORT

AUDIT TRIP TO THE WATTS BAR NUCLEAR POWER PLANT

by

G. K. MILLER
J. N. SINGH
G. L. THINNES

CONTENTS

INTRODUCTION

The Equipment Qualification Branch (EQB) of the Nuclear Regulatory Commission (NRC) has the lead responsibility in reviewing and evaluating the dynamic qualification of safety related mechanical and electrical equipment. This equipment may be subjected to vibration from earthquakes and/or hydrodynamic forces. Applicants are required to use test or analysis or a combination of both to qualify equipment essential to plant safety, such that its function will be ensured during and after the dynamic event. These pieces of equipment and how they meet the required criteria are described by applicants in a Final Safety Analysis Report (FSAR). On completion of the FSAR review, evaluation and approval, the applicant receives an Operating License (OL) for commercial plant operation.

A Seismic Qualification Review Team (SQRT), consisting of engineers from the EQB of NRC and Idaho National Engineering Laboratory (INEL), made a site visit to Watts Bar Nuclear Power Plant, Spring City, Tennessee April 26 through April 30, 1982. This team included a contingent of three from INEL as consultants to the NRC. The purpose of the visit was to observe the field installation, review the equipment qualification methods, procedures (including modeling technique and adequacy), and documented results for a list of selected seismic Category I mechanical and electrical equipment and their supporting structures. Following the site visit, EG&G personnel were to advise NRC with respect to the adequacy of qualification of this equipment to perform its intended function. This is a preliminary report containing our findings. This report indicated which of the items are qualified and require no additional documentation. It also identifies some equipment and certain general concerns for which additional information is needed in order for EG&G to complete the review. These are referred to as open items. The applicant is to further investigate and provide additional documentation to resolve these issues. A final version of this report will be issued after all the outstanding issues are resolved.

Subsequent sections of this report give a brief overview and identify our concerns, followed by our findings, for each of the selected seismic Category I equipment.

1. ICE CONDENSER INTERMEDIATE DECK DOORS

The component under consideration consists of a steel framework 13 ft x 5-1/2 ft with four doors bolted to the frame at their hinges. Two rows of similar frame and door assemblies are mounted horizontally in the annulus between the crane wall and containment wall at the 804 ft elevation. Two pairs of doors constructed of sheet metal with foam insulation cores are bolted at their hinges back to back on each frame. Their function is to form an insulation barrier for the ice storage area and to open upward in LOCA conditions to allow air and steam to flow up into the upper containment. The doors were fabricated by Dayco Industries and the frame and hinges by Stahl-Rider.

The intermediate deck doors, frames and beams have been qualified to withstand LOCA or DBA loads. The door panels were subjected to full scale blowdown tests which simulated forces and flow rates, up to 140 percent, of maximum design conditions (ref. WCAP-8110, Supplement 3). These full scale tests qualified the door panel design and also verified the Westinghouse computer program "DOOR" which was used to calculate the reaction forces on the door hinges, frames and beams. The hinges, frames and beams were then qualified by structural analysis (ref. Calc No. 009).

Seismic loads (OBE and SSE) on the intermediate deck doors, frames and beams were considered to be negligible when compared to the DBA loads imposed. As an example, Calculation No. 009, Section J, identifies the seismic door hinge loads on the TVA Sequoyah and AEP Cook plants to be less than 30 lbs. By comparison, the DBA reaction loads on the door hinge were calculated to be in excess of 9000 lbs, so the seismic input would be approximately 0.3 percent of the DBA input. It should also be pointed out that the DBA loads used were for the 140 percent design case and that an additional load factor of 1.3 was imposed on DBA loads for calculating stresses.

A comparison of the seismic design loads for the intermediate deck door frame for the TVA Sequoyah and Watts Bar plants shows the Watts Bar SSE horizontal loads are at most 2.2 times those for the Sequoyah plant. Again, if we correlate this to hinged loads, as was done before, a 66 lb hinge load (2.2 x 30) would only be approximately 0.7 percent of the DBA hinge loads, and still considered negligible. A review of Calculation No. 009 shows that all stresses on the intermediate deck door, frames and beams to be well within the allowable stress limits.

Considering these margins, the doors are seismically qualified.

2. REACTOR TRIP SWITCHGEAR

The Reactor Trip Switchgear has Model No. 9125D23 and is supplied by Westinghouse. It is qualified in the report Equipment Qualification Test Report, Reactor Trip Switchgear, Westinghouse Electric Corp., July 1981.

The switchgear cabinet was qualified by seismic testing. In the tests, two cabinets were bolted together as in the field and were mounted on the test table with twelve 3/8 in. bolts. A resonance search in the 1-50 Hz range at 0.3 g was performed, and several natural frequencies between 5-12 Hz were identified in the lateral directions. After resonance testing, the cabinet was subjected to multifrequency motion with superimposed sine beat input. The corresponding TRS enveloped the RRS. The specimen was tested in one direction at a time in four orientations to get the effect of multi-axis testing.

The auxiliary relays were actuated during the SSE testing and were observed to have changed state. Voltage, frequency, and power tests were performed during and after tests, and operation was satisfactory.

To complete the qualification of this equipment the applicant was requested to resolve the following items:

1. The cabinet was mounted to the test table using 3/8 in. bolts, while the installed cabinet was mounted using continuous welds along the front and back edges. Demonstrate that the field mounting is at least as adequate as the test mounting. (Generic consideration)

2. A box-shaped cable support beam that extends downward from the floor above contacts the cabinet near its top. Explain whether the contact with this beam affects the qualification of the cabinet.

3. There is no peak broadening in the TRS or RRS. Justify the acceptability of a narrow response spectrum peak. (Generic consideration)

4. Explain how damping was considered in this qualification for both OBE and SSE seismic input. (Generic consideration)

3. REACTOR PROTECTION SYSTEM CABINET

This three-bay vertical cabinet (Model 1057E57) built by Westinghouse houses the reactor protection system output relays and amplifiers. The cabinet is welded at its base to beams embedded in the concrete floor. Electrical wiring enters the cabinet through flexible conduit attached to the top of the cabinet. Mounting panels are welded and bolted to the cabinet. Each bay is separated by a steel panel welded to the cabinet. The outside dimensions of the cabinet are 90 in. x 30 in. x 91 in. and it weighs approximately 2300 lbs. The cabinet is mounted approximately 1/4 in. to 3/8 in. from tne adjacent safeguards test cabinet.

The Westinghouse qualification reports WCAP 7817 and WCAP 7817 Supplements 2 and 3 document the testing performed on the cabinet. Single axis, single frequency, sine beat tests in the frequency range of 1-35 Hz were performed on a shaker table. The first natural frequency was encountered at 8 Hz in the front-to-back direction and other frequencies in the 15-25 Hz range in the side-to-side direction.

Westinghouse's justification for this type of testing was to note the conservatism of the single frequency test in acceleration response magnitude compared to the RRS. The 5 Hz sine beat test had a response acceleration level of three times the required spectrum peak response acceleration. Sine beat tests were not performed at the 8 Hz or 15-25 Hz frequencies, however, and the amount of energy applied at these significant modes is in question. Fatigue or seismic aging was not considered. These issues are of a generic nature at Watts Bar and are unresolved at this time.

Specific concerns lay in the difference between the test mount bolting condition and the field mount condition of welding the base to an embedded beam. No evaluation has been provided by TVA on the strength capability of the welds used. Another concern is the close proximity mounting of two cabinets which could possibly impact. Testing was not done with this mounting configuration. A third specific concern, even though it has some generic aspects, is in the area of the sine beat testing. It is felt that

some evaluation of the amount of resonance of the cabinet should be provided. This might be addressed by determining the amount of magnification encountered at the top of the cabinet in the two horizontal directions during the 5 Hz sine beat test.

To complete our review the applicant was requested to resolve the following:

1. Demonstrate that field mounting is at least as adequate as test mounting. (Generic consideration)

2. Evaluate how qualification is affected by the close mounting of cabinets.

3. Provide an evaluation of the degree of amplification in response incurred by the cabinet during tests to more clearly justify single frequency testing.

4. ENGINEERING SAFEGUARDS CABINET

This cabinet was fabricated by Westinghouse and tested in the same manner as the reactor protection system cabinet. This is a single bay cabinet which, upon inspection, was located immediately next to the protection system cabinet and contains instruments providing at-power testing capability in the reactor protection system. Qualification procedure for this cabinet was also described in WCAP 7817. The first side-to-side mode shape frequency was 9.5 Hz while the front-to-back was 19-20 Hz.

Generic and specific concerns with this cabinet are the same as those expressed for the reactor protection cabinet. Qualification cannot be assumed until these items are resolved.

5. PRESSURIZER SAFETY VALVE

The Pressurizer Safety Valve has Model No. HB-BP-86 Type E and is supplied by Crosby Valve and Gage Company. It is qualified in the document entitled Stress Report EC-155 Rev. 1-10/1/75.

The Pressurizer Safety Valve was qualified by analysis to acceleration levels of 3 g horizontal and 2 g vertical applied biaxially. The natural frequencies of the valve were calculated from a mass-spring model. The lowest natural frequencies, which correspond to lateral bending vibration, were calculated to be 116 and 247 Hz. Loads on the valve in the Westinghouse analysis included seismic, deadweight, and operating (fast closure, valve popping) loads applied simultaneously. Forces and moments at the inlet, outlet, and bonnet flanges due to these loads were determined and then an equivalent pressure was calculated according to NB-3647.1(a) of the ASME Code, Section III. A flange design pressure based on this equivalent pressure was then calculated.

Required bolt area, minimum wall thickness and thread shear stress calculations were also performed. The valve crotch section modulus and cross-sectional area were shown to exceed those of the attached piping.

The applicant furnished values for acceleration levels at the valve locations and these were less than the qualification g levels. This item was considered to be adequately qualified.

6. CHARGING/SAFETY INJECTION PUMPS

There are two of these horizontally mounted pumps in the two redundant Chemical Volume Control systems. Pacific Pump manufactures this eleven stage pump. Its serial number is No. 48593. The pump, motor, and gear drive on a common base weigh 21,220 lbs. The base is bolted to anchors in a concrete pedestal with 16 1-in. diameter bolts.

Pacific Pump documented its analysis of the pump in Report No. K-318-1, Rev. 5. Due to the fact that there were no natural frequencies below 35 Hz, a static analysis was performed using 3 g's horizontal and 2 g's vertical acceleration combined with other operating loads.

An area of concern in the analysis was the use of an analysis technique (published by P. P. Bijlaard) for the suction nozzle which is not applicable to the geometry of the suction nozzle nor its type of connection to the pump casing. Since the calculated stress was approximately 2/3 to 3/4 the allowable stress in the faulted condition, it is felt that a more detailed analysis should be done in this area. A second concern is that the nozzle loads used for analysis on the pump not be exceeded. Verification should be provided by listing the appropriate piping loads calculated at the nozzle connections.

To complete our review the applicant was requested to resolve the following:

1. Perform a detailed analysis on the suction nozzle connection using an approach appropriate for the nozzle geometry.

2. Provide a comparison between nozzle loads used in the pump analysis and those obtained from piping analysis. (Generic consideration)

7. BORIC ACID FILTER, TRANSFER PUMP

The Boric Acid Filter has Model No. 5EHD 10702-032-EG32 and is supplied by Pall Trinity Micro Corp. It is qualified in the document entitled 150 GPM Filter Stress Report, Dynamic Analysis No. 49-5-4, February 5, 1976.

The filter was qualified by analysis, in which the natural frequencies were calculated to be far above 33 Hz. Thus, static loads based on the ZPA's of the Watts Bar SSE required response spectra were applied to the filter to determine stresses in the vessel and leg supports. Calculated stresses were compared to ASME Section VIII, Division 1 and AISC Code allowables and were found to be acceptable.

This item was considered to be adequately qualified.

The Boric Acid Transfer Pump has Model NO. 3196 MT and is supplied by Goulds Pump Inc. It is qualified in the document entitled Static Seismic Analysis, No. 717672, March 30, 1976.

The pump was qualified by analysis, in which natural frequencies were calculated to be greater than 35 Hz in each direction. Thus, static loads based on the ZPA's of the Watts Bar SSE required response spectra were applied to the pump to determine stresses in the holddown bolts and deflections in the shaft. Operating and nozzle loads were also included. The pump and motor shafts were decoupled by the presence of a flexible connector. Stresses were lower than ASME Code, Section III and AISC allowables, and shaft deflections were minimal.

This item was considered to be adequately qualified.

8. POWER RANGE NEUTRON DETECTOR

Four of these Model WL-23686 detectors manufactured by Westinghouse are located around the circumference of the reactor vessel in the reactor cavity. The detector consists of a 126 in. long, 3-1/8 in. diameter cylinder with 3 triaxial cables in it. The assembly weighs approximately 60 lbs and is supported by the positioning tube wheel axle vertically and the neutron detector positioner horizontally. The detector was not available for inspection at the site.

Westinghouse Report WAT-D-4385 dated 4/29/81 documents the testing done on this detector. Four fragility tests of ascending input levels were performed using multifrequency and multiaxis input. The TRS of the input history of the last three tests envelope the RRS for 5% damping.

The component is considered seismically qualified.

9. CONTROL ROD DRIVE MECHANISM

The Control Rod Drive Mechanism has General Assembly No. 115E238603 and is provided by the Westinghouse Electro-Mechanical Division. It is qualified in the document entitled Stress and Thermal Report of Type L-106A and L-106B CRDM, EM 4531 including Revisions 1 and 2, January 31, 1974, August 19, 1975 (Rev. 1), April 12, 1976 (Rev. 2).

The CRDM is qualified by analysis for dynamic loading. The analysis was performed using a finite element model and response spectrum input. The response spectra used were general Westinghouse spectra that account for damping differences between the CRDM and its support structure. The CRDM was assumed to have 5% critical damping and the support 1% damping for an OBE; the CRDM had 5% damping and its support 1% damping for an SSE. The spectra were also peak broadened 15%.

Several natural frequencies in the 4 to 7 Hz range corresponding to motion in the lateral direction were identified. These frequencies contributed to flexible response of the CRDM. Calculated stresses were less than allowable.

In order to complete our review, the applicant was requested to resolve the following:

1. The qualification documentation did not identify load combinations used. Identify all load combinations, such as seismic plus Loss-of-Coolant-Accident (LOCA), and explain how responses were combined.

2. Verify that the Westinghouse response spectra envelope the Watts Bar floor-level response spectra.

3. Compare natural frequencies identified during pluck tests on the CRDM with calculated natural frequencies.

10. MAIN CONTROL PANEL

The Main Control Panel has Model No. 1142E62 and is supplied by Westinghouse. It is qualified in Westinghouse documents WCAP-8501, January 29, 1975, and WCAP-8540, May 1975.

The Main Control Panel was qualified by a combination of test and analysis. One of the five panel sections was tested for its natural frequencies and its response to sine beat input. The response obtained from these tests was compared to results obtained from an analysis using a structural model of the same section. Natural frequencies obtained from test and analysis compared as follows:

Test (Hz)	Analysis
14.2	12.1
21.5	21.1
24	35

The mode shapes for test and analysis showed reasonable correlation. Additionally, the dynamic amplifications at equipment locations due to sine beat input in each direction correlated well.

Because favorable comparisons between test and analysis were achieved, an analysis using a similar model for all five panel sections was used to qualify the entire panel. This analysis showed that coupling between adjacent panel sections increases the natural frequency of any section and reduces the response of the section. Calculations also showed that the natural frequencies of the four untested panels exceed 24 Hz.

A time history analysis was performed to determine the acceleration response at several equipment locations on the panel. Input was applied independently in three directions. The responses were amplified to account for directional coupling.

The response spectra at the control room floor level corresponding to the input time history exceeds the floor level RRS. Stresses in the panel members were within yield. The accelerations observed at equipment locations during the sine beat tests exceeded corresponding calculated accelerations.

To complete qualification of this panel tne applicant was requested to resolve the following items:

1. The analysis was performed assuming the panel to be fixed at its base. An inspection revealed that the panel is attached to the floor with spot welds along the inside edge only of an angle-shaped member at the base of the panel. The freedom of the outside edge of this member could introduce flexibility into the base-to-floor attachment. Evaluate by test or analysis whether the installed attachment is adequately fixed.

2. There is no peak broadening in the TRS or RRS. Justify the acceptability of a narrow response spectrum peak. (Generic consideration)

11. ELECTRICAL PENETRATIONS

There were several electrical penetrations installed in the containment at various locations. They are reportedly of various sizes and cylindrical in appearance. Only one of them was field inspected. The mounting is a cantilever type. There was no model number visible for verification. This was a very similar penetration to one of a group of penetrations tested by Southwest Research Institute. The related qualification documents are: SWRI Report 02-584-308 on Conax Penetration P/N 7508-10003-01 of July 28, 1980 and IPS-752, Rev. A; Design Qualification Report for Electric Penetration Assemblies for Watts Bar Nuclear Plant, Units 1 and 2 of April 21, 1981. These documents were reviewed by TVA. The pertinent reference design specifications for qualification requirements are contained in: TVA Spec. 2697 for furnishing and delivering electrical penetration assemblies.

Electrical penetrations are safety-related, operationally passive devices which function to pass electric conductors through an aperture in the containment structure while simultaneously maintaining a pressure barrier. For structural integrity due to seismic events, a sample of electrical penetrations was tested. The mounting simulated the intended field condition. For seismic qualification, there were two kinds of tests performed. The first set was a frequency-search to establish the natural frequencies.

For Test Data Bases One, Two, and Four a resonant frequency search was performed by inputing uniaxial sinusoidal excitation in each of the principal axes of the penetration in the frequency range of 1-200 Hertz (below 1 Hertz was beyond the limits of the test equipment). The excitation level was 0.1 g peak with a sweep rate of 1/2 octave per minute. The penetration response was monitored with an accelerometer located on the header. The Cartesian coordinate system was defined as follows:

X Axis - Horizontal along the axis of the penetration.

Y Axis - Horizontal, perpendicular to the axis of the penetration.

Z Axis - Vertical

Resonances were recorded as follows: (Given in Hertz)

A. Test Data Base One

X Axis	Y Axis	Z Axis
14.9	17.2	31.1
75.1	60.0	43.2
114.0	83.5	78.2
161.0	161.0	157.0
	192.5	

B. Test Data Base Two

X Axis	Y Axis	Z Axis
18.3	16.0	74.1
113.5	24.7	104.5
130.0	95.3	125.3
	111.6	
	195.0	

C. Test Data Base Four

X Axis	Y Axis	Z Axis
74.0	26.0	61.5
95.0	46.0	82.5
126.5	193.0	165.0

The second set of tests was for qualification. These were multifrequency, multiaxis tests. These were phase incoherent biaxial inputs. Test response spectra using a damping value of 2.5% were generated. These spectra were then compared to 2% damping generic required response spectra. The TRS do not completely envelope the generic RRS. This is an apparent deficiency. However, the TRS when compared to the site-specific RRS might prove to be adequate. Further, at one point it is mentioned that SSE = 2.0 X OBE and at another SSE = 1.5 OBE. It is not known, however, which one was used for comparison. There were five OBE level and one SSE level tests performed. The functionality was verified.

In order to complete our review the following is required:

1. A comparison of site specific RRS with the TRS showing adequate enveloping of the RRS by the TRS, and

2. A satisfactory response as to which one of the SSE levels was used for comparison.

12. 125 V DC VITAL BATTERIES

The 125 V DC Vital Batteries have Model No. Gould HCX-2250 and are provided by Gould, Inc. They are qualified in Wyle Laboratories Report No. 43479-1.

The batteries were qualified by multifrequency, multiaxis tests in which corresponding TRS envelope the Watts Bar RRS. Resonance search tests were performed over the 1 to 33 Hz frequency range and natural frequencies of 10 Hz side-to-side and 15 Hz front-to-back were identified.

Functional operability of the batteries was verified during and after the multifrequency proof tests and no malfunctions occurred. The batteries were installed with spacers between batteries during the qualification tests, but not all plant-installed batteries had spacers.

In order to complete our review the applicant was requested to resolve the following:

1. Explain what surveillance programs will be instituted to maintain the seismic capability of the vital batteries throughout plant life.

2. Verify that all batteries will have spacers installed as they did during qualification tests.

3. The TVA specification for bid required positive anchorage of the battery cells, which was accepted by the vendor. Explain whether the vendor was given a release from this requirement.

13. DIESEL GENERATOR CONTROL AND PROTECTION RELAY PANEL

The DG Control and Protection Relay Panels are of various model numbers and are provided by the Delta Switchboard Co. They are qualified in Wyle Laboratories Report No. 54064, January 13, 1975.

The panel was qualified by tests. A resonance search over the 1 to 33 Hz frequency range was performed. Several natural frequencies from 14 to 30 Hz corresponding to motion in the lateral directions were identified. Single frequency sine beat tests at the resonance frequencies were then performed with input motions applied along vertical and horizontal axes both in-phase and out-of-phase to affect multi-axis test input. The lab specimen was mounted to the test table using bolts while the field specimen is floor mounted with welds.

Safety-related equipment in the panel was monitored for functional operability. Some relay chatter occurred, the consequence of which was not addressed. Additionally, the monitored circuits were only tested in the open mode.

In order to complete our review, the applicant was requested to

1. Provide a comparison between a RRS and the TRS and justify adequacy of the single frequency input motion.

2. Explain the consequence of the observed relay chatter.

3. Demonstrate that all relays (including differential relays) will be functional in both the open and closed positions.

4. Demonstrate that field mounting of the panel is at least as structurally sound as lab mounting. (Generic consideration)

14. METAL CLAD SWITCHGEAR

The Metal Clad Switchgear is a 7.2 kV model and is supplied by General Electric. It is qualified in Report No. 42868-1, Wyle Laboratories, December 16, 1974.

The switchgear cabinet was qualified by random biaxial multifrequency tests with superimposed sine beats to generate a TRS that envelopes the RRS. Tests were conducted on a two-bay unit over the 1-50 Hz frequency range. The superimposed sine beats had frequencies of 8, 10, and 12.6 Hz with an amplitude adjusted to give a 6.3 g or greater response. The sine beats were applied sequentially during a 45-second period to encompass the RRS's broadened peak.

The unit was monitored for damages and malfunctions, and the only notable problems observed occurred at excitation levels far exceeding Watts Bar requirements. At Watts Bar levels, the equipment functioned properly.

Natural frequencies were not reported in the qualification documentation, but should not affect the adequacy of the qualification since the TRS exceeds the RRS.

To complete qualification of this item the applicant was requested to describe the mounting method used during testing and to show that field mounting is at least as structurally sound as test mounting.

15. BATTERY RACK

These two step battery racks (Model No. 507-074526-806 and 816) are supplied by Gould, Inc. There are a total of twelve racks. Each rack, thirteen feet in length and 37-7/8 in. in height, weighs about 1650 pounds. They are welded to the floor in the Auxiliary Control Building at an elevation of 772 feet. These racks provide seismic supports to the batteries. The reference qualification document is: Seismic Qualification; TVA WBNP Power Plant Control Building Unit No. 1 and No. 2, Contract No. 76-85763, prepared by Gould, Inc. and reviewed by TVA. The pertinent design specification for qualification requirements are contained in TVA Spec 1980. Seismic loads are considered in the qualification.

These racks have been qualified by analysis. The critical acceleration for the rack analysis is the maximum acceleration level of the batteries. That is 3.75 g in each of the two horizontal directions and 0.3 g in the vertical. A hand calculation indicated a frequency of about 27 Hz. This is in the ZPA range and hence a static analysis has been performed for seismic qualification. A conservative calculation for the vertical tubes resisting horizontal loads shows a stress level of 21327 psi compared to an allowable of 23760 psi.

The analysis performed is adequate. The critical stresses and deflections are within allowables. It should be pointed out that the arrangement configuration seemed inadequate. However, this problem has been deferred in favor of addressing it in battery qualification.

Based on our observation of the field installation and review of the qualification document, the battery rack is adequately qualified for seismic loads.

16. DUPLEX ALARM RELAY/SUM AND DIFFERENCE AMPLIFIER

The Duplex Alarm Relay (Model No. 553-C2-B2-B1) and Sum and Difference Amplifier (Model No. 574) were supplied by Robert Shaw Control Company. They are mounted in a cabinet attached to the floor in the Auxiliary Control Building at an elevation of 708 feet. Their functions are to annunciate alarms and give logic signals respectively for various safety related systems. The referenced qualification documents are: Wyle Laboratories Report No. 42934-1 of April 29, 1975 and No. 43675-1 of July 28, 1977. The pertinent design specifications for qualification requirements are contained in TVA SPEC 2782. Seismic load is considered in the qualification.

These items have been qualified by test. The cabinet, with dummy weights for equipment and accelerometer mounted at those locations was subjected to a series of biaxial input tests. The biaxial inputs were one horizontal with one vertical and independent. They were both random in nature. TRS were generated which enveloped the RRS for the cabinet. The acceleration levels for the equipment locations were obtained.

Subsequently, resonance searches (with 0.2 g input) were performed on the duplex alarm relay and sum and difference amplifier. The alarm showed semiweak magnification at 29, 33 and 35 Hz. The amplifier exhibited a frequency of 35 Hz. The frequencies are essentially in the rigid range. Following this, sine beat tests at 4.5, 6.0, 9.0, 12.0, 18.0, 24.0, 29.0 and 33 Hz were performed on these two items. These tests were pseudo biaxial in nature with 45° inclination. The input magnitude was 4.5 g in each case. This would be equivalent to a component of 3.0 g in the horizontal and 3.0 g in the vertical direction. These components are more than the required level obtained from the cabinet test.

The operability of the amplifier and the alarm relay (in both open and normally closed position) were verified before, during and after the test. The tests performed are adequate.

Based on our observation of the field installation, review of the qualification document and applicant's response to our questions these items are adequately qualified for the seismic load.

17. MAIN STEAM ISOLATION VALVE

The Main Steam Isolation Valve is a 32-in. valve supplied by the Atwood and Morrill Co. It is qualified in the document entitled 32-Inch Main Steam Isolation Valve Stress Analysis Procedure No. 501-13824-00, September 9, 1976.

The MSIV was qualified by a combination of analysis and test. The analysis demonstrated that the valve is rigid and that stresses in the valve compoments are less than ASME Section III allowables for internal pressure and seismic loads of 3 g horizontal and 2 g vertical applied simultaneously. Forces and moments at the bonnet flange due to these loads were determined and then an equivalent pressure was calculated according to NB-3647.1 of the ASME Code, Section III. Stresses due to this pressure were acceptable as were resultant loads on the flange bolts. The valve cover was analyzed to the ASME Code, Section VIII, Division 2, Article D-7, and its thickness was found to be adequate. Stresses in other valve components such as the valve crotch, valve stem, operator shaft and pulldown bolts were also found to be satisfactory. The valve inlet and outlet section moduli and cross-sectional areas exceed those of the attached piping.

Tests were performed to demonstrate valve operability while excited to levels greater than 3 g horizontal and 2 g vertical. During tests the valve was also subjected to nozzle loads and internal pressure. The test report was not available during the audit because of reluctance from Atwood and Morrill to release the document. TVA did, however, have a witness present during the tests.

To complete qualification of the valve the applicant was requested to resolve the following:

1. Provide nozzle loads and compare these to allowable values for the attached piping. (Generic consideration)

2. Provide maximum g levels at the valve location as obtained from piping analysis results.

3. Describe tests performed on the 32-in. MSIV and explain how these assure operability of the valve under Watts Bar seismic conditions.

18. ERCW PUMP

The essential raw cooling water system provides cooling for vital components in the plant. There are eight of these Model 32RXL-2 stage deep draft pumps which are manufactured by Borg-Warner Corp./Byron-Jackson Pump Division. The dry weight of the pump and motor is 31,785 lbs. The pump is bolted to the floor with eight 1-1/2 in. diameter bolts.

McDonald Engineering Analysis Company documented this pump analysis in Report Number ME-274 dated December 12, 1975 and Addendum 3 dated March 17, 1977. Stress criteria for the analysis was ASME Code, Section III and Appendix XVII.

The analysis consisted of hand calculations and a beam finite element analysis of the pump, column and seismic supports. The seismic restraints provide lateral support for the pump column which is approximately 90 ft long. These supports are designed for a nominal 3/8 in. gap. A linear analysis using the ICES-STRUDL computer code was performed modeling some of the seismic restraints as fixed points and no stiffness for the remaining restraints and having the pump fixed at its base in all directions.

There are two areas of concern in this analysis. First, since a linear dynamic analysis was performed, the resulting impact loads from the nonlinear supports were not adequately evaluated. Secondly, the horizontal dynamic loading was determined using a rigid body acceleration which was conservative compared to the RRS's ZPA. Considering the inaccuracy of the modal analysis (in light of the nonlinear supports) used to determine that the system was rigid, justification should be made to show that the column response will not be in the amplified region of the required response spectra. The second concern will be further considered before furtner action from the applicant is requested on that matter.

To assist in completion of our review the applicant was requested to perform an evaluation of the effects of impact loads due to nonlinear supports along the pump column.

19. DIESEL COMBUSTION AIR INTAKE FILTER

This air intake filter is provided by the Power Systems Division of the Morrison-Knudsen Co., Inc.

The qualification report for this item was not available at the plant audit. The applicant was requested to submit the qualification documents for review.

20. CONTROL DAMPER, MOTOR OPERATED

A number of these Ruskin Manufacturing Co. dampers of various sizes were observed in the Auxiliary Control Building. They are flange mounted to square ducts in the HVAC with varying numbers of blades depending upon the duct size. The Johnson Controls operators are attached to the vent frame outside the duct.

The Qualification Report, Ruskin Report No. CD82AF4, documented analysis on Ruskin Damper Model CD82AF-276 and Wyle Lab Test Report No. 43516-1 documented the motor qualification. The analysis showed the damper to be rigid (33 Hz) and qualified it to 3 g's horizontal and 2 g's vertical acceleration while having a pressure differential of 3 psi across the damper in an equivalent static analysis. The American Institute of Steel Construction Manual was used as stress criteria. The motor was tested to 3 g's horizontal and vertical acceleration throughout the range of 1-35 Hz with sine beat tests.

TVA Design Specification WB-DC-40-31.8 (August 5, 1974) specifies duct support spacing and support cross section adequate to give rigidity in all HVAC ducting.

Since the g level qualified to is above the building RRS g level, the damper is seismically qualified.

21. EMERGENCY GENERATOR STARTING AND CONTROL SYSTEM CONTACTOR: BARKSDALE PRESSURE SWITCH/SQUARE D RELAYS

Barksdale pressure switch (Model No. E1HMSOV) and Square D relays (Class 8501, Type: KP) were supplied by Power Systems-A Morrison-Knudson Division. They are located in the diesel generator building at an elevation of 742 feet. The Barksdale switch is mounted on the diesel generator/diesel air compressor which is attached to the floor. The Square D-relay is mounted on a panel which is attached to the floor. Seismic load has been considered in the qualification of these items. The referenced document is: Wyle Laboratories Report No. 42749-1 of June 24, 1974. This was reviewed by TVA. The pertinent reference design specification for qualification requirements are contained in TVA SPEC 2042.

These two items were qualified by tests. The qualification of the Barksdale switch included analysis of the diesel generator/diesel generator air compressor structure which was found to be relatively rigid. Then a group of equipment were tested in what is known as a Series 1 test. Series 1 test included the following items.

Fuel oil pump,
Battery,
Soak back oil pump,
Battery charger,
Contactor/Relay system.

The contactor/relay system included the following items:

One Square D temperature switch,
One finwall temperature switch,
One Barksdale pressure switch,
One overspeed trip limit switch,
One crankcase pressure switch,
Two Square D relays.

First a resonance search was reportedly done with accelerometers mounted on each equipment. This indicated natural frequencies of 7, 12 and 33 Hz in the horizontal and 7 and 33 Hz in the vertical direction. Resonance was defined to occur at magnifications of 2 or greater. Following this, a qualification test was done. The qualification test consisted of a single-axis, sine beat test with a 3 g level input. This was repeated at 7, 12 and 33 Hz in the horizontal direction. The same kind of test was done at 7 and 33 Hz with an input of 1 g in the vertical direction. The functionality was verified. The required ZPA acceleration for the 742 feet elevation in the building is 0.54 g in the horizontal and 0.36 g in the vertical direction for OBE and twice those values for SSE. These numbers are reported to be conservatively quoted.

The Square D relays were also tested, mounted in the panel simulating the field mounting. The panel test frequencies were reported to be 6, 13, 16, 28 and 33 Hz. These qualification tests were also single axis sine beats. The functionality was verified.

Bi-axial qualification tests were also reportedly performed on some items. The details of these tests were neither evident nor could be supplied by the applicant.

In order to determine the seismic adequacy of these two items, the following is required:

1. Details of the biaxial tests and the items involved in them, or

2. A satisfactory justification of the single axis, single frequency tests in the presence of the magnification frequencies.

GENERIC CONCERNS

As part of our review of the seismic qualification program, the applicant was requested to respond to several generic concerns. Some of these have been previously mentioned in the qualification description for individual items. Thus, the response to a generic concern should clearly resolve the issue for any affected specific item. The generic concerns requiring resolution are:

1. Numerous NSSS equipment items were qualified using single frequency and/or single axis testing. Westinghouse claimed to have previously produced rationale for the acceptability of this form of testing for qualifying their equipment. Since members of the audit team were unfamiliar witn the justification that Westinghouse had prepared, they requested references relative to this justification and any other documentation supporting the use of single frequency, single axis tests in qualifying the NSSS equipment.

2. Westinghouse was requested to provide a statement as to how damping values were used in qualifications for OBE and SSE input obtained from floor response spectra provided by TVA.

3. In numerous situations, there is no peak broadening in the TRS or RRS. Thus, the applicant was requested to justify acceptability of a narrow response spectrum peak.

4. The field installed mounting was frequently different from that used in the qualification tests or analyses of safety-related equipment, especially for electrical cabinets. Can the applicant, in all cases, state that the equipment was mounted as adequately in the field as in the lab or as assumed in analysis?

5. The nozzle loads exerted on safety-related equipment by attached piping were frequently not mentioned. Can the applicant, in all cases, state that the nozzle loads on the equipment were considered and that the attacned piping was designed accordingly?

ATTENDANCE LIST/SQRT VISIT

Name	Organization
David P. Ormsby	TVA - Power
F. Hugh Coleman	TVA - ENDES CEB
Vince Bianco	TVA - ENDES NEB
John S. G. Williams	TVA - ENDES CEB
Steve Robbins	TVA - ENDES CEB
Dwain W. Alexander	Westinghouse - NTD
Francis Scapellato	Westinghouse - NTD
Gordon Yetter	Westinghouse - NSD
Charles M. Scrabis	Westinghouse - NTD
James Parello	Westinghouse - NTD
J. McInerney	Westinghouse - NTD
G. Bagchi	NRC - EQB
T. J. Kenyon	NRC - DOL
Gary Thinnes	EG&G Idaho
Jag N. Singh	EG&G Idaho
Greg Miller	EG&G Idaho