UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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MEMORANDUM FOR: Zoltan R. Rosztoczy, Chief
Equipment Qualification Branch
Division of Engineering

FROM: Arnold Lee
Equipment Qualification Branch
Division of Engineering

THRU: Charles H. Hofmayer, Section Leader
Equipment Qualification Branch
Division of Engineering

SUBJECT: TRIP REPORT FOR SEISMIC CRITERIA IMPLEMENTATION REVIEW MEETING WITH SOUTH CAROLINA GAS AND ELECTRIC COMPANY ON V. C. SUMMER UNIT 1

The Seismic Qualification Review Team (SQRT), consisting of engineers from the Equipment Qualfication Branch (EQB) and the Brookhaven National Laboratory (BNL), made a site visit to V. C. Summer Nuclear Generating Station at Columbia, South Carolina, on October 14-17, 1980. The purpose of the visit was to conduct a plant site review of the qualification methods, procedures, and results for a list of selected Seismic Category I mechanical and electrical equipment and their supporting structures. The intention was also to observe the field installation of the equipment, based on which judgments can be made as to the validity of the equipment modelling employed in the qualification program, with respect to the equipment configuration and its mounting condition.

A list of attendees at the meeting is contained in Attachment I. Prior to the visit, a representative sample of 22 pieces of Seismic Category I mechanical and electrical equipment, both in NSSS and BOP, were selected for the plant site review. At the conclusion of the visit, the staff requested the applicant to provide the tests and analysis reports for three additional pieces of equipment, to be included in a followup confirmatory review. The 25 pieces of equipment which were selected for the SQRT review are listed in Attachment II. The background, review procedures, findings and conclusions of the meeting, and the required followup actions are summarized as follows.

I. Background

The applicant has implemented a seismic qualification program for seismic Category I mechanical and electrical equipment and the associated supports for that equipment. Although this plant was docketed prior to October 27, 1972, the BOP equipment seismic qualification program was aimed at compliance with the current criteria of Standard Review Plan (SRP) Sections 3.9.2 and 3.10, instead of IEEE 344-1971. The NSSS electrical equipment for Summer Station, however, was originally qualified to IEEE 344-1971. This equipment was procured on a similar basis to that which was qualified under the Westinghouse

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seismic qualification demonstration test program. In order to further confirm the adequacy of the NSSS electrical equipment seismic qualification program, certain NSSS electrical equipment, together with that of NSSS mechanical, were included in the plant site review. SRP Sections 3.9.2 and 3.10 specify criteria which when confirmed will satisfy the applicable portions of GDC 2 of Appendix A to 10 CFR 50. SRP Section 3.10 references Regulatory Guide 1.100. The principal change in these criteria from the earlier criteria is to require consideration of equipment multimode response and biaxial coupling effects. The plant site review was performed to determine the extent to which the qualification of equipment, as installed in V. C. Summer, meets current licensing criteria as described in SRP Sections 3.9.2 and 3.10.

II. Review Procedures

The review was conducted by dividing the selected equipment according to their categories. In doing so, NSSS mechanical equipment and NSSS electrical equipment were first reviewed on October 14. This was then followed, on October 15, by the review of BOP electrical equipment and, on October 16, the review of the BOP mechanical equipment. The above review of equipment qualification consisted of field observations of the actual equipment configuration and its installation, followed by the review of the corresponding test and analysis documents. A brief technical session was held after each review session to provide SQRT's feedback to the applicant on the qualification program for the equipment just reviewed. On the final day, October 17, an exit conference was held to summarize and conclude the plant site review.

III. Findings and Conclusions

Among the 18 BOP equipment originally selected, a review of the qualification of the Reactor Building Cooling Unit Damper Actuator and the Radiation Monitoring Control Panel had not been completed by the applicant's architect-engineer, Gilbert/Commonwealth Associates, and therefore qualification reports were not available for review. In addition, the qualification documents for Main Steam Isolation Valve, although having been approved by Gilbert/Commonwealth Associates, was not available for review during the visit, but were provided to the SQRT at the conclusion of the visit. The complete documents for 480-volt substations were only briefly reviewed during the visit and were also provided to SQRT for further review. The Hydrogen Analyzer Panels had not been delivered to the plant and complete information was not available during the plant site visit. Among the four NSSS equipment originally selected, the appropriate qualification documents for the Post Accident Monitors (PAM) Indicators were not available for review.

In addition to the six outstanding qualification reports identified above, the SQRT, at the conclusion of the visit, requested the applicant to provide the test and analysis reports for three additional selected pieces of equipment (encompassing both the BOP and NSSS category) totalling nine pieces of equipment, to be included in a followup confirmatory review. These equipment are Diesel Generator and Associated Equipment (Electrical and Air Starting Controls), Accumulator Tanks, and Electrical Containment Penetrations and Miscellaneous Connectors.

The qualification reports for the remaining 16 pieces of equipment were reviewed during the SQRT visit. The results of the review of the six pieces of equipment conducted by the NRC SQRT members are summarized in Attachment III, and the results for the ten pieces of equipment reviewed by the BNL SQRT members are summarized in Attachment IV. The review identified the need to clarify the details of the qualification for some pieces of equipment. The applicant has committed to submit additional information and clarification for a followup review prior to approval of plant operation. The equipment for which additional information is required and the specfic items to be addressed are discussed in Section IV, Followup Actions.

Based on the results of the review to date, we conclude that an appropriate equipment qualification program has been defined for the seismic Category I mechanical and electrical equipment which will provide adequate assurance that such equipment will function properly during and after the excitation from vibration forces imposed by the Safe Shutdown Earthquake.

IV. Followup Actions

In order to complete our review we have requested the applicant to provide the following information:

1. Identify all equipment still to be qualified and provide documentation to demonstrate the completion of the qualification program. Provide SQRT "Qualification Summary of Equipment" forms for this equipment and update the forms provided for the site visit.

2. Review and revise, as necessary, FSAR tables in Chapter 3 to include updated information of all safety-related systems and components.

3. Provide a copy of the revised SQRT tables which include a list of equipment and the summary of the qualification program.

4. For all safety-related valves describe the design procedure used to demonstrate that the accelerations used in the valve qualification equal or exceed the accelerations obtained in the final as-built piping analysis. Provide specific information for the valves reviewed by SQRT.

5. Provide qualification reports for the four pieces of equipment not available during the visit and the three additional pieces of equipment selected by the staff at the conclusion of the visit. These and the reports for the two pieces of equipment which were already available to the SQRT at the conclusion of the visit, totalling nine report packages, will be subjected to a followup confirmatory review.

6. Provide confirmation that Westinghouse's generic response spectra for equipment qualification envelop the corresponding plant-specific required response spectra.

7. Clarify details as discussed in Attachments III and IV concerning the qualification of Component Cooling Water Pump and Motor, Turbine Appurtenances for Turbine-Driven Emergency Feedwater Pump, Charging Pump, RHR Pumps, Battery Chargers, Control Valves, and Pressure and Differential Pressure Transmitters.

We are continuing our review of the implementation of the equipment qualification program and require the applicant to resolve all outstanding items as identified in Sections III and IV.

Arnold Lee
Equipment Qualification Branch
Division of Engineering

Enclosures: As stated

ATTACHMENT I

SQRT PLANT SITE CONFERENCE
V. C. SUMMER UNIT 1
LIST OF ATTENDEES

NRC

Charles Hofmayer
Arnold Lee
Jack Skols (NRC Site Inspector)

Brookhaven National Laboratory

John Curreri
Mano Subudhi

South Carolina Electric and Gas Company

Carl A. Price
Fred B. Brabham
A. G. Alvarez
J. A. Wactor
Nivert Demian
Gary Moffatt
Stephen M. Cunningham
B. G. Croley
Al Koon
Gary Guy
Ronald Clary

Gilbert/Commonweath Associates

Donn K. Kelly
Chai-Chin Suh

Westinghouse

R. A. Strongh
R. E. Kelly

ATTACHMENT II

EQUIPMENT LIST FOR
SQRT PLANT SITE REVIEW

I. BOP Mechanical Equipment

1. Reactor Building Cooling Unit (AH, XAA-1A, B), Assembly

2. Reactor Building Cooling Unit (AH, XAA-1A, B), Damper Actuator

3. Component Cooling Water Pump (CC, XPP-1A, B, C), Pump and Motor

4. A. Turbine Driven Emergency Feedwater Pump (XPP-8-EF) Appurtenances
   b. Turbine Driven EFW Pump Turbine (TPP-008-EF) Appurtenances

5. Main Feedwater Isolation Valves (FW, XVG-1611A), Valve and Actuator

6. Control Valve (MS-1F-2030)

7. Main Steam Isolation Valve (MS, XVM-2801A)

8. Main Steam Safety Valve (MS, XVS-2806A)

9. Refueling Water Storage Tank (SF, XTK-25)

II. NSS Mechanical Equipment

1. Charging Pump (CS, XPP-43A)

2. Residual Heat Removal Pump (RH, XPP-31)

3. Accumulator Tank

III. BOP Category I Instruments, Electrical Equipment, and Supports

1. 480-Volt Unit Substations

2. Battery Chargers

3. Transfer Switches (7200 Volt)

4. Control Board Switch Modules

5. Reactor Protection Underfrequency and Voltage Relay Panels

6. Main Control Board

7. Hydrogen Analyzer Panels

ATTACHMENT II (continued)

8. Control Room Evacuation Panels (XPN 7200 A/B)

9. Radiation Monitoring System Panel (XCP-6200)

10. Diesel Generator and Associated Equipment-Electrical and Air Starting Control

11. Electrical Containment Penetration and Miscellaneous Connectors

IV. <u>NSSS Category I Instrument, Electrical Equipment and Supports</u>

1. Pressure Transmitters and Differential-Pressure Transmitters

2. Post-Accident Monitors (Indicators)

ATTACHMENT III

V. C. SUMMER UNIT 1
REVIEW OF QUALIFICATION REPORTS
BY
NRC SQRT MEMBERS

I-1.	Reactor Building Cooling Unit, Assembly
I-3.	Component Cooling Water Pump, Pump and Motor
I-8.	Main Steam Safety Valve
III-2.	Battery Chargers
III-8.	Control Room Evacuation Panels
IV-1.	Pressure Transmitters and Differential-Pressure Transmitters

I-1 Reactor Building Cooling Unit, Assembly

Four reactor building cooling units manufactured by American Air Filter are located in the Reactor Building at El. 514 ft. Each assembly is bolted to its supporting structure by using 34 size 5/8-in. bolts. Seal welds are used to connect different sections of the assembly. Due to the high elevation at which the unit is installed, field observation was made only from far distance on ground elevation.

The qualification of this equipment is documented in the report "Seismic Analysis and Justification of the Reactor Building Cooling Units for the V. C. Summer Unit 1 Under Seismic and Design Loads," dated 1979 by American Air Filters.

The equipment was qualified by a finite element method of analysis which considered response spectrum seismic loads as well as dead and pressure loads. The OBE seismic loads (for 2% damping) were provided by the floor response spectra which have 0.399 g and 0.288 g as ZPA, and 4.3 g (4.3 - 5.8 Hz) and 2.75 g (12.5 - 17.5 Hz) as peak accelerations, respectively, for the horizontal and vertical directions. The corresponding SSE response spectra (for 5% damping), on the other hand, have 0.599 g and 0.302 g as ZPA and 3.9 g and 2.1 g as peak accelerations. Plane stress/strain plate elements and prismatic beam elements were used to construct the equipment mathematical model. For modal and dynamic analysis, a kinematic condensation technique was then utilized to reduce the total number of degrees-of-freedom (DOF) from 1330 to 76 dynamic DOF. Modal analysis results indicated that 9 modes of vibration existed within the range up to 30 Hz, i.e., from 12.75 hz to 29.01 Hz. Modal participation factors and "Normalized Mode Coefficients" were used to identify the importance of each mode in each directional response. It was found that no significant "gross cantilever" action existed in horizontal directions. In addition, no significant vertical response of the entire equipment structure was observed within this frequency range. It was found that no member was stressed beyond its limiting criteria under the seismic and other loading conditions considered.

Based on our review of the analysis report, we conclude that the structural and functional integrity of the cooling unit assembly will be maintained under OBE, DBE, operating pressure, dead load, LOCA pressure, design pressure, and their combinations. In no cases were the stresses found to exceed the corresponding AISC Code-allowable limits or material yield strength. We therefore conclude that the reactor building cooling unit assembly is adequately qualified for all the loading conditions considered.

I-3 Component Cooling Water Pump

Three component cooling water pumps (Model Number 18x20x24 HSA) manufactured by Bingham-Willamette Co. are located in the Intermediate Building at El. 412 ft. The motor for each pump (Model No. CSPAM TEWAC) was manufactured by Westinghouse Electric Corporation. Each pump is supported by four individual pedestals and each motor by two longitudinal pedestals. All pedestals are welded to a base plate which is stiffened by cross members and grouted underneath. The base plate is fastened to the floor by fourteen anchor bolts.

The qualification of this equipment is documented by the following reports:

1. Report BTI-76026-001, "Operability Assurance Analysis for Component Cooling Pumps," dated July 15, 1977, by Basic Technology, Inc. for Bingham-Willamette Company.

2. Report BTI-77065, "Seismic Testing for Appurtenances of the Component Cooling Pump (18x20x24 HSA, 1 stage)," dated September 15, 1977, by Basic Technology Inc. for BWC.

3. Memo No. LME 77007, "Seismic Analysis for Component Cooling Water Pump Motors," dated March 8, 1978, by Westinghouse Electric Corporation.

4. "Seismic Analysis of Main Lead Conduit Box for Service Water Pump Motors," dated August 1978, by Westinghouse Electric Corporation.

The pump was designed to meet the requirements of the 1974 ASME B&PV Code, Section III, subsection ND. A finite element model was constructed of the pump, motor and support assembly. The ANSYS Computer Program was used for modal analysis as well as static analysis. The fundamental frequency of the pump/motor assembly was found to be greater than 30 Hz. Therefore, the seismic stresses and deflections were evaluated using static analysis.

The static "g" loads used in design are tabulated below along with the required "g" loads based on the final floor response spectra. The design loads were based on an earlier revision of the floor spe ra and are conservative.

	DESIGN OBE	REQ'D OBE	DESIGN DBE	EQ'D DBE
X	.36	.18	.558	[illegible]
Y	.32	.308	.497	[illegible]
Z (vert.)	.25	.209	.398	.3[illegible]

The seismic loads were combined by SRSS and then added absolute to the response from the other loads. The combined loads included dead ight, suction and discharge nozzle loads, motor torque and seismic loads. stresses for the pump assembly were found to be within allowable limits. The pump shaft deflection was also calculated and found to be .0116 "which was within the defined allowable of .0125."

The only appurtenance of concern for the pump was the seal circulation piping (Sch 80 with a 3/4" diameter). Typical spans of this piping were tested at the design peak acceleration by sinusoidal excitation at a frequency of 30 Hz (in some cases higher frequencies were used) for at least 1.5 minutes. Prior to this testing, the natural frequencies of the piping were determined and found to be much higher than 30 Hz. All piping segments maintained their integrity and function throughout the test.

The pump motor was qualified by Westinghouse for the required "g" loads stated above. A seismic model was developed which considered the frame on springs to the foundation with various lumped masses (rotor, cooler, stator) connected to it. The analysis demonstrated that the natural frequency was greater than 30 Hz, therefore static methods were used to calculate the stresses in the motor. The summary of stresses in Table 1 of the report demonstrated that all stresses were within the allowable criteria. The seismic loads were assumed to be acting simultaneously in all three directions.

An analysis of the main lead conduit box was performed as a supplement to the motor analysis. The natural frequency of the box and its support was calculated to be much greater than 33 Hz, therefore the box was analyzed statically. Conservative seismic loads (HOR=1.5g and VERT=.85g) were used in the analysis, and the calculated stresses were found to be small compared to the allowables. We noted that the analysis on the box was done for the service water pump motors. The applicant stated and provided photographs demonstrating that this box and support was the same for the CCW pump motor. The applicant agreed to provide documentation to confirm this situation.

Based on our review of the test report and observed field installation, we conclude that the component cooling water pumps are adequately qualified for the defined seismic loads pending the applicant's submittal of the information requested in the preceding paragraph.

I-8 Main Steam Safety Valve

The main steam safety valve (Model Number Consolidated Type 3707RA) manufactured by Dresser Industrial Valve & Instrument Division, is located in the West Penetration Room at EL. 436 ft. The valve is supported on the concrete floor using twelve 1-3/8-in. bolts. The qualification of this equipment is documented in the report "Seismic Simulation Testing of Valve Type 3700," dated 1976 by Dresser Industrial Valve & Instrument Division.

The equipment was qualified by single-axis, single-frequency sinusoidal tests. Since sweep tests at 0.5 g level and 1/2 octave/min were performed in each of three directions, between 5 to 75 Hz. Resonant frequencies of around 37 Hz and 55 Hz were observed in the horizontal directions, whereas no resonance was observed in the vertical.

The valve survived through approximately 140 pops under simulated seismic excitations, at 5 g input, and showed no apparent damage at the end of the test. Since the first natural frequency of the equipment is greater than the rigid frequency of 33 Hz, we believe that the input level of 5 g used in the qualification test is conservative compared to the corresponding response spectrum. We requested and the applicant agreed to provide documentation which verifies that the input motion used in the test was much greater than the valve would ever be subjected to in the field.

Based on our review of the test report and the observed field installation, we conclude that the main steam safety valve is adequately qualified for the anticipated seismic loads, pending the applicant's submittal of the verification requested in the preceding paragraph.

III-2 Battery Chargers

Three battery chargers (Model Number BCS 12300) manufactured by Solidstate Controls, Inc. are located in the Intermediate Building at El. 412 ft. Each cabinet is welded to plates embedded in the concrete floor slab. The qualification of this equipment is documented in the report "Summary Report on Seismic Evaluation of a 300 AMP Battery Charger," dated June 30, 1977, by Battelle Columbus Laboratories. A revision to this report dated January 4, 1978 also was provided.

The equipment was qualified by single-axis multifrequency random motion tests. The cabinet was bolted to a shake table using grade 2 bolts. Sine sweep tests in each of three directions were performed to determine resonant frequencies, damping and cross coupling effects. Off-axis coupling response plots were obtained to determine the required single-axis base acceleration that would result in the same cabinet response acceleration if the required accelerations in the two horizontal directions were applied simultaneously.

The Test Response Spectra (TRS) exceeded the Required Response Spectra for all frequencies. Nine OBE tests with durations of approximately 25 to 30 sec per run and an SSE test with a duration of 20 sec were run in each direction. The output of the battery charger was recorded and no anomalies in electrical performance were observed. In addition, no cracks, loose bolts, or significant permanent deformations of the cabinet structure were observed.

The comparisons of TRS with RRS shown in the test report are based on Revision 1 of the floor response spectra for the Intermediate Building. The final floor response spectra for this building should be based on Revision 3 dated May 15, 1975. The applicant stated, and it was confirmed during our review, that the Revision 3 spectra were lower than the Revision 1 spectra and that the TRS still enveloped the RRS.

As noted above, the equipment was bolted to the test table, but is welded to the floor in the plant. We inquired as to how these differences were reconciled. The applicant indicated that an engineering evaluation was made to provide assurance that the installed support condition was acceptable. We requested and the applicant agreed to provide a copy of this evaluation for our review as well as a description of the general procedure followed for similar situations for other equipment.

Based on our review of the test report, the observed field installation, and the clarifications provided by the applicant, we conclude that the battery chargers are adequately qualified for the defined seismic loads, pending the applicant's submittal of the clarifications requested in the preceding paragraph.

III-8 Control Room Evacuation Panel

Two control room evacuation panels manufactured by Reliance are located in the Intermediate Building at El. 436 ft. Each panel is welded, 6 in. long on 12-in. centers, to embedments in the concrete floor. The qualification of this equipment is documented in the report "Seismic Analysis of the XPN7200 A and XPN7200 B Panels," dated July 23, 1978, by Reliance Electric Co., Stone Mountain, Georgia.

The equipment was qualified by a dynamic analysis method. A multidegree of freedom mathematical model was created using the STARDYNE computer program. The model was used in the calculation of natural frequencies and mode shapes, as well as gravity load and the defined seismic load cases. The first five lowest natural frequencies are given below:

1	21.45Hx
2	26.72 Hz
3	35.83 Hz
4	40.35 Hz
5	40.81 Hz

The OBE seismic loads (for 2% damping) were provided by the floor response spectra which have 0.481 g and 0.222 g as ZPA, and 5.6 g (5.5 - 7.5 Hz) and 1.8 g (11.0 - 15.0 Hz) as peak accelterations, respectively, for the horizontal and vertical directions. The corresponding SSE response spectra (for 5% damping), on the other hand, have 0.746 g and 0.344 g as ZPA and 4.805 g and 1.55 g as peak accelerations.

The analysis shows that the panel structure as well as its anchorage to the base provides sufficient margins of safety. It concludes that the structure can maintain its integrity for the loading conditions presented. For the module switches installed in the panel, qualificaton tests have been conducted at 3-g input level for the similar switches installed in the main control board. This input motion is larger than the environment of the module switches in question.

Based on our review of the analysis report and the observed field installation, we conclude that the control room evacuation panels are adequately qualified seismically.

IV-1 Pressure Transmitters and Differential-Pressure Transmitters

A number of ITT/Barton Class IE Pressure and Differential Pressure Transmitters (Model Numbers 763 and 764) are located in various buildings. Each transmitter is bolted to its supports by 5/16" bolts. The qualification of this equipment is documented in the report "Qualification Testing of ITT/Barton Transmitters Production Lot No. 2," dated December 21, 1979, by ITT/Barton.

The equipment was qualified by biaxial multifrequency tests. Different input signals were required to generate the test response spectrum. The equipment was so positioned and oriented on the test table with respect to the horizontal component of the input that it resulted in equal and simultaneous inputs to all three principal equipment axes.

Sine sweep exploratory tests at a level of 0.2 g and 1 Octave/min. were conducted between 1 to 50 Hz, and no resonant frequency was observed in this range. Five OBE tests were conducted prior to a number of SSE tests. In the SSE tests, four equipment positions were considered, namely, 0°, 90°, 180°, and 270°, and three tests were conducted in each position to result in a total of twelve SSE tests. The broad-band test response spectra enveloped the generic required response spectra which have 1.4 g and 5.0 g, respectively, as ZPA and peak response for OBE, and twice these valves for SSE.

All tranmitters remained functional throughout the 17 test runs and no structural failure or loosening of bolts was observed.

Based on our review of the test report and the observed field installation, we conclude that the pressure transmitters and differential-pressure transmitters, with Model Numbers 763 and 764, are adequately qualified for the defined seismic loads. We requested and the applicant agreed to identify all the safety-related pressure and differential-pressure transmitters, with model numbers other than 763 and 764, used in V. C. Summer Station, and to describe their seismic qualification program. The applicant was also requested to update the SQRT summary sheet by including all pertinent model numbers of the transmitters which perform safety functions and their location on each floor and in each building. Finally, the applicant was requested to provide the confirmation that the previously mentioned generic required response spectra do envelop the required response spectra for each specific transmitter.

ATTACHMENT IV

Virgil C. Summer
Plant Visit
Documentation Review
Introduction and Summary

This report deals with the evaluation of the seismic qualfication of particular equipment at the Summer Nuclear Power Plant. A site visit was made during the period of October 14-17. At that time, 22 pieces of equipment were scheduled for review by the SQRT. At the conclusion of the visit, three more pieces of equipment were selected to be included in a followup confirmatory review. Therefore, a total of 25 pieces of equipment will be reviewed. The revi team consisted of J. Curreri and M. Subudhi of BNL and C. Hofmayer and A. Lee of NRC.

The BNL group was assigned the review of 19 equipment items; of these only 11 qualification reports were made available during the site visit for review. One report (III-1) was briefly reviewed during the site visit. A final review will be included in a followup report. An additional report was made available at the close of the visit. Seven more reports have not as yet been received at BNL. The remaining 6 of the 25 pieces of equipment were reviewed by NRC personnel.

The text that follows contains the BNL evaluations for the following equipment:

I-4. Tubine Driven Emergency Feedwater Pump (EF, XPP-8), Pump and Turbine Piping Appurtenances

I-5. Main Feedwater Isolation Valves (FW, XVO-1611A), Valve and Actuator

I-6. Control Valve (MS-1F-2030)

I-9. Refueling Water Storage Tank (SF, XTK-25)

II-1. Charging Pump (CS, XPP-43A)

II-2. Residual Heat Removal Pump (RH, XPP-31)

III-3. Transfer Switches (7200 Volt)

III-4. Control Board Switch Modules

III-5. Reactor Protection Under-frequency and Voltage Relay Panels

III-6. Main Control Board

Item I-7 (Main Steam Isolation Valve) and Item III-1 (480-Volt Unit Substations) will be completed shortly while Item I-2 (Reactor Building Cooling Unit), III-7 (Hydrogen Analyzer Panels), III-9 (Radiation Monitoring System Panel), and IV-2 (Post-Accident Monitors [Indicators]), as well as the 3 additional pieces of equipment, as mentioned, have still not been received at BNL. The three additional items include:

II-3. Accumulator Task

III-10. Diesel Generator and Associated Equipment-Electrical and Air Starting Control

III-11. Electrical Containment Penetration and Miscellaneous Connectors

In summarizing the results, it was found that the seismic qualification reports satisfactorily demonstrate the design adequacy for the equipment listed. Specific details of the results of the individual reviews are given in the individual evaluations that follow.

I-4. Turbine-Driven Emergency Feedwater Pump, Pump and Turbine Piping Appurtenances

The complete design assembly includes the pump, turbine, and pump and turbine piping appurtenances. It was the original intent by SQRT to review the pump and turbine piping appurtenances only. However, it was found at the plant site that the report for the piping appurtenances was included with the reports for the pump and the turbine. Hence, the designs of the pump, turbine, and all the piping appurtenances were studied together, although special efforts were made on the appurtenances design.

The turbine-driven Emergency Feedwater (EFW) pump assembly is located in the Intermediate Building at El. 412 ft. The turbine assembly was secured rigidly to the floor foundation. The pump (Model No. 3X6X9C MSD 7-stage) was manufactured by Bingham-Willamette Co., whereas the turbine was built by Terry Steam Turbine Division of Ingersoll-Rand. The function of this unit is to provide emergency feedwater to steam generators.

The qualification of this equipment is documented in the following reports:

(1) Report BTI-77062, "Seismic Testing for Appurtenances of the EFW Pump No. BWC-14210471, 3X6X9C MSD, 7 stage."

(2) Wyle Test Report E/L 20299 on the Turbine Driven EFW Pump Turbine and Appurtenances (TPP-088-EF).

The pump appurtenances are documented in the first report as per GAI Spec. DSP-508B-044461-000 (Rev. 1). All the tests were made by Basic Technology, Inc. The pump was assumed to be rigid and hence the attenuation due to the pump itself was neglected. The RRS ZPA level of 0.36 g in the horizontal direction and 0.209 g in the vertical direction were used for the qualification test. Following was the test procedure reported by BTI:

(1) Assume the pump is rigid

(2) Determine the natural frequency (fn) of the mounted appurtenances

(3) Excite the appurtenances in their as-mounted position at operating pressure

(4) Excitation is applied at fn or 30 Hz, whichever is lower

(5) Monitor the appurtenance for function during the excitation period of 1.5 minutes

(6) The appurtenance is qualified if it functions successfully during and after the test.

DYNAL-5 Vibration Analyzer was used as the test equipment. Only single-frequency and single-axis tests were made. After field inspection it was found that all the piping appurtenances were still rigidly attached to the pump body.

The turbine appurtenances (TPP-008-EF) are documented in the second report by Wyle laboratories. The same GAI specifications were used for the seismic qualification. All turbine appurtenances including gauge boards, electrical junction boxes, and pipes were rigidly mounted either on the turbine base structure or floor. Based on the BTI test results on the pump assembly, Terry developed the span criteria from simple strength of material formulas.

During the resonance search, the T & T (Trip and Throttle) valve latch spring was found to trip the valve. The existing spring was replaced with a stiffer spring: stiffness = 32.5 lb/in. (the replacement was confirmed by the utility company). The loosening of nuts and shims after 9 OBE and 1 DBE test was claimed to be conservative in the report. A maintenance routine was recommended to insure that such loosening never occurs in the operating life of the equipment. After several further inquiries regarding the test findings, it was concluded that the equipment was designed properly for the seismic condition. The specific tests conducted by Wyle Laboratories were:

(1) 3 orthogonal axis resonance search.

(2) 7 separate sine beat/random test runs in Z-Y biaxial plane which comprise or envelope one SSE spectrum.

(3) 9 separate sine beat/random test runs in X-Y biaxial plane which envelope one SSE spectrum.

(4) Repeated the OBE and SSE simulation after rotating 90 degrees about the vertical center line.

Sine beat tests with 20 oscillations per beat were superimposed at frequencies of 1.0, 1.25, 1.6, 2.0, 2.5, 3.15, 4.0 and 5.0 Hz. The overall review showed the design to be adequate except for the following items:

(1) A couple of drain lines coming out of the assembly were loose.

(2) One 6-inch pipe running vertical in the same general area was found unsupported for the seismic condition. Its failure could impair the functional ability of the pump.

The above items were addressed to the utility company and the GAI field engineers. These items were also referred to the NRC Office of Inspection and Enforcement for followup verification of satisfactory correction or resolution before plant operation. Otherwise, based on our review, we find the unit is properly qualified for the seismic environment.

I-5. Main Feedwater Isolation Valve

The relevant seismic qualification documents are the Anamet Report, Lab. No. 1077.540, October 19, 1977, Seismic Analysis of 18" X 14" X 18" -900# Feedwater Isolation Valves with Hydraulic Actuator, letter from Anamet Labs (signed Shig Yamahara) dated October 17, 1978, letter from Gilbert Associates (signed J. A. Noviello) dated October 3, 1978.

The valve actually inspected at the site was serial No. XVO-1611C. There are two others in the plant. It is a pneumatic and hydraulic gate valve manufactured by the Anchor/Darling Valve Co. The valve weighs 10,000 lbs and is about 11 feet high by 40 inches long with an 18-inch OD. It is located at the 436' elevation in the West Penetration Room. It is used to isolate the steam generators.

The valves are qualified by analysis which was done by the Anamet Laboratories of Berkeley, California. The fundamental natural frequency of the valve is 57.48 Hz. The vibratory modes of the valve assembly are idealized by a series of simple mechanical models. As such, a static analysis is carried out to investigate the stresses.

The loading is taken at 3.0 g in any direction. The valve is designed to withstand the maximum combination of design loads due to pipe reaction effects, seismic acceleration, internal pressure, and mechanical loads. It is assumed that these loads act simultaneously and the absolute sum is kept within acceptable limits. The maximum stresses are derived for the combination of design basis earthquake and maximum pressure. Therefore, the loading is comparable to the Faulted Plant Condition, as defined by the ASME. The calculations were examined in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Subsection NA, Appendix XIII requirements regarding stress limits. From the code, pressure components designed to NC and ND-3300 are limited to a membrane stress of less than 2.0 times the allowable and a combined membrane plus bending stress of less than 2.4 times the allowable. The design stresses in the body, bonnet, and disc are within these limits.

For nonpressure-retaining components, where the stress limit is set at 90% of the yield stress, the design stresses are also at satisfactory levels. We requested that the applicant provide the verification procedure regarding the acceleration level in the final as-built piping analysis.

It has been demonstrated that the valve assembly satisfied the seismic design requirements, pending the submission by the applicant that the g level used in the qualification report is conservative compared to the as-built analysis.

I-6. Control Valve (MS-IF-2030)

One unit of the main steam control valve manufactured by Fisher Controls Company is located in the Intermediate Building at EL. 414' -4¼" near the EFW pump unit. The model identification number is 4" ES (ANSI 900 lb) with type 657 size 80 Actuator. The design specification is GAI Specification DSP-519-04461-000, Rev. 3. The function of this valve is to control the main steam supply to the Turbine-Driven Emergency Feedwater Pump Turbine.

Structurally, the valve is supported for seismic load by two hydraulic snubbers attached to the actuator from the nearby wall. In the vertical direction there exists a one-way vertical spring right next to the valve (as mentioned in the EFW pump review). The only vertical constraint is imposed by the pump turbine nozzle. A question was raised regarding a vertical restraint. Therefore, the applicant was asked to check the piping analysis for the available flexibility near the valve against seismic loading. The qualification of this valve was originally made by tests as well as analysis. The analysis by Fisher Controls Co. indicates that the natural frequencies in X, Y and Z direction are 45.5, 45.7, and 45.8 Hz, respectively. Using 1.5 g in the horizontal direction and 1.0 g in the vertical, the finite element analysis resulted in very low stress levels.

In addition, testing was made at Wyle Laboratories (Report #58363, dated November 13, 1978). Both resonance search and multi-axis excitation tests were conducted. The former test revealed that the natural frequencies of the system in the horizontal direction is 26 Hz, whereas in the vertical, 25 Hz.

Both test and analysis took account of the snubber attachments at the actuator. This large difference in the natrual frequencies between the test and analysis was questioned. However, since both are high enough to be considered as rigid, we concluded that the affect on the final response would not matter.

Wyle tests include the valve body assembly, valve actuator assembly and appurtenances which consisted of four limit switches, two solenoid valves, supply regulator, and two angle valves. The test specimen was welded to the test fixture at the body nipple joint (i.e., rigid mounting). Separate tests were conducted by Automatic Switch Co. (ASCO) on each individual appurtenance component. In the Wyle tests, multiaxis (X + Y, Z + Y) excitations were imposed. For the lateral-vertical test, sine beat test frequencies were 25, 29, 33.5, and 40 Hz, and the corresponding for the longitudinal-vertical test were 23.5, 26, 29, 33.5, and 40 Hz. Prior to these tests, sweep tests were conducted at a rate of one octave per minute to find the resonant frequencies.

The g values used in the test and analysis, as mentioned earlier, were set as the limits for the piping design engineers to insure that they do not exceed these values in their analyses. GAI confirmed that this is a standard practice in their organization.

Based on our r[illegible]f the as-built installation, the review of the test reports, and the clarifications provided by the applicant, we conclude that the valve is adequately qualified for the seismic loads, pending verification by the applicant that the flexibility near the value against seismic loading is satisfactory and that the g level used in the qualification report is conservative compared to the as-built analysis.

I-9. Refueling Water Storage Tank

This is a one-of-a-kind special tank that was specifically designed for the task that it is used for. It is 68 feet high by 40 feet inside diameter. It is located on the outside next to the Auxiliary Building, at Elevation 413'. It is used for the storage of refueling water, spray water for post-LOCA safety injection water supply, and post-LOCA cooling.

The qualification report is dated June 20, 1975 and has the title "Design of Refueling Water Storage Tank for Virgil C. Summer Nuclear Station-Unit 1 at Parr, S.C." It is accompanied by a letter dated June 28, 1979 from Gilbert Commonwealth, signed by G. H. Costonuis, accepting the design.

The vendor of the tank is Pittsburgh-Des Moines Steel Company. The r design report is a detailed disclosure of the calculations that were made in accordance with ASME III, Subsection NC 3300, Class 2 vessel.

The tank is bolted to its foundation with ninety 2-1/2-inch bolts. The calculations show this to be more than adequate. The tank itself is a stiffened shell type. The number of stiffeners and the section properties are all designed so that the stresses are less than the allowable stresses. Different cross-sectional properties are used at different levels, in accordance with the stress requirements. Shell stability is established by using the David Taylor Model Basin Formula. Load combinations include static plus pressure plus seismic.

The natural frequencies of the tank are in excess of 33 Hz in all directions. The maximum floor acceleration of 0.268 g in the Y direction and 0.239 g in the X direction was used with the required response spectra envelop at the 412' elevation for a horizontal earthquake and vertical earthquake. All stresses are at acceptable levels.

It is concluded that the water storage tank is qualified for the seismic loads that are required.

II-1. Safety Injection Charging Pump

Pacific Pumps Division of the Dresser Industries have designed the three units (Model 2½ inch RL-IJ) of the Safety Injection Charging Pumps. These were located in the Auxiliary Building at elevation 412 ft. Our inspection was limited to one of the three units since access to the others was restricted by working people in that building. Each unit weighs 22,300 lbs and has the dimensions of 236" x 52" x 55". These were supplied by the NSSS (Westinghouse), and the qualification of the unit was documented in the following reports:

(1) Dresser Report on the Complete Stress Analysis of the Assembly

(2) Dresser Report on the Operability Calculations

(3) Seismic Analysis of the Speed Increaser by Westinghouse

(4) Seismic Analysis of Charging Pump Motors for Summer Plant by Westinghouse

All the above documents were classified as proprietary by Westinghouse and were tied by the same Purchase Order Number and the word "CGE". Other than this, there is no other way to identify any particular documentation.

The seismic qualification of the equipment was made by a static analysis performed on the basis of 3-g loading in the horizontal and 2 g in the vertical directions. According to Westinghouse personnel, a static analysis procedure was selected after the model and in-situ tests indicated that the first fundamental frequency was above 33 Hz. Westinghouse was asked to submit documents to support this contention.

The visual inspection of the installed unit revealed that many small lines used for monitoring pressure or temperature at different locations were flexible (i.e., frequencies much lower than the rigid value). The utility company was requested to verify that failure of those lines would not impose any safety problems. In addition, some small tubes or pipes were found also unsupported and hence subject to breakage during seismic loading. The NRC site inspector as well as the utility company personnel were requested to insure that these were secured before plant operation.

The unit was well anchored to the foundation with sixteen 1-1/8-inch bolts. No other immediate problem was noticed during the site visit. Based on our review of the installation as well as the analysis reports, we conclude that the units were adequately qualified for the defined seismic loads pending the applicant's submittal of the information by Westinghouse on their in-situ tests and the adequacy of the supports for the attached piping discussed above.

II-2. Residual Heat Removal Pump Motors

This is a vertical single-stage centrifugal pump manufactured by Ingersol Rand, Model Number 8X20WDE. It is a large pump, measuring almost 7 feet high and weighing 8000 lbs, located in the auxiliary building. The qualfication document is dated December 30, 1974 and includes an Addendum No. 1, dated August 22, 1975, entitled "Structural Integrity and Operating Analysis of Residual Heat Removal Pump, No. ME174."

The pump is qualified by analysis which is carried out in accordance with ASME Boiler and Pressure Vessel Code Section III. The McDonal Engineering Company did the analysis. A dynamic model is developed and a computer frequency analysis is made to show that all natural frequencies are greater than 35 Hz. The ICES-STRUDL code is used to analyze the pump and motor using a stick model. The finite element model uses 11 mass points with a total of 21 degrees-of-freedom. The fundamental natural frequency is shown to be 40.6 Hz.

The seismic loading for the finite element model is taken to be the following:

	OBE	SSE
lateral	1.5g	3.0g
vertical	1.0g	2.0g

The stre[illegible] the pump due to internal pressure is investigated using NASTRAN. The finite element model of the pump casing assumes axisymmetry.

Nozzle loads were added in three orthogonal directions with seismic loads of 2 g lateral, 1.5 g vertical fo· SSE and 1 g lateral and 0.75 g vertical for OBE.

These exceed the loads of the Watts Bar spectra that is used. We requested that the applicant explain why Watts Bar spectra were used to qualify Summer. The applicant stated that the Summer spectra is equal to or less than Watts Bar. It was agreed that the confirmation would be provided.

The qualification document shows that all stresses and deflections are below the allowable limits. It is therefore concluded that the pump meets all requirements and will perform the intended operation during normal, normal + OBE + maximum nozzle and normal + maximum nozzle + SSE condition, pending the submission by the applicant of requested confirmation.

III-3. Transfer Switches - 7200 Volts

Three 7.2-kV Speed Transfer Switch units were located in various buildings at different floor levels. They were manufactured by Gould-Brown-Boveri (ITE). Each unit was plug welded to the foundation at every 6 to 9 inches. Each weights 4800 lbs and has a dimension of 6'W x 5'D x 7½'H. The function of each switch is to select source of 7.2-kV power for "swing" pumps. The seismic qualification of this equipment was made by tests of the complete assembly at Wyle Laboratories, and the seismic input was chosen as per GAI Specification SP-613-4461-00. Wyle Laboratories report 43972-1 and SCE&G Reference IMS-92-3298-0 (CGGS-17191, 11/29/78) were documented as the references for seismic qualification of this equipment.

The tests were done on a 3-frame, 7.2-kV power switch center, consisting of three 13.8-kV, 600-amp, HPL switches with three gang-operated poles per switch. The test specimen was installed on a rigid mounting fixture with the aid of eighteen ½"-13 grade bolts and w shers. GAI claimed that the test fixing by bolts was confirmed by them to simulate the actual field installation mountings. The maximum ZPA for SSE (RRS) values chosen from the GAI Specification were 0.425 g for S/S, 0.715 g to F/B and 0.416 g for vertical excitation. The tests were conducted with multifrequency, multiaxis random excitations. For each test setup of the equipment (i.e., F/B + vertical or S/S + vertical), five OBE random multifrequency excitation tests were done followed by one SSE excitation. The input ZPA g-level for the tests were 5.4 g for S/S, 5.5 g for F/B and 2.8 g for vertical directions. It was demonstrated that the test specimen was able to withstand the prescribed seismic events without compromise of structural or electrical function.

The report also indicated some anomalies during the test procedure. These included (a) structural degradation during the S/S + V test orientation, (b) contact chatter (of less than 0.5 msec duration) in the F/B + V during the 6th run, and (c) various minor structural problems were incurred by enclosing the frame (only) of the switch gear. Further clarification on these were requested from the GAI personnel and, as a result, additional information regarding the test results was submitted later. It was then confirmed and concluded that all the structural failures of the test specimen were minor in nature. Their failure would not impair any functional ability of the equipment. The contact chatter level was found to be within the allowable limit for such test conditions.

Based on our review of the test report, the observed field installation, and the clarifications provided by the applicant, we concluded that the 7.2-kV transfer switches are adequately qualified for the seismic loads defined for the Summer site.

III-4. Control Board Switch Modules

Twenty-three electrical devices, consisting of eleven different types, and two fiberglass sheets were subjected to a qualification test program to determine the adequacy of the design. The tests were carried out at the Wyle Labs in Huntsville, Alabama.

The manufacturer was the Reliance Electric Company, Stone Mountain, Georgia. The devices are mounted on the main control board located in the control building. The test program was performed to satisfy IEEE 323-1974, IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations and IEEE 344-1975, IEEE Recommended Practices for Seismic Qualfication of Class IE Equipment.

The test devices were secured to the test machine by a reliance fabricated fixture. The test fixture was welded to the Wyle Multiaxis Seismic Simulator Test Table. The mounting of the devices simulated the inservice arrangement.

The test specimens were subjected to 30-second simultaneous horizontal and vertical inputs of phase incoherent random motion consisting of frequency band widths spaced one-third octave apart over the frequency range of 1.0 Hz to 40 Hz. The input was shaped to envelop the Required Response Spectra. The resulting table motion was analyzed by a spectrum analyzer at five percent damping and plotted at one-third octave frequency intervals over the frequency range of interest.

Five operating basis earthquake tests were applied to the specimens prior to the application of three safe shutdown earthquakes in each test axis. The actual tests exceeded the zero period acceleration, as well as other regions of the RRS in order to meet and envelop the peaks of the curves.

Table 1, on page 001781, is entitled "Summary of Tests Performed and Results Obtained." The table lists 12 test items. These include the following devices:

Quantity	Item
2	G.E. SBM 10-Pt. Swtich, Reliance Mk. #15
1	G.E. SB-IN 20-Pt. Switch
2	G.E. SB-IN 12-Pt. Switch
2	G.E. SB-10 18 Pt. Switch
2	Micro Switch CMC-910-AEA-53-1 Switch with Two PTCC Contact Blocks
2	Westinghouse #OT1V9C Three-Position Selector Switch with One OT1C Contact Block
2	Westinghouse #OT1A1 Pushbutton with Two OT1C Contact Blocks
2	Cutler-Hammer 12-Pole, 120 VAC Relay D26MR804A
2	Cutler-Hammer 12-Pole, 120 VDC Relay D26MRD704A1
2	G.E. 3-Pole Fuse Block, GE8431-3
2	G.E. ET-16 Indicating Lights
2	Matrix Connectors, MB16R-2431S and MB10R24-31P-001
2	Sheets of Fiberglass to Fit Reliance Modules

The table notes that almost all items had passed the tests. However, a number of anomalies occurred. An isolated failure of a Cutler-Hammer 12-pole relay occurred. Investigation of this failure disclosed that the particular relay tested was manufactured prior to July 1976. Previous data had indicated that a material change was indicated. A relay made after this date passed the tests. The change in material in the specifications ensures that this type of failure will not recur. Questions were raised during our meeting at the site concerning the nature of the anomalies and the parts that experienced some degree of failure. The replies indicated that all parts passed the mechanical and electrical tests. Some parts were damaged on disassembly. Others were damaged in the process of handling during remounting. It should be kept in mind that the parts were subjected to a series of tests in addition to seismic. This includes initial functional tests, mechanical cycling, post-mechanical cycling functional tests, first temperature aging, post-temperature aging cycle functional tests, second temperature aging cycle, first seismic tests, and post-seismic functional tests. In between the second seismic series of tests, additional temperature tests were performed. The table reports on the anomalies for the entire series of tests, and it was noted that all items had passed the second seismic series without any problems provided that the following restrictions were followed:

1) All SBMs are limited to a maximum of 2-AMP inductive interrupting current at 125 VDC.

2) All Cutler-Hammer relays must be of a type manufactured after July 1976.

Both of these restrictions have been made part of the operating specifications for the equipment.

It was demonstrated that the ecimens possessed sufficient structural integrity to withstand the prescribed si ated seismic environment. The report adequately documents that the modules are qualified for the seismic environment at the control board location.

III-5. Reactor Protection Under-Frequency and Under-Voltage Relay Panels

One component of the Reactor Protection UF and UV Relay Panel was located in the Intermediate Building at an elevation of 436 ft. The equipment weights 9000 lbs and has a dimension of 9'W x 6'-7½"D x 7½'H. It is manufactured by General Electric Company, and its function is to sense the voltage and frequency of the reactor coolant pump supply to provide reactor protection system input signals. The appearance of the equipment was a three-bay floor-mounted cabinet. The complete structure was mounted to the foundation via 4-inch welds spaced 6 to 12 inches apart. The seismic qualification of this equipment was documented by a Wyle Laboratories test report #349-18403 on the General Electric requisition 349-18403 as per GAI Specification SP-702-4461-00 for the Class 1E Vertical Life Metal Clad Switchgear. The other reference to the documentation is SCE&G Reference: IMB-948-92-2857-(CGGS-14800,3/3/78 & CGGS-16952,10/31/78).

The test procedure at Wyle Lab assumed the ZPA values of 0.715 g in S/S, 0.425g in F/B, and 0.344 g in vertical directions for RRS as per GAI Specifications. In the program multiaxis (F/B + V and S/S + V), multifrequency testings with superimposed sine beats to excite the specimen above RRS values were performed. The g-values used in the test were 1.7 g in S/S, 3.4 g in F/B and 1.95 g in vertical directions. The laboratory mounting to the vibration platform was done by bolting. A question was raised about the validity of this mounting difference as compared to the actual field installation by plug welding. It was later confirmed by GAI personnel that they had looked into this matter at the time of testing and found that the test mounting simulated the actual situation as closely as possible. Reports indicated compliance of the test procedure with Section 8.5 of IEEE-344 (1975).

Based on our review of the test report, field inspection of the installed equipment, and the clarifications provided by the applicant, we found this equipment adequately designed to resist the specific seismic loads.

III-6. Main Control Board

The seismic qualification report is intended to provide analytical and test data for the Main Control Board, the Heating Ventilating and Air Conditioning Control Board, and the Control Room Evacuation Panel. All of this equipment was supplied by the Reliance Electric Company. The report contains Appendixes A through F which includes Seismic Analysis of the Main Control Board, Qualification of Equipment, and Dynamic Evaluation Tests. The Main Control Board is located in the Control Building at elevation 463. The control devices mounted to the Control Board are required to monitor and control safety-related plant auxiliaries and conditions.

The structural integrity of the Main Control Board was developed and demonstrated by various procedures. These include:

1) Mathematical modeling of boards and cabinets.

2) Computer analysis of the modeled boards and the cabinets to determine the response stress values induced.

3) Seismic simulation test of the Main Control Board.

4) Comparison of the computer analysis and the results of the tests.

A multidegree of freedom-of-finite element model for the five Main Control Board sections was analyzed. The Stardyne computer code was used to calculate the natural frequencies and the normal modes. The required response spectra was obtained at the device mounting locations on the boards. The response from two horizontal combined with a vertical seismic input was obtained. These were combined according to the square root of the sum of the squares of each. The loads that were considered include the operating loads plus the horizontal and vertical design basis earthquake. The required response spectra was obtained by mutiplying the OBE by 1.55 to get the DBE.

Appendix E contains the Test Report 44087-1 prepared by Wyle Labs, dated August 6, 1978. The tests were carried out to determine the primary resonant frequencies, mode shapes, and damping values for the Main Control Board.

The dynamic characteristics were obtained by providing a force input with a small exciter locally attached to the panel. Tests were conducted along each of three orthogonal axes. Sine sweeps were carried out over the frequency range from 2 Hz t 50 Hz using sinusoidal force magnitudes of from 5 lbs to 20 lbs to identify the major resonances.

Damping values were calculated from oscillograph decay records of the accelerometer reading taken after the exciter was turned off. This recorded the transient decay from which log decrement measurements were made. The damping ratio was computed to be 1%.

This type of decay plot contains information regarding natural frequency as well as damping. Examining the test data and comparing this to the results of the finite element analysis showed some difference between a natural frequency as determined by test and by analysis. For example, Section II, pg. 187 (document page 002416) shows the natural frequency to be 20 Hz, while Appendix C, page 001423 shows the corresponding natural frequency to be 27.91 Hz.

We raised a question regarding this difference since the response spectrum is a function both of frequency as well as damping. The applicant clarified that the Required Response Spectrum is flat in the region above 20 Hz and, in addition, this happens to be the region where the response is also not sensitive to large changes in damping. And so, establishing that the natural frequency is above 20 Hz insures that the seismic response will be small and so the panel is okay for seismic excitation.

It was further noted that in the Seismic Analysis of Sub-Panel 3 of Section II, dated September 12, 1979, the first natural frequency of the panel is 16.4 Hz. This is within a portion of the RRS that can excite a response. However, the minimum margin of safety was calculated to be 11.55, which should be adequate to take care of any response that is excited.

It is concluded that the safety margins for the main control board are high enough to maintain the structural integrity under seismic loading plus normal load.