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SEISMIC MARGIN REVIEW
MIDLAND ENERGY CENTER PROJECT

VOLUME VII

ELECTRICAL, CONTROL, INSTRUMENTATION AND MECHANICAL EQUIPMENT MARGINS

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1. INTRODUCTION

Seismic qualification of selected electrical, control, instrumentation and mechanical equipment has been reviewed to determine the magnitude of margins that exist between the equipment qualification level or code allowable response and the required input for the Seismic Margin Earthquake (SME). Most electrical, control, instrumentation and mechanical equipment installed in Midland was purchased from outside suppliers by either the Architect, Bechtel, or the reactor vendor, Babcock and Wilcox. Equipment making up the primary coolant system pressure boundary, reactor internals and mechanical portions of the scram system is evaluated in a separate Volume. Piping, cable tray and HVAC systems and their supports are also evaluated in separate volumes.

Qualification for the design basis SSE and OBE was conducted by the supplier using methods specified in the FSAR. Documentation of seismic qualification was submitted to the purchaser for review and approval. These seismic qualification documents formulate the bases for developing margins for the SME.

Several generations of seismic in-structure response spectra have evolved in the Midland project and the date of purchase of the equipment defined the particular generation of response spectra specified for equipment qualification. Midland equipment qualification is currently being reviewed by the purchasers to verify qualification to the latest SSE spectra. In the seismic margin study, original equipment qualification documentation was compared to the appropriate SME spectra to verify qualification and to compute the ensuing margins.

Items of equipment, such as pumps, vessels, valves, electric power and control cabinets were selected for review and verification for the SME loading. The selected equipment represents a broad sampling of the most important equipment required to achieve a maintain a cold shutdown. The equipment selected had a variety of design configurations, with varied acceptance criteria, and was located in representative areas of safety related structures. This report documents the review that was conducted and summarizes the seismic margins that exist for the equipment items selected.

The SME study was limited to seismic category 1 equipment required to achieve and maintain safe shutdown from full power operation. Equipment with a sole purpose to mitigate effects of a loss of coolant accident (LOCA) was not included in this study.

Chapter 2 of this report describes the criteria and considerations for selecting the equipment that was reviewed. Chapter 3 defines the methodology utilized in developing margins against the SME. Chapter 4 summarizes the results of the review of selected equipment and tabulates margins between code allowables and SME response or between test levels and SME required acceleration levels. In Chapters 5, 6, 7 and 8, descriptions of the equipment considered, the qualification methods and details of seismic margin development are presented. Appendix A contains summaries of the original qualification of each equipment item in a format similar to short form SQRT (Seismic Qualification Review Team) summaries.

Individual equipment items and subsystems selected for evaluation were all verified to meet acceptance criteria formulated for the SME. General acceptance criteria, for which the equipment was demonstrated to comply, was presented in Chapter 9 of Volume I and is reiterated herein.

2. EQUIPMENT SELECTION

Equipment selected for review and development of seismic margins against the SME represents many of the major elements of electrical power, control, instrumentation and mechanical equipment required to achieve and maintain a cold shutdown. Prior to selecting the equipment items for which seismic margins were developed, a thorough review was made of the plant systems descriptions contained in the FSAR (Reference 2) and a plant walk down was conducted to observe the construction and anchorage features of candidate equipment items.

The plant systems or portions of systems required to achieve a cold shutdown are:

Reactor Coolant and Pressure Control

Makeup and Purification

Decay Heat Removal

Component Cooling Water

Service Water

Safeguards Chilled Water

Emergency Diesel Generator Fuel Oil Storage and Transfer

HVAC

Main Steam

Condensate and Feedwater (Auxiliary Feedwater System)

Emergency Diesel Power Generation

Station Batteries

In addition, the electrical power distribution, control and instrumentation systems for each of the above are vital to a cold shutdown.

The equipment items selected represent one or more of the most important items in each of the systems listed except in the case of the Reactor Coolant and Pressure Control systems. This system is designed by Babcock and Wilcox and its qualification for the SME is addressed in Volume VIII. Equipment selected is located in the auxiliary building, service water pump structure and diesel generator buildings. Most of the equipment is contained within the auxiliary building and several different elevations and zones of the auxiliary building are represented in the selection process.

Comparisons were made between the SME spectra and the most recent SSE spectra specified for design. Equipment was selected at locations where the SME spectra applicable to the selected equipment exceeded the latest SSE spectra in at least one earthquake component direction in a discrete frequency range. Equipment selections were more concentrated in areas where the SME spectra exceeded the SSE spectra by the greatest amounts. Very large vertical amplification of floor spectra at the center of the floor slab at Elevation 685'-0" in the auxiliary building control tower was observed. In this area, two motor control centers, four HVAC control panels, two air conditioning units and two air filter units were included in the sample size.

Overall, the equipment items selected are considered to be representative of all purchased equipment essential to a cold shutdown and representative of all conditions observed regarding the frequency range and magnitude for which SME spectra exceed SSE spectra. The equipment selected are grouped by category rather than by system and location. The four major category groupings are:

Electrical Power Distribution
Electrical Power Supply (AC & DC)
Instrumentation and Control Equipment
Mechanical Equipment

Mechanical equipment is further broken down to identify the purchaser (Bechtel or Babcock and Wilcox). Table VII-2-1 itemizes the equipment selected for review and development of seismic margins for the SME and identifies the location of each of the items. Equipment numbers listed in Table VII-2-1 identify equipment for both units 1 and 2. In all cases, unit 1 and 2 equipment are identical and the seismic margins developed represent both units.

Table VII-2-1

EQUIPMENT SELECTED FOR EVALUATION TO SME CRITERIA

Electrical Power Distribution Equipment	Location
4160 V Main Switchgear 1A05, 2A05 (Twelve cabinets/unit)	Aux. Bldg. Control Tower, EL 614'
4160 V Main Switchgear 1A06, 2A06 (Eleven cabinets/unit)	Aux. Bldg. Control Tower, EL 614'
Motor Control Centers 1B23, 2B23	Aux. Bldg. Control Tower, EL 614'
Motor Control Centers 1B24, 2B24	Aux. Bldg. Control Tower, EL 614'
Motor Control Centers 1B43, 2B43	Aux. Bldg. Control Tower, EL 614'
Motor Control Centers 1B44, 2B44	Aux. Bldg. Control Tower, EL 614'
Motor Control Centers 0B45, 0B46	Aux. Bldg. Control Tower, EL 685'
Motor Control Centers 1B53, 2B53	Diesel Bldg., EL 634'
Motor Control Centers 1B54, 2B54	Diesel Bldg., EL 634'
Motor Control Centers 1B55, 2B55	Aux. Bldg. Control Tower, EL 614'
Motor Control Centers 1B56, 2B56	Aux. Bldg. Control Tower, EL 614'
Motor Control Centers 1B63, 2B63	Service Water Pump Structure, EL 634'
Motor Control Centers 1B64, 2B64	Service Water Pump Structure, EL 634'
Motor Control Centers 0B65, 0B66	Service Water Pump Structure, EL 634'
Motor Control Centers 0B68, 0B69	Service Water Pump Structure, EL 634'
Motor Control Centers 1B79, 2B79	Aux. Bldg. Control Tower, EL 614'
Motor Control Centers 1B80, 2B80	Aux. Bldg. Control Tower, EL 614'

Electrical Power Supply Equipment (AC&DC)	Location
Batteries and Battery Racks (125V), 1D-1, 1D-2, 2D-1, 2D-2	Aux. Bldg. Control Tower, EL 614'
Diesel Generator Units	
Engine and Appendages 1G-11, 1G-12, 2G-11, 2G-12	Diesel Generator Bldg., EL 630'-0"
Neutral Grounding Cabinet 1G-11X, 1G-12X, 2G-11X, 2G-12X	Diesel Generator Bldg., EL 652'-9"

Table VII-2-1

(Cont.)

Electrical Power Supply Equipment (AC&DC) (Cont.)	Location (Cont.)
Generator Control Panel 1C-231, 1C-232, 2C-231, 2C-232	Diesel Generator Bldg., EL 634'-6"
Engine Control Panel 1C-111, 1C-112, 2C-111, 2C-112	Diesel Generator Bldg., EL 634'-6"
Generator Unit 1G-11, 1G-12, 2G-11, 2G-12	Diesel Generator Bldg., EL 630'-0"
Exhaust Air Silencer 1M-101 A&B, 2M-101 A&B	Diesel Generator Bldg., EL 664'-0"
Air Receiver Tank 1T-93 A-D, 2T-93 A-D	Diesel Generator Bldg., EL 634'-0"
Air Intake Filter 1F-19 A-D, 2F-19 A-D	Diesel Generator Bldg., EL 664'-0"
Jacket Water Standpipe 1T-94 A&B, 2T-94 A&B	Diesel Generator Bldg., EL 634'-6"
Auxiliary Skid and Equipment	Diesel Generator Bldg., EL 634'-6"
Starting Air Skid and Equipment	Diesel Generator Bldg., EL 634'-6"
Instrumentation and Control Equipment	**Location**
Auxiliary Shutdown Panel 1C-114, 2C-114	Aux. Bldg. Elect. Wing, EL 659'-0"
HVAC Control Cabinets for Diesel Generator 1C-175 A&B, 2C-175 A&B	Diesel Generator Bldg., EL 664'-0"
HVAC Control Panel 0C-151	Aux. Bldg. Control Tower, EL 685'-0"
ESFAS Cabinet 1C-44, 2C-44	Aux. Bldg. Control Tower, EL 659'-0"
BOP Logic Cabinet 1C-166, 2C-166	Aux. Bldg. Elect. Wing, EL 659'-0"
Mechanical Equipment	**Location**
Bechtel Purchased Equipment	
Safeguards Chiller 1VM59 A&B, 2VM59 A&B	Main Aux. Bldg., EL 645'
Control Room HVAC 0VM-01 A&B	Aux. Bldg. Control Tower, EL 674'
Component Cooling Water Surge Tanks 1T-73 A&B, 2T-73 A&B	Main Aux. Bldg., EL 659'
Service Water Pumps 0P-75 A-E	SWPS, EL 634'-6"
Component Cooling Water Pumps 1P-73 A&B, 2P-73 A&B	Main Aux. Bldg., EL 559'
Component Cooling Water Heat Exchanger 1E-73 A&B, 2E-73 A&B	Main Aux. Bldg., EL 559'

Table VII-2-1

(Cont.)

Mechanical Equipment (Cont.)	Location (Cont.)
Bechtel Purchased Equipment (Cont.)	
Aux. Feed Pump (Electric) 1P-05A, 2P-05A	Main Aux. Bldg., EL 599'
Aux. Feed Pump (Turbine) 1P-05B, 2P-05B	Main Aux. Bldg., EL 599'
Air Filter Unit OVM-79 A&B	Aux. Bldg. Control Tower, EL 685'
Miscellaneous Active Valves	Various Locations in Reactor and Auxiliary Bldgs.
B&W Supplied Equipment	
Decay Heat Removal Pump 1P-60 A&B, 2P-60 A&B	Main Aux. Bldg., EL 568'
Decay Heat Removal Heat Exchanger 1E-60 A&B, 2E-60 A&B	Main Aux. Bldg., EL 584'
Makeup Pump 1P-58 A,B&C, 2P-58 A,B&C	Main Aux. Bldg., EL 599'

3. SEISMIC MARGIN METHODOLOGY

A review was conducted of the qualification reports for each of the equipment items selected to determine the qualification procedure, seismic input requirements, dynamic characteristics and equipment response to the specified input. Results extracted from the test reports were compared to the required SME input to derive equipment margins.

Throughout this report, the margin is denoted as F_{SME} and is defined as the factor by which the SME would have to be increased to raise the combined normal plus seismic stress level to code allowable or to reach a functional deformation limit if qualified by analysis, or to reach a response level equal to the achieved test level if qualified by test.

For equipment qualified by testing, F_{SME} was derived from the ratio of the test response spectrum (TRS) divided by the required response spectrum (RRS) defined for the SME.

$$F_{SME} = \frac{TRS}{RRS} \qquad (3-1)$$

The ratio of TRS/RRS was defined at the equipment fundamental frequency as determined by testing. Equipment will exhibit a fundamental mode of vibration in each of its three principal axes. The margin was, therefore, determined for each of the three axes and the minimum of the three margins was considered to be the seismic margin against the achieved test level.

Typically, the damping specified for purposes of qualification was one percent for Midland equipment and the test response spectra were defined at one percent damping. In some instances, higher damping was justified on the basis of testing and the test response spectra were defined for the higher damping values. The appropriate damping value for SME evaluation of equipment is defined by Regulatory Guide 1.61 at three percent. The exception to this is the case of dynamic analysis of active equipment for which two percent is specified. However, in deriving margins for equipment qualified by testing, the comparison between the TRS and RRS was made on an equal damping basis.

For structural failure modes of equipment qualified by analysis, the seismic margin was defined as:

$$F_{SME} = \frac{\sigma_A - \sigma_N}{\sigma_{SME}} \qquad (3\text{-}2)$$

where:

σ_A = allowable stress from governing code
σ_N = stress due to normal operating loads
σ_{SME} = stress due to the SME

The allowable stress σ_A and appropriate load combinations are defined in Volume I, Chapter 9 and are reiterated in this report in the description of the margin derivation for each of the equipment items evaluated. For functional failure modes of equipment qualified by analysis, F_{SME} was derived from Equation 3-2, substituting appropriate deflections in place of stresses.

In many instances, the qualification reports did not separate out the stress contribution of normal operating loads from the SSE induced stresses. Stresses were computed via finite element modeling and specified combinations of loading. In these cases, the seismic margin against code allowable could not be directly derived for the SME without review of the suppliers detailed analyses. This would entail a significant and unnecessary engineering effort, therefore, alternative methods were utilized to derive a conservative lower bound margin. One of two scaling approaches were used where stress response to normal operating loads and SSE loads could not be separated depending on whether:

1. SME spectra exceeded SSE spectra at the equipment fundamental frequency

2. SSE spectra enveloped the SME spectra at the equipment fundamental frequency.

In the first case, the governing total stress derived from SSE and normal operating loads was scaled by the ratio of SME/SSE spectral acceleration and a conservative seismic margin was computed from:

$$F_{SME} > \frac{\sigma_A}{\sigma_T} \qquad (3\text{-}3)$$

where:

$$\sigma_T = \frac{Sa_{SME}}{Sa_{SSE}} (\sigma_{SSE} + \sigma_N) \qquad (3\text{-}4)$$

Sa_{SME} and Sa_{SSE} are the spectral accelerations for the SME and SSE spectra defined at the equipment fundamental frequency and $(\sigma_{SSE} + \sigma_N)$ is the combined stress response for the specified safe shutdown earthquake plus normal load. For functional failure modes, allowable and predicted displacements were substituted in Equations 3-3 and 3-4.

The resulting margin is conservative since the normal load stress response was scaled upward along with the SSE stress response. In all situations where this conservative scaling was used, the conservatively computed margins were positive and further refinement was not necessary.

In the second situation, scaling the SSE plus normal load stress response downward by the ratio of SME/SSE is unconservative for purposes of defining seismic margin. Since the SSE spectra exceeded the SME spectra at the equipment fundamental frequency and positive margins were present for the SSE plus normal loading, no further evaluation is necessary and the margin reported is that derived from the SSE plus normal load response.

$$F_{SME} > \frac{\sigma_A}{\sigma_D} \qquad (3\text{-}5)$$

where:

$$\sigma_D = (\sigma_{SSE} + \sigma_N) \qquad (3\text{-}6)$$

If deformation was the governing criteria to assure function, the margin was derived from Equation 3-5 using allowable and computed deformations.

In cases where piping is connected to mechanical equipment and the SSE seismic margin for the piping/equipment interface resulted in the minimum margin against code allowable, different approaches for scaling seismic response were necessary. Seismic induced nozzle loading on equipment is principally dependent upon piping response and not equipment response. Therefore, any scaling of response for a different spectrum should be done on the basis of piping fundamental frequency in lieu of equipment fundamental frequency. In general, actual piping frequencies and seismic reactions at equipment nozzles were not conveniently available unless the connecting piping was a system that had been selected for independent evaluation as reported in Volume IX. As such, the following conservative approach utilizing the readily available information was used to scale equipment nozzle loads to upper bounds for the SME.

Initially, the equipment nozzle stresses, reported by the supplier in his seismic qualification report, were scaled by the maximum ratio of the SME spectra to the SSE spectra used in the design of the connecting piping system. A comparison of SME to current SSE spectra indicated that the frequency range where the SME exceeded the SSE was generally in the 5-18 Hz range, a range where many piping response modes would occur. Comparisons of SME to earlier versions of response spectra actually used for piping design revealed similar behavior. Scaling the computed nozzle responses by the maximum ratio of SME to SSE is very conservative for two reasons. It is implicitly assumed that all response is in one mode and one direction, and at the frequency where the SME/SSE ratio is the greatest; plus, the total stress response for the design load, which upper bounds the normal operating loads as well as seismic loads, was scaled upward. This scaling method, though very conservative, is also efficient compared to reanalyzing piping or conducting a careful review of existing piping analysis and scaling response on a mode by mode basis.

The next step was to compare the scaled nozzle stress response to code allowable response. If positive margins resulted, no further evaluation was necessary. If a negative margin resulted the following further refinement was necessary.

A breakdown of computed nozzle reactions for selected connecting pipe was obtained from the purchasers, Reference 34. The calculated SSE induced nozzle loading was scaled upward by the maximum ratio of the SME/SSE spectral acceleration. The resulting seismic induced nozzle loads were still conservatively calculated due to the use of the maximum ratio of the SME/SSE spectral acceleration for scaling seismic response. The resulting nozzle stresses were compared to code allowables to develop lower bound SME margins against code.

$$F_{SME} = \frac{\sigma_A - \sigma_N}{\sigma_S} \qquad (3\text{-}7)$$

where σ_s is the scaled SME nozzle stress and is equal to

$$\sigma_s \leq \left(\frac{SME}{SSE}\right)_{max} \left(\sigma_{SSE}\right) \qquad (3\text{-}8)$$

where σ_{SSE} is the seismic induced stress in the equipment nozzle for the applicable SSE response spectrum and is obtained from the equipment vendor design report.

Reference 25 advised that some difficulty has been experienced with high strength, low alloy quenched and tempered bolts in meeting the minimum specified yield strength requirements, and suggested that bolting hardness be tested if the seismic margin against code allowable was computed to be less than 1.3. Only one case occurs where the minimum seismic margin for high strength bolting is less than 1.3. That case is clearly identified in this report and results from very conservative scaling of nozzle load reactions.

4. SUMMARY AND CONCLUSIONS

Minimum conservatively computed seismic margins relative to the SME are listed in Table VII-4-1 for all items of equipment that were evaluated. In all cases, the margins against code allowable against functional failure or against achieved test level are greater than 1.0 and the equipment is considered to be qualified for the SME.

The margins reported, herein, are applicable to the vendor supplied equipment and the equipment hold down bolting. Table VII-4-1 is, therefore, felt to represent the minimum seismic margin of the component and its anchorage. In Table VII-4-1, for each equipment item listed, the method of qualification and the critical area of the equipment for which the minimum margin exists are listed. If testing was utilized in the original qualification, the test method is noted.

Table VII-4-1

SUMMARY OF SEISMIC MARGINS

Equipment	Qualification (1) Method	Governing Critical Area (2)	Minimum F_{SME} Margin (3)	Notes
Main Switchgear 1A05, 2A05	Test,(Random Input)	N/A	6.10	
Main Switchgear 1A06, 2A06	Test,(Random Input)	N/A	6.10	
Motor Control Centers 1B23, 2B23	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B24, 2B24	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B43, 2B43	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B44, 2B44	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 0B45, 0B46	Test,(Sine Beat)	N/A	6.3	
Motor Control Centers 1B53, 2B53	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B54, 2B54	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B55, 2B55	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B56, 2B56	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B63, 2B63	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B64, 2B64	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 0B65, 0B66	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 0B68, 0B69	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B79, 2B79	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B80, 2B80	Test,(Random Input)	N/A	>3.25	
Motor Control Centers 1B89, 2B89	Test,(Random Input)	N/A	>3.25	(9)
Motor Control Centers 1B90, 2B90	Test,(Random Input)	N/A	>3.25	(9)
125V DC Batteries and Racks 1D1, 2D1, 1D2, 2D2	Anal. & Test (Random Input)	Battery Rack Structures	2.24	

<u>SUMMARY OF SEISMIC MARGINS (Cont.)</u>

Equipment	Qualification Method (1)	Governing Critical Area(2)	Minimum SME Margin (3)	Notes
Diesel Generator, Engine and Appendages	Anal. & Test (Random Input)	Engine and Turbo-Charger Bolting	>4.00	
Diesel Generator, Neutral Grounding Cabinet 1G-11X, 2G-11X, 1G-12X, 2G-12X	Test,(Random Input)	N/A	3.83	
Diesel Generator, Generator Control Panel 1C-231, 2C-231, 1C-232, 2C-232	Test,(Random Input)	N/A	3.55	
Diesel Generator, Engine Control Panel 1C-111, 2C-111, 1C-112, 2C-112	Test,(Random Input)	N/A	1.5	
Diesel Generator, Generator Unit 1G-11, 2G-11, 1G-12, 2G-12	Analysis	Stator, beam adjacent to foot pad	1.98	
Diesel Generator, Exhaust Air Silencer 1M-101 A&B, 2M-101 A&B	Analysis	Shell	>1.24	(5)
Diesel Generator Intake Air Filter 1F-19 A-D, 2F-19 A-D	Analysis	Shell	>1.86	(5)
Diesel Generator Jacket Water Standpipe 1T-94 A&B, 2T-94 A&B	Analysis	Bolting at platform/ support leg interface	>2.06	(7)
Diesel Generator Skid and Building Mounted Auxiliaries Qualified by Testing	Testing (Random Input)	N/A	>5.0	
Other Diesel Generator Building Mounted Equipment	Analysis	Misc.	>2.06	(10)
Auxiliary Shutdown Panel 1C-114, 2C-114	Analysis	Support Angle (Struct.) Devices	1.52 Incomplete	(4)
HVAC Control Cabinet 1C-175A-B, 2C-175A-B	Analysis & Test (Random Input)	Angle Frame (Struct.) Devices	25.2 Incomplete	(4)

Table VII-4-1

SUMMARY OF SEISMIC MARGINS (Cont.)

Equipment	Qualification Method (1)	Governing Critical Area (2)	Minimum SME Margin(3)	Notes
HVAC Control Panel Oc-151	Analysis & Test (Random Input)	Roof Bar (Structural Devices	1.48 Incomplete	(4)
ESFAS 1C-44, 2C-44	Test, (Random Input)	N/A	1.33	
Balance of Plant Logic Cabinet 1C-166, 2C-166	Test, (Sine Beat)	N/A	1.49	
Safeguards Chiller, IVM-59A&B,2VM-59A&B	Analysis & Testing (Sine Beat)	Cooler Shell(Structural) Control Panel	>1.04 9.3	(5) (4)
Control Room HVAC, OVM-01 A&B	Analysis & Test (Sine Sweep)	Finned Coils	1.42	
Component Cooling Water Surge Tank 1T-173 A&B, 2P-73 A&B	Analysis	Tank Legs	1.31	(6)
Service Water Pumps OP-75 A-E	Analysis	Anchor Bolts	1.50	
Component Cooling Water Pumps 1P-73 A&B, 2P-73 A&B	Analysis	Suction Nozzle Flange	2.98	
Component Cooling Water Heat Exchanger 1E-73 A&B, 2E-73 A&B	Analysis	Anchor Bolts	1.34	(6)
Auxiliary Feed Pump (Electric) 1P-05A, 2P-05A	Analysis	Anchor Bolts	>1.51	(7)
Auxiliary Feed Pump (Turbine) 1P-05B, 2P-05B	Analysis	Anchor Bolts	>1.47	(7)
Air Filtration Unit OVM-79 A&B	Analysis	Door Frame	>1.50	(7)
Decay Heat Removal Pump 1P-60 A&B, 2P-60 A&B	Analysis	Flange Bolting Foundation Bolting	1.69 Incomplete	(8)

Table VII-4-1

SUMMARY OF SEISMIC MARGINS (Cont.)

Equipment	Qualification Method (1)	Governing Critical Area (2)	Minimum SME Margin (3)	Notes
Decay Heat Exchanger 1E-60 A&B, 2E-60 A&B	Analysis	Shell At Support	1.23	
Makeup Pump 1P-58 A,B&C, 2P-58 A,B&C	Analysis	Anchor Bolts	1.24	(7)

Notes:

1. For designs governed by allowable stresses, the margin against code allowable is (code allowable/applied SME stress). For equipment qualified by test, the margin is defined as (test response/required response).
2. Qualification test method is described in Sections 5 through 8 and in Appendix A.
3. Critical area is local region or component within a subsystem with the governing minimum margin.
4. Structural portion qualified by analysis. Devices qualified by test. Completion of SSE qualification of all devices is pending.
5. Margin calculation was very conservative. Stresses in vendor report were scaled upward by the maximum ratio of the SME to the SSE in effect at the time of equipment qualification.
6. Nozzle loading is unresolved pending comparison of computed piping nozzle reactions to load used by vendor for design.
7. Margin based upon original design load since seismic and normal portion of design load could not be separated out from information in design report. Safe shutdown earthquake load exceeded SME load.
8. Foundation bolting margin is incomplete. Insufficient information in design report to factor nozzle loads and inertial loads separately. SSE inertial loads are less than SME. Nozzle loads are greater. Resolution pending receipt of more detailed information from vendor.
9. These units are not required for safe shutdown to cold condition.
10. Detailed margins not computed. Equipment less critically stressed than other items evaluated for SME.

5. ELECTRICAL POWER DISTRIBUTION EQUIPMENT

All 4160 volt switchgear and all 460 volt motor control centers required to achieve cold shutdown were evaluated for the SME. The evaluation included a total of twenty-three (23) switchgear cabinets for each plant unit, twelve (12) motor control center cabinets for each plant unit plus six (6) motor control centers common to both units. In addition, four seismic category 1 switchgear cabinets not required to achieve a cold shutdown were identical and are included in the SME qualification.

Brief descriptions of the equipment, the qualification method, seismic margin derivation, resulting margins and equipment for which the margins are applicable are contained in the following sections. Summaries of the equipment qualification are contained in Appendix A.

5.1 Main Switchgear Cabinets

The main switchgear cabinets are located in the auxiliary building control tower area at Elevation 614'-0". They distribute 4160 volt AC power to various seismic category 1 equipment required for safe shutdown. Seismic qualification test reports were reviewed for switchgear 1A05, 2A05, 1A06 and 2A06 . There are 12 switchgear cabinets in 1A05 and 11 switchgear cabinet in 1A06. The cabinets in 2A05 and 2A06 are identical to 1A05 and 1A06, respectively.

Qualification was by multifrequency biaxial testing, Reference 6. Appendix A, Table A-1 summarizes the qualification testing. A comparison of the TRS and corresponding SME spectra are shown in Figures VII-A-1-1 through VII-A-1-3 for the 3 principal axes. Fundamental frequencies in the 3 axes were determined from sine sweep testing. The lowest modes were 5 Hz side to side, 15 Hz front to back and 23 Hz vertical. Margins were determined using equation 3-1, comparing the TRS to the SME spectra at the fundamental frequency in each direction. The TRS was specified at one percent damping and one percent damped SME spectra were used in the comparison between the TRS and SME spectra. Margins derived from the comparison are:

	F_{SME}
Front to Back	9.1
Side to Side	6.1
Vertical	15.0

5.2 Motor Control Centers (MCC)

A review of the seismic qualification data revealed that two comprehensive test programs, Reference 7, qualified a total of thirty-four (34) motor control centers utilized throughout the auxiliary building, diesel generator building and service water pump structure in both plant units. Thirty of the thirty-four units are MCCs required to achieve a cold shutdown. The MCCs are all Gould 6500 Series 460 volt units. The thirty-four MCCs for which the qualification testing and margins derived herein are applicable are:

MCC Designation	Location
0B45	Auxiliary Bldg., Elev. 685'
0B46	Auxiliary Bldg., Elev. 685'
1B23	Auxiliary Bldg., Elev. 614'
1B24	Auxiliary Bldg., Elev. 614'
1B53	Diesel Gen. Bldg., Elev. 634'
1B54	Diesel Gen. Bldg., Elev. 634'
1B55	Auxiliary Bldg., Elev. 614'
1B56	Auxiliary Bldg., Elev. 614'
2B23	Auxiliary Bldg., Elev. 614'
2B24	Auxiliary Bldg., Elev. 614'
2B53	Diesel Gen. Bldg., Elev. 634'
2B54	Diesel Gen. Bldg., Elev. 634'
2B55	Auxiliary Bldg., Elev. 614'

MCC Designation	Location
2B56	Auxiliary Bldg., Elev. 614'
1B43	Auxiliary Bldg., Elev. 614'
1B44	Auxiliary Bldg., Elev. 614'
2B43	Auxiliary Bldg., Elev. 614'
2B44	Auxiliary Bldg., Elev. 614'
1B63	Service Water Bldg., Elev. 634'
1B64	Service Water Bldg., Elev. 634'
2B63	Service Water Bldg., Elev. 634'
2B64	Service Water Bldg., Elev. 634'
0B65	Service Water Bldg., Elev. 634'
0B66	Service Water Bldg., Elev. 634'
0B68	Service Water Bldg., Elev. 634'
0B69	Service Water Bldg., Elev. 634'
1B79	Auxiliary Bldg., Elev. 628'
1B80	Auxiliary Bldg., Elev. 614'
2B80	Auxiliary Bldg., Elev. 614'
2B79	Auxiliary Bldg., Elev. 628'
1B89	Auxiliary Bldg., Elev. 614'
1B90	Auxiliary Bldg., Elev. 614'
2B89	Auxiliary Bldg., Elev. 614'
2B90	Auxiliary Bldg., Elev. 614'

Of the above list, 1B89, 1B90, 2B89 and 2B90 are the four units not required for a safe shutdown to cold conditions.

Qualification was originally conducted by sine beat testing and is summarized in Appendix A, Table A-2. Some additional units added to the order contained a different type of motor starter and these units were tested using multifrequency random input. A summary of the test qualification is contained in Appendix A, Table A-3. The sine beat testing resulted in greater response of the equipment and is applicable to 0B45 and 0B46. These units are at the highest elevation and experience the greatest response of any of the units installed. Of all the other MCC locations, the service water pump structure at Elevation 634'-6" has the most severe RRS at the equipment fundamental frequencies. Two margins are consequently developed. One margin is based upon the sine beat testing response and the RRS for the auxiliary building control tower at 685'-0". The other margin was developed from the random input TRS and the service water pump structure RRS at Elevation 634'-6".

Sine sweep testing was initially conducted to determine fundamental frequencies in each direction. The fundamental modes were 10 Hz side to side, 8.75 Hz front to back and 35 Hz vertical. Sine beat testing was biaxial. Ten cycles per beat were applied in the vertical direction and 12 cycles per beat were applied in the 2 horizontal directions. Maximum input accelerations without malfunction or relay chatter were 1.55g side to side, 0.88g front to back and 1.2g vertical. The amplification factor for 10 cycles per beat is 10 at 3 percent equipment damping and is greater for 12 cycles per beat. The resulting 3 percent damped test response spectral accelerations are greater than 15.5g side to side, greater than 8.8g front to back and 12.0g vertical.

Review of the transmissibility plots and sine sweep resonant frequency data reveals that the second mode frequencies for the front to back and side to side directions are greater than 33 Hz and that there is no significant coupling. Therefore, the sine beat test response spectra does not require a reduction factor to account for multifrequency response or multimode coupling.

Applying equation 3-1 the resulting margins applicable to 0B45 and 0B46 are:

	F_{SME}
Front to Back (E-W)	6.3
Side to Side (N-S)	17.6
Vertical	34.3

For the remaining margins, the TRS from the biaxial random input TRS are compared to the service water pump structure RRS at Elevation 634'-6". These comparisons are shown in Figures VII-A-3-1 through VII-A-3-3. The resulting margins derived for the equipment fundamental frequencies are:

	F_{SME}
Side to Side	8.30
Front to Back	3.25
Vertical	9.3

As can be seen from the conservatively derived margins, the Gould 56 series 460 volt motor control centers have large margins relative to the SME required response spectra and would easily withstand earthquake motions significantly greater than the SME.

6. ELECTRICAL POWER SUPPLY (AC AND DC)

Emergency DC electrical power is supplied by 125 volt DC batteries and emergency AC power is supplied by four diesel generators, two for each plant unit. Qualifications of these power sources and derivation of margins for the SME are described in sections 6.1 and 6.2. Summaries of the qualifications of the batteries and racks and critical parts of the diesel generator package are contained in Appendix A.

6.1 BATTERIES AND RACKS

The 125 volt DC batteries provide emergency DC power to various safeguards equipment. They are located in the auxiliary building electrical wings at Elevation 614'-0". Qualification of the racks was by analysis and of the batteries by test. Test data were also used to verify battery rack fundamental frequencies computed by analysis. A summary of the battery and rack qualification is provided in Appendix A, Table A-4. The racks were analyzed for generic response spectra that exceeded the SME spectra. Computed seismic responses and internal loads for the battery racks were, therefore, scaled by the ratio of the SME spectral accelerations to the generic spectra spectral accelerations at the battery rack fundamental frequencies. Battery rack frequencies determined by test were 8.5 Hz side to side, 12.0 Hz front to back and 26 Hz vertical. The minimum difference between the SME and generic spectra spectral accelerations resulted in a conservative scaling factor of 0.44. In other words, the internal seismic loads from the original calculations were reduced by a factor of 0.44. Using linear interaction formula for comparing the ratios of axial and bending stress response to allowable code stress and applying equation 3-2, a minimum margin for the SME was:

$$F_{SME} = 2.24$$

The batteries were tested using multifrequency biaxial random input. Comparisons of the TRS and the SME RRS are made in Figures VII-A-4-1 through VII-A-4-3. The margin for the batteries is always greater than that computed for the racks and the battery rack margin of 2.24 governs.

6.2 DIESEL GENERATOR UNITS

The diesel generator units consist of a large number of individual components that were qualified by analysis and by test. Margins were computed for the governing component or critical areas of the units for the following categories.

Diesel Engine and Appendages
Neutral Grounding Cabinet
Generator Control Panel
Engine Control Panel
Generator Unit
Building Mounted Auxiliaries

Qualification of the diesel generator units is documented in References 16, 17 and 18 and is sumarized in Appendix A.

6.2.1 Diesel Engine and Appendages 1G-11, 2G-11, 1G-12 and 2G-12

The diesel engine and appendages are part of the diesel generator system which provides emergency AC power to all essential equipment required for safe shutdown of the plant. The items are located in the Diesel Generator Building at various elevations.

Qualification of the engine and appendages was by testing and analysis (Reference 16). Refer to Appendix A, Section A-5-1, for a summary of the qualification report.

Seismic margins were calculated using Equation 3-1 for items qualified by testing and Equation 3-2 for items qualified by analysis. Typically, the design accelerations and TRS utilized in the equipment qualification exceeded the corresponding SME accelerations and spectra by large margins. For equipment qualified by analysis, computed seismic stresses were scaled by the appropriate ratios of SME/SSE to compute the seismic margins for the SME.

Appendages qualified by test did not govern seismic margins. The engine block was demonstrated to act as a rigid body; thus, base mat spectra were applicable to the engine appendages. Appendages were either demonstrated by test to be rigid or were modified to be rigid. All appendage tests had vibratory input levels exceeding 1.5g while the zero period acceleration (ZPA) of the applicable RRS for the SME is only 0.25g max. The margin between the resulting TRS and the RRS exceeded 6.0 in all cases.

Engine appendages qualified include:

- Governor
- Overspeed Trip with Shutdown Valving
- Engine Driven Lube Oil Pump
- Engine Driven Fuel Oil Booster Pump
- Engine Driven Jacket Water Pump
- Turbochargers (2)
- Intercooler
- Lube Oil Inlet Pressure Strainer
- Fuel Oil Strainer
- Fuel Oil Filter
- Solenoid Operated Air Start Valve
- Lube Oil Strainer
- Engine Mounted Starting Air Filter and Air Strainer

The governing seismic margins against code allowable are as follows:

	F_{SME}
Engine Anchor Bolt:	> 4.70
Turbocharger Bolt:	> 4.00
Engine Appendages:	> 6.00

Seismic margins against code allowables are governed by bolting for the engine anchorage and turbocharger mounting. It should be noted that the reported bolting margins are very conservative as they include preload stress as well as seismic induced stress, even though preload stress is not directly additive to the applied stress. In service, the maximum induced shear stresses would not occur until friction from dead weight and bolt preload is overcome and the seismic induced tension stresses would reduce the preload stresses. The conservatively computed minimum margin is greater than 4.0 for bolting, therefore, the possibility of having soft bolts with a reduced yield strength as low as 3/4 of code specification, Reference 25, does not alter the conclusion that the diesel engine and appendages meet all seismic qualification requirements for the SME.

6.2.2 Neutral Grounding Cabinet

The neutral grounding cabinet is part of the diesel generator system. It is mounted in the diesel generator building at Elevation 652'. Qualification was by multiaxial random input testing, Reference 17. The test qualification is summarized in Appendix A, Section A-5-2.

Seismic margins relative to the TRS were calculated from Equation 3-1. SME spectra for Elevation 664'-0" were used in the margin derivation since they were the next highest elevation above the cabinet mounting location. Appendix A, Figures A-5-2-1 through A-5-2-3 show the comparison between the TRS and SME-RRS.

Cabinet fundamental frequencies determined by sine sweep testing were 10 Hz side to side, 9 Hz front to back and 15 Hz vertical. The TRS enveloped the SME-RRS by a significant margin at these frequencies but at lower frequencies the SME-RRS was greater. However, for both the horizontal :d vertical cases, the TRS enveloped the SME-RRS at all frequencies within 50 percent of the resonant frequencies and the cabinets are considered to be qualified for the SME.

The resulting margins for each of the three directions are:

	F_{SME}
Side to Side	4.25
Front to Back	3.83
Vertical	4.50

6.2.3 Generator Control Panel 1C-231, 2C-231, 1C-232 and 2C-232

The generator control panels are located in the Diesel Generator Building at Elevation 634'-6". They provide the necessary control circuitry for the generator units. Qualification of the panels was by testing (Reference 17). Refer to Appendix A, Section A-5-3 for a summary of the qualification report.

Seismic margins were calculated using Equation 3-1. SME one percent damped spectra were extrapolated from the existing SME floor spectra and compared with the TRS of the qualification report. See Appendix A, Figures A-5-3-1 through A-5-3-3.

Results of the spectra comparisons revealed the TRS do not completely envelope the SME spectra. However, the TRS do envelope the SME spectra at the panel's fundamental frequencies. The lowest fundamental frequency for each of the three input directions is greater than 1.5 times the frequency where the TRS do not envelope the SME-RRS.

Therefore, the qualification test is considered applicable to qualify the control panel for the SME. The resulting seismic margins at the panel's fundamental frequencies are:

	F_{SME}
Side to Side	3.55
Front to Back	5.75
Vertical	5.3

6.2.4 Diesel Engine Control Panel 1C-111, 2C-111, 1C-112 and 2C-112

The diesel engine control panels are located in the Diesel Generator Building at Elevation 634'-6" and provide the necessary circuitry and servo systems to control vital functions of the diesel engine. Qualification of the panels was by testing (Reference 17). Refer to Appendix A, Section A-5-4 for a summary of the qualification report.

Seismic margins were calculated using Equation 3-1. SME one percent damped spectra were extrapolated from the existing SME floor spectra and compared with the TRS of the qualification report. See Appendix A, Figures VII-A-5-4-1 through VII-A-5-4-3.

The spectra comparisons revealed the TRS do not completely envelope the SME spectra, but they do envelope the SME spectra at the panel's fundamental frequencies. Also, the lowest fundamental frequency for each of the three input directions is larger than 1.50 times the frequencies where the TRS do not envelop the RRS. Therefore, the test is considered valid to qualify the panels for the SME.

The resulting seismic margins at the panel's fundamental frequencies are:

	F_{SME}
Side to Side	7.00
Front to Back	4.55
Vertical	1.50

6.2.5 Diesel Engine Generator

The generator provides AC power to essential equipment required for safe shutdown of the plant. The generator is located in the Diesel Generator Building at Elevation 634'-6". Qualification of the generator was by finite element analysis (Reference 18). Refer to Appendix A, Section A-5-5 for a summary of the qualification report.

The fundamental frequencies determined by analysis were 36 Hz side to side, 14 Hz front to back and 21 Hz vertical. A comparison of the SME to SSE spectra used for qualification revealed that the SME was enveloped by the SSE at 14 Hz but not at the higher frequencies. A maximum ratio of 1.7 of the SME/SSE occurred in the rigid range.

The governing stress delineated in the qualification report was, therefore, factored by the largest ratio of SME/SSE and the seismic margin was calculated by Equation 3-3. The minimum seismic margin at the stator's beam adjacent to the footpad connecting end plate was computed to be:

$$F_{SME} = 1.98$$

The generator is considered qualified for the SME.

6.2.6 Building and Skid Mounted Diesel Generator Auxiliaries

Many of the items that make up the complete diesel generator system are mounted on an auxiliary skid in front of the engine, on the air starting skid or are building mounted. Qualification was by analysis and test. Those items qualified by analysis include:

Starting Air Receiver Tank	Elev. 634'-6"
Intake Air Filter	Elev. 664'
Jacket Water and Lube Oil Coolers	Elev. 634'-6"
Auxiliary Skid	Elev. 634'-6"
Jacket Water Standpipe	Elev. 634'-6"
Lube Oil Sump Tank	Elev. 634'-6"

Inlet Air Silences	Elev. 647'
Exhaust Air Silence	Elev. 664'
Starting Air Skid	Elev. 664'
Fuel Oil Dryer Tank	Elev. 634'-6"

Additional items mounted on the auxiliary skid at the front of the engine which were qualified by test include:

Motor Driven Lube Oil Pump (Auxiliary)
Motor Driven B and A Lube Oil Pump
Motor Driven Jacket Water Pump (Standby)
Motor Driven Jacket Water Pump (Heater Recirculating)
Motor Driven Fuel Oil Booster Pump
Pre-lube Filter
Lube Oil Filter
Fuel Oil Inlet Strainer

Other items qualified by test include:

Jacket Water Thermostatic Valve
Starting Air Compressor
Starting Air Dryer
Starting Air Cooler
Starting Air Check Valve

Many of the items were identical to previously qualified items who's qualification level exceeded the specified SSE. A few items were qualified by similarity to previously qualified items. All qualification test data and a list of similarities were included in the qualification report. The only new item qualified by test was the starting air dryer.

In addition, analyses of pump shaft deflections were conducted to verify operability under seismic loading. The analyses were a supplemental study to shake table qualification testing.

Most items were determined by testing to be rigid. All test response spectra exceeded 1.5g in the rigid range while the maximum SME ZPA in the diesel building is 0.3g at Elevation 664'. The resulting minimum seismic margin is:

$$F_{SME} = 5.0$$

The lowest frequency item tested was the starting air after cooler. Several resonant conditions were observed between 12 and 40 Hz. Examination of the TRS revealed that the lowest spectral acceleration in the non-rigid range was 6.0g at 22 Hz. The maximum SME spectral acceleration at 12 Hz or greater is 0.4g at Elevation 664'. Thus the seismic margin for this flexible component was greater than the minimum value derived for rigid components.

Other non-rigid components had fundamental frequencies no less than 20 Hz. At this frequency and greater, the ratio of the TRS to the SME-RRS was always greater than 5.0. Thus, all of the skid and building mounted diesel generator auxiliaries qualified by test have a seismic margin greater than 5.0.

Of the ten building mounted items qualified by analysis, most were rigid and had seismic margins greater than 2.0.

The minimum seismic margin was found to occur in the exhaust air silencers. The exhaust air silencers are 8-foot diameter horizontal tanks about 21 feet long that are mounted on three saddle supports at Elevation 664'-0".

The governing seismic margin was conservatively computed at the inlet nozzle to tank shell junctions by scaling of calculated design load stresses. The margin computation was very conservative due to the method used for scaling seismic response. Nozzle loads for the tank design were specified without separating the contribution from thermal, weight and SSE. In the range of possible frequencies for the inlet pipe, the maximum ratio of the SME spectral acceleration to the SSE design spectrum spectral accelerations was 1.87. This ratio occurred in both the rigid range for the vertical direction and in the 5 to 7 Hz range in the horizontal direction. The nozzle stresses resulting from the design nozzle loads were conservatively scaled upward by the 1.87 factor and the resulting stresses were compared to the faulted condition code allowable. The resulting seismic margin is:

$$F_{SME} > 1.24$$

This margin is overly conservative for several reasons which are:

1. Total nozzle load stress was scaled up since seismic stress was not separated from thermal and weight stress.

2. The maximum ratio of the SME/SSE spectral acceleration was used for scaling. This assumes that all inlet piping response is in a single mode and single direction at the discrete frequency where the maximum SME/SSE ratio occurs.

The next lowest margin calculated was for the intake air filter. The original analysis was conducted assuming the filter to cantilever outward from its mounting flange. No credit was taken for support offered by support pads. The filter was determined by analysis to have frequencies below the rigid range from 6.3 to 18.5 Hz. Comparison of the SME spectra to the specified SSE spectra resulted in a maximum ratio of SME to SSE of 1.4 occurring in the vertical direction at 6.3 Hz. The conservatively calculated seismic stress was increased by the maximum SME/SSE ratio of 1.4 to obtain an upper-bound SME stress. The resulting seismic margin computed by Equation 3.2 was:

$$F_{SME} > 1.86$$

Again, this is a very conservative value due to the conservatism of the original analysis and the conservative scaling of the seismic stress.

The third lowest seismic margin occurred in the jacket water standpipe. In this case, the SME spectral acceleration at the equipmental fundamental frequency was enveloped by the SSE acceleration used in the design analysis. Total stress response in the standpipe and bolting was not separated, thus, the seismic contribution could not be scaled downward. A minimum margin was computed by equation 3-5 for bolting at the platform to support leg interface to be:

$$F_{SME} > 2.06$$

This represents the margin for the original conservative design loads. The SME margin is greater. The other building mounted diesel generator equipment qualified by analysis had margins in excess of 2.06.

7. INSTRUMENTATION AND CONTROL CABINETS

A total of five Instrumentation and Control (I&C) cabinets were selected for comparison of their seismic qualification to the SME RRS. The cabinets are all located at high elevations in the auxiliary building control tower and electrical penetration wing areas where SME induced accelerations will be greatest. The cabinets and their locations are listed in Table VII-2-1.

7.1 AUXILIARY SHUTDOWN PANEL, 1C-114 and 2C-114

The auxiliary shutdown panels provides a remote shutdown capability in the event that shutdown equipment or operating personnel in the control room are incapacitated. The panels are located in the Auxiliary Building Penetration Wings at Elevation 659'-0".

Qualification of the panels for structural integrity was by analysis (Reference 4). See Appendix A, Sections A-6 for details and results of the qualification. Qualification of devices within the panel was by random input biaxial testing, Reference 30. There were a few internal devices for which qualification documentation is not yet complete. Therefore, the seismic margins reported are limited to the structural elements of the control panel. The minimum margin for components within the panel will be included when their qualification documentation has been completed and reviewed.

Seismic margins for the cabinet structures were calculated using Equation 3-2. Loads from the qualification report modal response spectrum analysis were multiplied by the factor:

$$\frac{\text{SME spectral acceleration at 3\% damping}}{\text{Qualification spectral acceleration at 2\% damping}}$$

Spectral accelerations were compared at the panel first natural frequency. Since the analysis was for two components of earthquake, the two load cases, X+Y directions and Y+Z directions, were combined by SRSS to obtain conservative three component seismic loads.

The resulting seismic margins against code at the governing members are:

	F_{SME}
Barrier terminal support box angle:	3.85
Base support angle:	1.52

In conclusion, the panels would maintain their structural integrity during an SME.

7.2 HVAC Control Cabinet, 1C-175A-B and 2C-175A-B

HVAC control cabinets C-175 control the HVAC systems for the Diesel Generator Building. The cabinets are located in the Auxiliary Building Control Tower at Elevation 688'-0".

Qualification of the cabinets for structural integrity was by analysis (Reference 5). See Appendix A, Section A-7 for details and results of the qualification. Qualification of devices within the cabinet was by random motion testing, References 31 and 32. Documentation of seismic qualification of a few internal devices has not been completed. Therefore, the seismic margins reported are limited to the structural elements of the control cabinet. SME margins will be included for internal components when qualification information is completed and reviewed.

Seismic margins were calculated using Equation 3-2. SME loads were scaled from the original analysis in the same manner as discussed in Section 7.1. The floor spectra at Elevation 704'-0" were used because the cabinet is wall mounted at an elevation greater than the 685'-0" elevation for which the next lower floor level spectra exist. The minimum seismic margin against code occurs in the cabinet angle frame and is:

$$F_{SME} = 25.2$$

In conclusion, the cabinet would maintain its structural integrity during an SME.

7.3 HVAC Control Panel, No. OC-151

HVAC control panel OC-151 controls the HVAC system for the auxiliary building. The panel is located in the Auxiliary Building, Control Tower at Elevation 685'-0".

Qualification of the panel for structural integrity was by analysis (Reference 10). See Appendix A, Section A-8, for details and results of the qualification. Qualification of devices within the panel was by random motion testing, References 31 and 32. Documentations of the seismic qualification of a few internal devices has not been completed. Therefore, the seismic margins reported are limited to the structural elements of the control panel. Component margins for the SME will be included when documentation has been completed and reviewed.

Seismic margins were calculated using Equation 3-2. Loads from the qualification report modal response spectra analysis were multiplied by the factor:

$$\frac{\text{SME spectral acceleration at 3\% damping}}{\text{SSE spectral acceleration at 2\% damping}}$$

Spectral accelerations were compared at the panel first natural frequency. The SSE accelerations are those used in the original analysis. Since the analysis was for two components of earthquake, the two load cases, X+Y directions and Y+Z directions, were combined by SRSS to obtain conservative three component seismic loads.

The minimum seismic margin against code was determined to be in the roof bar and was computed to be:

$$F_{SME} = 1.48$$

In conclusion, the panel would maintain its structural integrity during an SME.

7.4 Engineered Safety Features Actuation System Cabinet, 1C-44 and 2C-44

The ESFAS cabinets contain an electronic system which monitors key plant process variables and initiates the operation of various Engineered Safety Features subsytems to control and mitigate the consequences of detected abnormal conditions. The cabinet is located in the Auxiliary Building, Control Tower, Elevation 659'-0".

Qualification was by testing (Reference 3). See Appendix A, Section A-9 for details and results of the qualification.

Seismic margins were calculated using Equation 3-1. The SME floor response spectra (two percent damping) were compared with the two percent damped TRS, Figures VII-A-9-1 through VII-A-9-3. The SME vertical spectrum was scaled by a Vertical Amplification Factor (VAF) of 1.4 to account for potential floor slab amplification of response (See Volume 1, Appendix A for VAF criteria).

Fundamental frequencies determined by test are 6.1 Hz side to side, 10.7 Hz front to back and 35 Hz vertical for the actuation and sensor cabinets and 8.1, 12.5 and 29 Hz, respectively, for the ECCAS cabinet. Margins were computed for each of the principal directions by comparing the TRS to the SME-RRS at the fundamental frequency in each direction. The resulting margins are:

Actuation Cabinet and Sensor Cabinet

	F_{SME}
Front to Back	2.71
Side to Side	1.33
Vertical	1.41

ECCAS Conditioning Cabinet

	F_{SME}
Front to Back	3.38
Side to Side	2.00
Vertical	1.76

The TRS do not completely envelope the SME spectra in the low frequency regions. See Appendix A, Figures VII-A-9-1 through VII-A-9-3. The unenveloped regions of the SME spectra have negligible effects on the total response of the cabinet because the cabinet fundamental frequencies are at least 1.5 times higher than the unenveloped frequencies of the SME spectra. In conclusion, the cabinet and instruments are considered qualified for the SME.

7.5 BOP LOGIC CABINET, 1C-166 and 2C-166

The cabinets are located in the Auxiliary Building, Penetration Wings, Elevation 659'-0".

Qualification was by testing (Reference 11, 12). See Appendix A, Section A-10 for details and results of the qualification.

Seismic margins were calculated using Equation 3-1. The cabinet qualification was by single axis, single frequency, sine beat tests and the input motion was a peak amplitude of 2.0g. Ten beats of 10 cycles/ beat at frequencies of 2-35 Hz were applied. The TRS was generated by scaling the input motion of 2.0g by the magnification (Q) factor, as given by Figure VII-A-10-1. For 10 cycles/beat and three percent of critical damping, the dynamic amplification, Q, is equal to 10. For purposes of determining the margin, the resulting TRS was scaled downward by an upperbound factor of 1.5 to account for the possibility of multimode responses prior to comparing the TRS to the SME-RRS.

The scaled down TRS was compared with a conservative SME spectrum (three percent damping) derived by the SRSS combination of the applicable floor spectra to account for possible coupled responses, see Figure VII-A-10-2. A VAF for floor slab amplification was not applicable because the cabinet is located next to an exterior wall.

The cabinet devices were qualified by biaxial, random vibration tests. The TRS was assumed to be the test input levels of the devices which were 15g side to side, 10g front to back and 5g vertical. These device test levels were compared with the required test input levels. The required test input was derived by scaling the SME-SRSS of three directional spectra Figure VII-A-10-2, by the cabinet response amplification factors determined at the fundamental frequencies of the cabinet.

Amplification factors determined for the cabinet were:

Side to Side at 8 Hz	5.2
Front to Back at 15 Hz	6.1
Vertical at 33 Hz	1.3

The resulting required test level for the devices were obtained by multiplying the above factors times the SME-SRSS spectrum shown in Figure VII-A-10-2.

The resulting minimum seismic margins calculated for the cabinet and internal devices are:

	F_{SME}
cabinet:	3.50
devices:	1.49

The cabinet and internal devices are considered qualified for the SME.

8. MECHANICAL EQUIPMENT

Seismic qualification documentation of selected active and passive mechanical equipment items was reviewed and seismic margins were derived for the SME. Equipment selected included BOP equipment purchased by Bechtel Associates Power Corporation (Bechtel) and safeguards equipment purchased by Babcock and Wilcox (B&W). The equipment items selected and their locations are listed in Table VII-2-1.

Summaries of the equipment qualification for the safe shutdown earthquake are included in Appendix A. Brief descriptions of the equipment, the method of qualification and derivation of the SME margins are included in the following sections. In cases where nozzle loading governed equipment margins, upper bounds on SME to SSE scale factors were derived by spectra comparisons and original qualification nozzle load responses were scaled accordingly to develop SME nozzle load margins. In some instances, this very conservative approach resulted in unsatisfactory margins and, therefore, actual nozzle loads were obtained from detailed piping analysis prior to scaling. The resulting margins were always found to be satisfactory when only the seismic reactions at nozzles were scaled.

8.1 SAFEGUARDS CHILLER IVM-59 A & B, 2VM-59 A & B

The safeguard chillers provide chilled water to several critical HVAC systems in the plant. They are located in the Auxiliary Building at Elevation 645'-0". Qualification of the chillers was by analysis (Reference 21). Refer to Appendix A, Section A-11 for a summary of the qualification report.

The most critically stressed area, as determined from the design report, was the cooler shell at the economizer liquid outlet pipe. Stresses are principally caused by reactions from the economizer outlet pipe, which is internal to the chiller and is included in the equipment dynamic analysis. A comparison was made of 0.5 percent damped SSE spectra applicable to the chiller at the time the equipment was qualified to the two percent damped SME spectra applicable to small diameter piping and equipment. The SME horizontal spectra are enveloped by the SSE horizontal spectra but the SME vertical spectrum exceeds the SSE vertical spectrum by an exceedance factor of 1.4 at the equipment fundamental frequency of 24.6 Hz. The shell stresses computed for specified nozzle loads were very conservatiely scaled up by the SME/SSE exceedance ratio of 1.4 and compared to faulted condition allowable stresses. The resulting margin was computed to be:

$$F_{SME} = 1.26$$

The next most critical area identified in the design report was the shell stresses in the cooler water box resulting from internal pressure and specified external nozzle loads. The two percent damped SME spectra were compared to one-half percent damped SSE spectra used in design of the connecting piping. The SME spectra were enveloped in the horizontal direction for all credible piping frequencies but the vertical SME exceeded the SSE by a maximum factor of 2.05 at 14 Hz. The water box stress response given in the design report was not broken down into individual contributions from the applied pressure, thermal, weight and seismic loads, therefore, the total stress was conservatively scaled upward for comparison to the code allowable. The resulting lower bound seismic margin was:

$$F_{SME} > 1.04$$

All other areas of the chiller units were much less critically stressed. The governing seismic margins derived is a very conservative lower bound for two reasons.

1. The stress scaling factor was very conservatively scaled by the ratio of the SME/SSE spectra for the vertical directions while the SME was enveloped by the SSE in both

horizontal directions. This assumes that the increased response of the connecting piping, when subjected to the SME, is governed by a single frequency and single direction.

2. The specified nozzle loads and resulting shell stresses were assumed to be 100 percent caused by the SSE and the total stress was scaled upward.

The conservatively calculated SME margin demonstrates that the safeguards chillers are qualified for the SME without further refinement in scaling stresses or in further analysis of connecting piping.

Qualification of active devices within the control panel subassembly was by biaxial sine beat testing, Reference 33. Ten cycles per beat were applied at one-third octave intervals from 1 Hz to 48 Hz. The minimum margin was determined by comparing the resulting TRS to the applicable SME-RRS throughout the test frequency range and was computed to be:

$$F_{SME} = 9.3$$

There are some chiller ancilliary devices for which qualification has not been resolved with the vendor. Upon resolution of qualifications for the SSE, the margins for the SME will be derived and included in this report.

8.2 CONTROL ROOM HVAC OVM-01A & OVM-01B

The control room HVAC units provide heating and air conditioning to the control room at Elevation 659'-0". The units are located in the Auxiliary Building Control Tower at Elevation 685'-0". Qualification was by analysis and testing (Reference 13). Refer to Appendix A, Section A-12 for details and results of the qualification.

Seismic margins were calculated using Equation 3-3. Components qualified by testing did not govern the margin because test levels were much higher than required. Since the design acceleration values at the equipment fundamental frequencies exceeded the corresponding SME accelerations, the calculated loads and stresses from the qualification report were reduced by the minimum ratio of the SSE/SME before the seismic margins were computed. The reduction was applied to seismic stresses only. Scaled seismic stresses were combined with dead weight stresses to determine the total stress state under the seismic margin condition. The resulting seismic margins are:

	F_{SME}
Isolator Bolt:	2.45
Isolator Channel:	1.61
Motor:	1.80
Finned Coils:	1.42

Margins for all but the coils are conservative because isolators with greater stiffnesses than the isolators analysed were actually supplied with the HVAC units. The isolator coil margin reflects the stiffer isolator condition. The stiffer isolators increased the equipment's fundamental frequencies and consequently, decreased the required design acceleration values.

8.3 COMPONENT COOLING WATER SURGE TANK 1T-173A, 2T-173A, 1T-173B & 2T-173B

The component cooling water surge tanks are located in the Auxiliary Building (Main Auxiliary Area) at Elevation 673'-0". Qualification of the tanks was by analysis (Reference 24). Refer to Appendix A, Section A-13 for a summary of the qualification report.

Seismic margins were calculated by Equation 3-2. SME floor spectra were not computed in the Main Auxiliary area above Elevation 659'-0". The CCW Surge Tanks are housed within a rigid concrete and reinforced masonry wall structure that extends above the operating floor at Elevation 659'-0". Upper bound spectral accelerations at the equipment fundamental frequency of 24 Hz were extrapolated from lower elevations to estimate the required spectral accelerations applicable to the tanks. The design accelerations were greater than the corresponding SME accelerations in all directions.

Consequently, the seismic loads for the three directions of response were scaled by the corresponding SME/SSE ratios to obtain SME loads. The resulting minimum seismic margin occurs in the tank legs and is:

$$F_{SME} = 1.31$$

Computed nozzle loads from connecting piping are currently being reviewed to develop margins for the tank nozzles. Nozzle margins will be included when developed.

8.4 SERVICE WATER PUMPS 0P-75A-E

The service water pumps supply cooling water to safety related equipment required for safe shutdown and to other non-safety related equipment. The pumps are located in the Service Water Pump Structure at Elevation 634'-6". Qualification was by analysis (Reference 14). Refer to Appendix A, Section A-14 for details and results of the qualification report.

The horizontal design spectral acceleration values at the pump's fundamental frequencies exceeded the corresponding SME acceleration values (two percent damping) and the vertical design acceleration value was less than the vertical SME acceleration value. Therefore, appropriate factors were computed from the ratios of spectral accelerations and the seismic loads and stresses from the qualification report were scaled to calculate seismic margins.

Service water pumps are connected to strainers and the strainers serve as anchors for the attached service water piping; thus, the service water pumps are not affected by external piping reactions. Very high piping reaction loads were specified for design and these loads tend to dominate the total stress at many critical locations. Since seismic inertial loads on the rigid pipe connecting the SW pumps to the strainers would be small relative to the specified pipe reaction loads. The specified pipe reaction loads were held constant in determining the seismic margins.

The resulting seismic margins are:

	F_{SME}
Pump Column:	2.9
Anchor Bolt:	1.5
Nozzle:	1.67

8.5 COMPONENT COOLING WATER PUMP 1P-73A, 2P-73A, 1P-73B & 2P-73B

The component cooling water pumps are part of the component cooling water system and circulate cooling water in the closed loop system. The pumps are located in the Auxiliary Building at Elevations 584'-0" and 599'-0". Qualification of the pumps was by analysis (Reference 20). Refer to Appendix A, Section A-15 for a summary of the qualification report.

Seismic margins were calculted using Equation 3-7. The suction nozzle flange was the most critical element of the pump. The highest seismic loads from attached piping resulted on pump 1P-73A. The vendor's analysis of the flange was conducted using standard ASME code flange formula methods. The governing stress criterion was the combination of:

$$1/2\ (S_H + S_T) \leq 2.0\ S$$

In the above equation, S_H is the longitudinal stress in the hub, S_T is the tangential stress in the flange and S is the code allowable stress of 14,000 psi.

In the vendor's design analysis, stress components were computed for pressure loading. The pressure loading consisted of specified design pressure plus an equivalent pressure derived for external nozzle loads. The resulting design stress components were 69 percent due to external loads and 31 percent due to design pressure. A breakdown of load components in the adjacent pipe revealed that the total external load applied was about 75 percent of the design load and that 57 percent of this was due to the SSE. From this information, the dead weight, SSE and pressure components of stress were computed at the nozzle hub and flange. The SSE stresses were then scaled upward by the maximum ratio of the SME/SSE spectral accelerations to obtain upper bound SME stress components. These stress components were then added to dead weight and internal pressure components to arrive at a total faulted condition stress state for the SME plus normal loading.

Two margins were derived for the combined SME plus DW plus pressure load combination, the margin against code allowable and the margin against the yield strength of 36,000 psi. The check against yield was made to assure function. The resulting margins are:

	F_{SME}
MS against code	= 2.98
MS against yield	= 3.83

The component cooling water pumps have sufficient margin to withstand a significantly greater seismic event than the SME.

8.6 COMPONENT COOLING WATER HEAT EXCHANGER 1E-73A, 2E-73A, 1E-73B & 2E-73B

The component cooling water heat exchangers are part of the component cooling water system. The exchangers' function is to transfer the plant waste heat from the component cooling water system to the service water system during normal, shutdown and emergency plant operations. The exchangers are located in the Auxiliary Building at Elevation 584'-0" and 599'-0". Qualification of the heat exchangers was by analysis (Reference 19). Refer to Appendix A, Section A-16 for a summary of the qualification report.

The minimum margin in the heat exchangers, not including of the nozzles, was computed to be at the anchor bolts. The SME spectral accelerations in the tank longitudinal and transverse directions were slightly less than the SSE design acceleration but exceeded the design case in the vertical direction. The vendor's calculated responses were consequently scaled for each direction by the ratio of the SME/SSE spectral accelerations at the calculated equipment frequencies. The resulting critical area was at the anchor bolts and the resulting margin was:

$$F_{SME} = 1.34$$

A margin of 1.34 meets the acceptance criteria of Reference 25 without further consideration of the possible effects of softer than specified bolting.

Evaluation of the nozzles and adjacent shell has not been completed pending review of calculated piping reactions at nozzles. Nozzle margins will be included when developed.

8.7 AUXILIARY FEEDWATER PUMP (ELECTRIC MOTOR DRIVEN) 1P-05A & 2P-05A

The auxiliary feedwater pumps provide a backup source of feedwater to remove decay heat transmitted to the steam generators by the primary coolant loops during a shutdown. The pumps are located in the Auxiliary Building at Elevation 584'-0". Qualification of the pumps was by analysis (Reference 22). Refer to Appendix A, Section A-17 for a summary of the qualification report.

The pump was determined by analysis to be rigid. The SME ZPA's were greater than the design ZPA's in both horizontal directions but were less than the design ZPA in the vertical direction. Seismic margins were calculated by Equation 3-2. The minimum margin was determined to be in the pump anchor bolts. In evaluating the anchor bolts, the pump inertial loadings reacted by the anchor bolts were scaled by the ratios of the SME/SSE in each of these component directions but the design nozzle loading reactions were held constant. A subsequent review was conducted of nozzle loads computed for the SSE plus normal operating conditions, Reference 34. The SSE portion of the load was conservatively scaled by the maximum ratio of the SME/SSE spectral acceleration. The resulting combination of SME plus normal operating loads was much lower than the specified design loads used in the calculation of F_{SME}. Thus, the margin computed using design nozzle loads and scaled inertial loads was conservatively computed to be:

$$F_{SME} > 1.51$$

8.8 AUXILIARY FEEDWATER PUMP (TURBINE DRIVEN) 1P-05B & 2P-05B

The auxiliary feedwater pumps provide a backup source of feedwater to remove decay heat transmitted to the steam generators via the primary coolant loops during a plant shutdown. The pumps are located in the Auxiliary Building at Elevation 584'-0". Qualification of the pumps was by analysis (Reference 23). Refer to Appendix A, Section A-18 for a summary of the qualification report.

Seismic margins were calculated by Equation 3-2. The pumps were determined by analysis to be rigid. The design zero period accelerations in the horizontal directions were less than the corresponding SME accelerations, but the vertical design acceleration was greater than the vertical SME acceleration. Therefore, the seismic stress responses were scaled by the appropriate zero period acceleration ratios to calculate SME stresses.

The minimum margin was computed in the anchor bolts using scaled SME inertial loading and design basis nozzle loading. A subsequent review was conducted of nozzle loads calculated for the SSE and normal operating conditions, Reference 34. Scaled SME plus normal operating condition nozzle loads were compared to the specified design loads and found to be significantly lower. Thus, the calculations of F_{SME} using design nozzle loads was conservative. The resulting lower bound F_{SME} is:

$$F_{SME} > 1.47$$

8.9 AIR FILTRATION UNIT OVM-79A & OVM-79B

The air filtration units remove airborne radioactivity and purge smoke and hazardous chemicals from the air in the control room supply, recirculation and exhaust system. The units are located in the Auxiliary Building Control Tower at Elevation 685'-0". Although the units are not required for cold shutdown, they were selected for evaluation because of the large vertical floor slab amplification that occurs at the 685'-0" elevation of the auxiliary building control tower. Qualification was by analysis (Reference 15). Refer to Appendix A, Section A-19 for the summary of the qualification report.

The lowest calculated fundamental frequency was 28.9 Hz and the component is essentially rigid. Seismic margins were calculated using Equation 3-5. The design acceleration values exceeded the corresponding SME acceleration values even in the vertical direction. Since the seismic stress components of the calculated design stresses were not separated from the total stresses, the seismic margins reported are for the design basis earthquake and are actually greater for the SME.

The resulting seismic margins against code allowables are:

	F_{SME}
Door Panel:	1.63
Vertical Door Frame:	1.50

The air filtration units are structurally qualified for the SME.

8.10 DECAY HEAT REMOVAL PUMP, 1P-60A, 1P-60B, 2P-60A and 2P-60B

The decay heat removal pumps circulate water in the decay heat and core flooding system. The pumps are located in the Auxiliary Building (Main Auxiliary Area) at Elevation 568'-0".

Qualification of the pumps was by analalysis (Reference 26). Refer to Appendix A, Section A-22 for details and results of the qualification.

The governing critical areas were in the suction and discharge flanges and the anchor bolts. The vendor resolved piping reactions specified for design into equivalent pressure loads and stresses in the flanges were computed by Standard ASME flange design formulae for pressure loading. In estimating the upper bound on flange stresses, the equivalent pressure for nozzle loading was scaled upward by the maximum ratio of the SME/SSE spectral acceleration. This is very conservative as all nozzle loading is assumed to be seismic and the attached piping is assumed to respond 100 percent in a single mode at the frequency where the SME/SSE spectral acceleration is the greatest. The maximum SME/SSE ratio used for scaling was 2.25.

Upper bound flange stresses were compared to ASME code faulted condition acceptance criteria and to computed stress levels that would be achieved in a hydrostatic test of the pump case. The check against hydrostatic test stresses was done to assure that the pump would not leak at the flanges in the event of a SME. Structural margins against code allowable and a functional margin against a known test level for which leakage would not occur are presented.

Conservatively computed seismic margins at the pump flanges for both a code allowable and a no leak criterion are:

	F_{SME} (Code Allowable)	F_{SME} (No Leak)
Suction Flange	2.95	1.86
Discharge Flange	2.25	1.91
Flange Bolting	1.69	1.06

Note that the margin for no leak is in relationship to a hydrostatic test level stress and does not indicate that leaking will occur when the margin is less than 1.0.

Anchor bolt margins are in the process of being developed. The pump vendor used a computer program to develop anchor bolt reactions from external nozzle loads and pump inertial loads due to earthquakes. Thus, scaling of results could not be accomplished without further details on bolt pattern geometry, nozzle locations, pump weight and center of gravity. This information is being obtained from the vendor and anchor bolt margins for the SME will be derived upon receipt of the required detail.

8.11 DECAY HEAT REMOVAL HEAT EXCHANGERS 1E-60A, 1E-60B, 2E-60A and 2E-60B

The decay heat removal heat exchangers transfer heat from the decay heat and core flooding system to the component cooling water system. The heat exchangers are located in the Auxiliary Building (Main Auxiliary Area) at Elevation 584'-0".

Qualification of the heat exchangers was by analysis (Reference 29), Refer to Appendix A, Section A-20 for details and results of the qualification. An equivalent static coefficient seismic analysis was conducted using 1.5 times the peak spectral acceleration. Inertial loading for the SME was also computed by the same method.

Detailed nozzle loading was provided by Bechtel for each of the four heat exchangers. The pipe stress results reflected response to Bechtel's 1977 response spectra for the Auxiliary Building. The maximum ratio of the SME spectral acceleration to the 1977 SSE spectral acceleration was 1.6 occurring at about 10 Hz in the North-South direction and at 14 Hz in the vertical direction. All nozzle loading for the SSE were conservatively increased by this factor. New total nozzle loads (herein called SME nozzle loads) were calculated and evaluated to determine the set of nozzle loads which would provide the maximum stresses at the tubeside and shellside nozzles. It was noted that the governing sets of nozzle loads did not occur together at one heat exchanger. Nozzle and shell stresses for the SME were determined by scaling the original stresses of Reference 29 by the upper bound factors of SME nozzle loads/design nozzle loads of Reference 29. These stress scale factors were:

	Stress Scale Factor
Tube side nozzle:	3.56
Shell side nozzle:	3.40

Seismic margins were calculated using Equation 3-7.

To conservatively evaluate the seismic margins for the foundation bolts and the shell at the saddle supports, the four governing sets of SME nozzle loads were assumed to occur simultaneously on one heat exchanger. Inertial loadings were computed using 1.5 times the peak spectral accelerations of the SME at three percent damping.

The governing seismic margins against code allowables were computed using Equation 3-7 and are:

	F_{SME}
Foundation Bolts:	1.95
Shell Stress at Fixed Saddle Support:	1.23

The bolt margin was greater than the supplemental acceptance criteria of Reference 25, therefore, no further consideration of actual vs specified bolting strength is necessary. The decay heat removal heat exchangers are considered qualified for the SME.

8.12 MAKEUP PUMPS 1P-58A-C and 2P-58A-C

The makeup pumps provide makeup water to the reactor coolant system and also act as high pressure injection pumps in the event of a small pipe break. The pumps are located in the Auxiliary Building (Main Auxiliary Area) at Elevation 599'-0". Qualification of the pumps was by analysis (References 27 and 28). Refer to Appendix A, Section A-21 for details and results of the qualification.

The pump was demonstrated by analysis to be rigid. Inertial loading used in seismic design of the pump anchorage exceeded the SME inertial loading by factors of greater than five in each of the three directions. In the possible frequency range of attached piping, the SME spectral accelerations exceeded the design basis SSE spectral accelerations by as much as a factor of 2.0. Vendor calculations for anchor bolt stress were redone using scaled down inertial loads and scaled up nozzle loads. The resulting margin was:

$$F_{SME} = 1.24$$

This does not meet the acceptance criteria delineated in Reference 25 without further verification of bolting strength. Since design nozzle loads were very conservatively scaled upward by the maximum ratio of the SME/SSE and are a major contributor to anchor bolt loading, detailed pipe reactions at the pump nozzles have been obtained and are undergoing review. Nozzle load scaling will be conducted on only the seismic portions of the nozzle loads and an increased margin will be demonstrated and included in the final report.

8.13 BALANCE OF PLANT VALVES

All BOP active valves within the ASME Class 1, 2 and 3 BOP piping systems selected for independent analysis have been examined for qualification to the SME. All valves were required to be qualified for 3g acceleration in any direction. Piping responses to the SME for all valve locations did not exceed 3g. Therefore, all the valves examined are considered qualification for the SME.

A tabulation of valve accelerations is contained in Volume IX, Class 1, 2 and 3 Balance of Plant Piping, Pipe supports and valves.

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APPENDIX A

<u>SUMMARY OF EQUIPMENT QUALIFICATION</u>

<u>FOR THE SAFE SHUTDOWN EARTHQUAKE</u>

A-1 Equipment Qualification Summaries

Summaries of seismic qualification of equipment selected for the seismic margin study are presented in a standardized tabular format in Tables VII-A-1 through VII-A-21. Information in the summaries was obtained from reviews of the vendor submitted seismic qualification reports and reflects qualification for the seismic loading specified at the time of equipment purchase. This information is subsequently used in development of seismic margins for the seismic margin earthquake.

For equipment qualified by testing, the test response spectra (TRS) are compared to the required response spectra (RRS) for the safe shutdown earthquake. The SME required response spectra are also superimposed so that a direct comparison can be made of the TRS and SME RRS.

The standardized forms consist of four sheets. Sheets 1 and 2 are always included and provides overall information about the equipment. Sheet 3 summarizes qualifications by test and Sheet 4 summarizes qualifications by analysis. In cases where one or the other is not applicable, the sheets are omitted to reduce volume. If equipment is qualified by both analysis and test, all summary sheets are included.

All references in the summaries to required input or resulting stress response pertain to the SSE specified at the time of purchase and not the SME.

Table VII-A-1

SUMMARY OF VENDOR SEISMIC QUALIFICATION

4160 VOLT SWITCHGEAR 1A-05, 2A-05, 1A-06 and 2A-06

Table VII-A-1 4160 VOLT SWITCHGEAR 1 A05, 2 A05, 1 A06 and 2 A06

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Main Switchgear Cabinets

1. Scope: ( ) NSSS (x) BOP
2. Model Number: I-T-E Type 5HK Switchgear
3. Vendor: I-T-E Imperial Corp.
4. If the component is a cabinet or panel, name and model No. of the devices included: 5HK switchboard including electrical bus and all standard electrical and mechanical hardware. (Refer to qualification report for list of devices).
5. Physical Description a. Appearance 12 Rectangular cabinets joined together.

   b. Dimensions 26'-0" L x 66" W x 80" H (overall dim.)

   c. Weight 15,975 lbs.
6. Location: Building: Aux. Bldg. - Control Tower

   Elevation: 614'-0"
7. a. System in which located: Switchgears feed various systems

   b. Functional Description: Provide 4160 Volt AC power

   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown

   (x) Both ( ) Neither
8. Pertinent Reference Design Specifications:

   Bechtel Spec. 7220-E-205

III. Equipment Qualfication Method:

(X) Test ( ) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 703-50382, Seismic Certification

(No., Title and Date) Report for Class IE Electrical Equipment, April, 1976

Bechtel Document No. : 7220-E205-222-1 to 7220-E205-224-1

Company that Prepared Report: I-T-E Imperial Corp.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg-Control Tower, El. 614'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .15g F/B = .19g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. ( ) Single Frequency   (X) Multi-Frequency: (X) random   ( ) sine beat   ( ) ________

2. ( ) Single Axis   (X) Multi-Axis

3. No. of Qualification Tests: OBE 6 SSE 6 Other 4 - Sine Sweep (specify)

4. Frequency Range: .5 - 50 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 5,13,23,27,31 F/B = 15,19,23,27,30 V = 23,27

6. Method of Determining Natural Frequencies

   (X) Lab Test   ( ) In-Situ Test   ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test ( ) Yes (Attach TRS & RRS graphs

8. Input g-level Test:

   SSE S/S = 1.9 g F/B = 1.85g V = .95g

9. Functional operability verified: (X) Yes ( ) No ( ) Not Applicable

10. Test Results including modifications made: Switchgear would provide safe shutdown operation during and after a SSE.

11. Other test performed (such as aging or fragility test, including results):

    None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

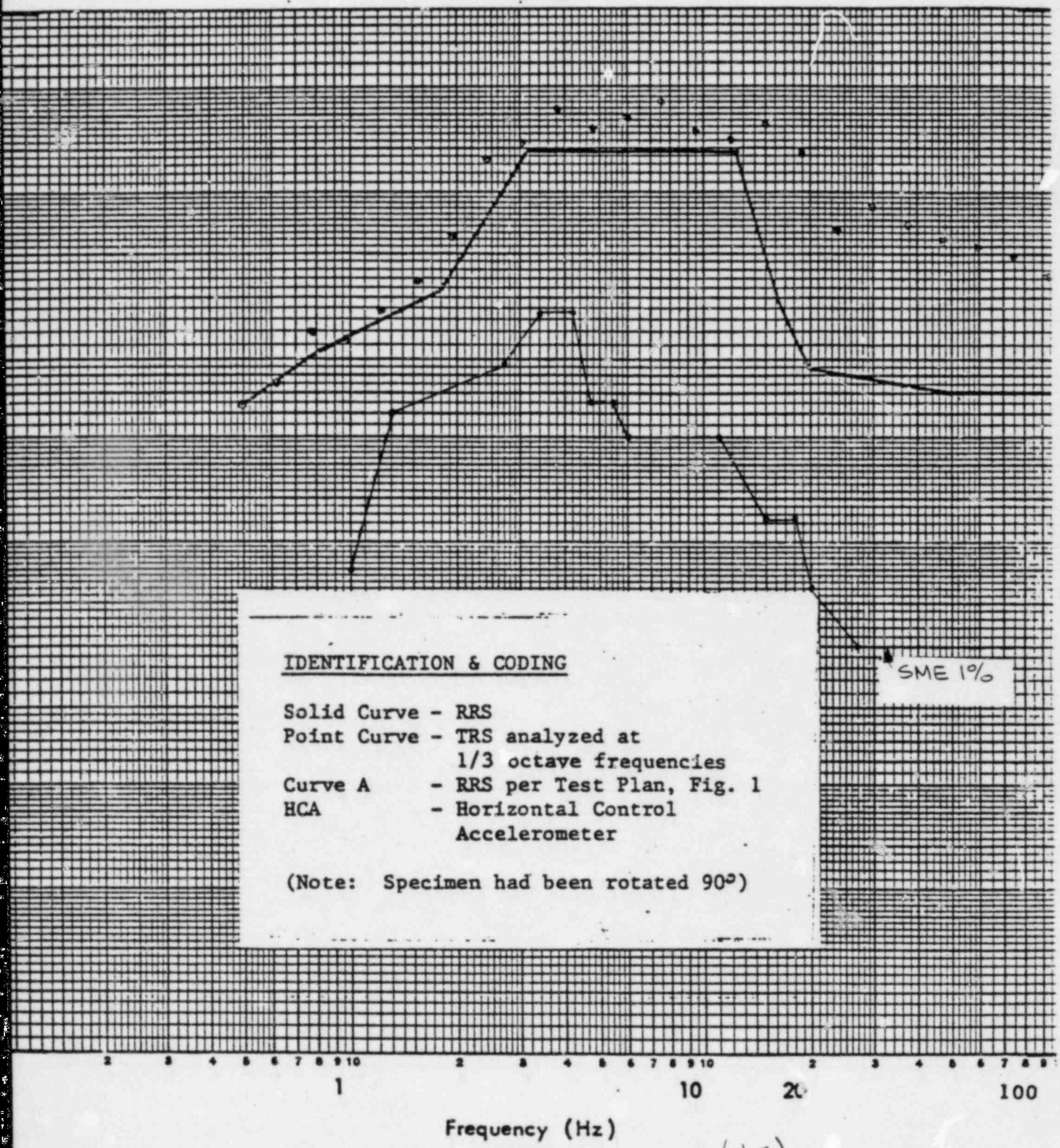
FIGURE VII-A-1-1 TRS VS SME RRS, MOTOR CONTROL CENTERS
NORTH-SOUTH DIRECTION

FULL SCALE SHOCK SPECTRUM (g Peak)

J/N ______
Page ______
Date ______

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 1 %



CUSTOMER ITE
SPECIMEN 5 HK
S/N CURVE A

AXIS (N-S) SS/U
LOCATION NO. HCA
TEST RUN NO. 76

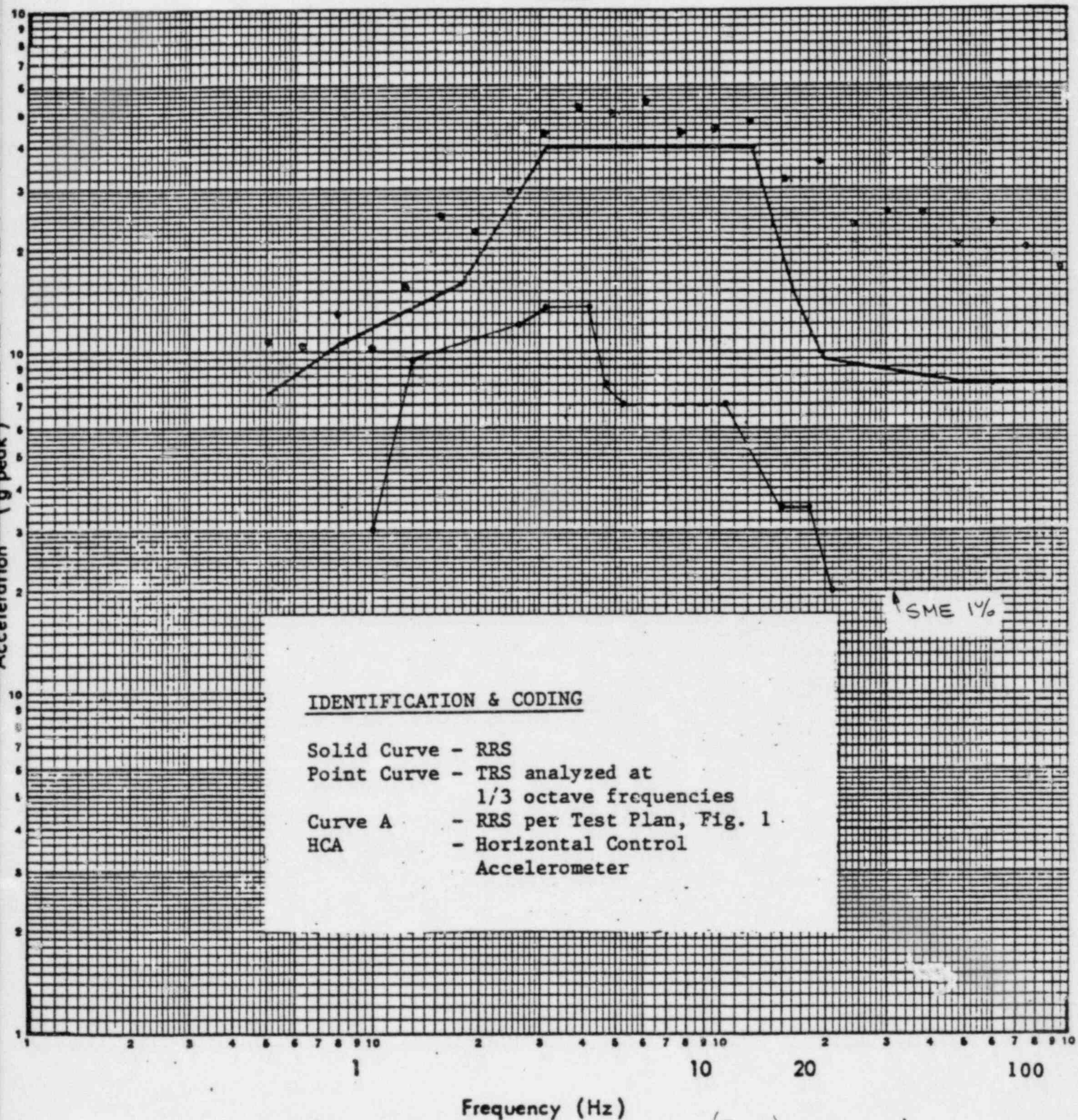
FIGURE VII-A-1-2 TRS VS SME RRS, MOTOR CONTROL CENTERS, EAST-WEST DIRECTION

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

J/N ______
Page ______
Date ______

DAMPING 1%



CUSTOMER ITE

SPECIMEN 5 HK

S/N CURVE A

AXIS (E-W) FB/V

LOCATION NO. HCA

TEST RUN NO. 19

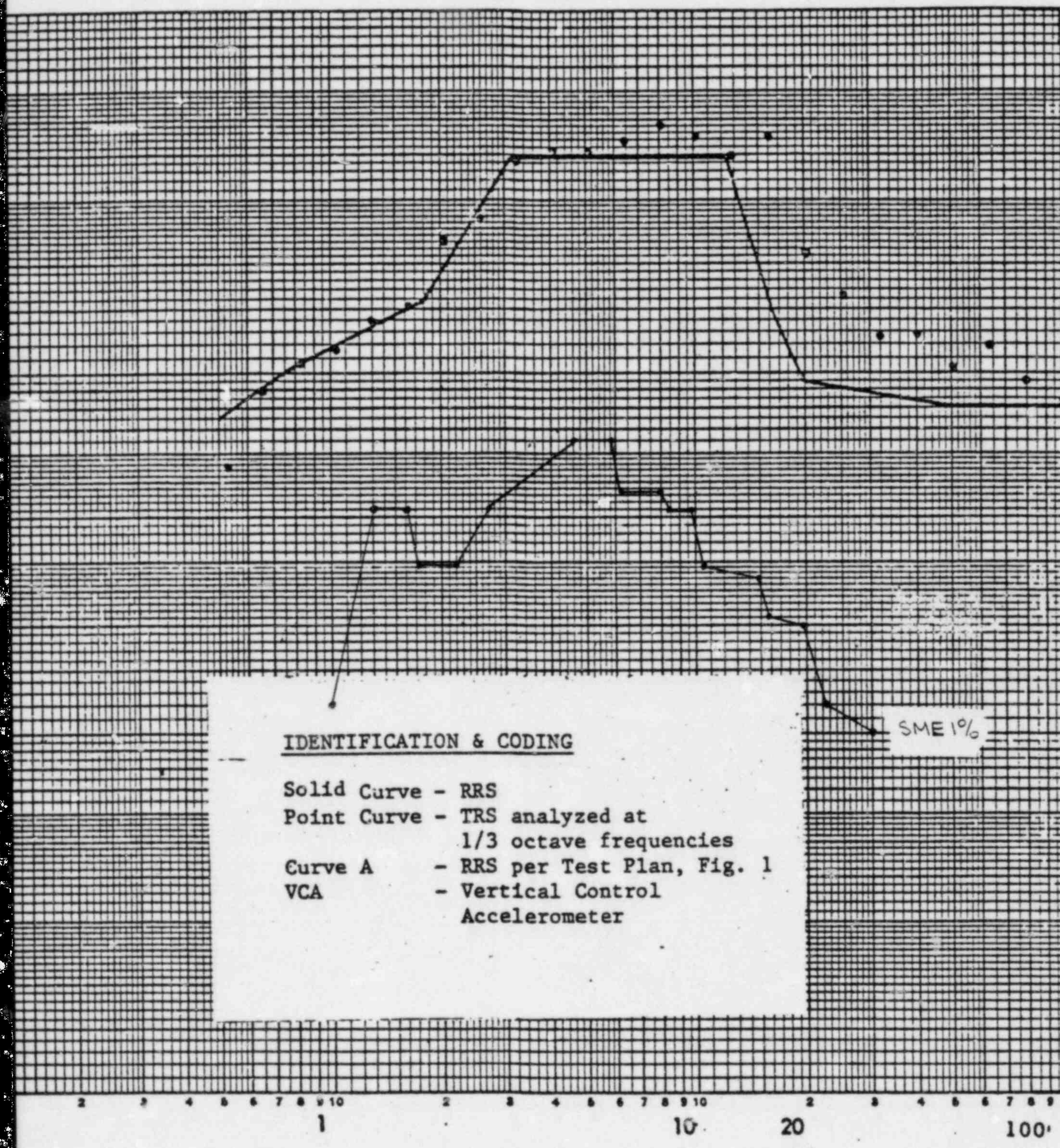
RE VII-A-1-3 TRS VS SME RRS, MOTOR CONTROL CENTERS, VERTICAL DIRECTION

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☒ 100 ☐ 1000 ☐

DAMPING 1%

J/N
Page
Date



CUSTOMER ITE

AXIS FB/V

SPECIMEN 5 HK

LOCATION NO. VCA

S/N CURVE A

TEST RUN NO. 19

Table VII-A-2

SUMMARY OF VENDOR SEISMIC QUALIFICATION

MOTOR CONTROL CENTER OB-45 and OB-46

Table VII-A-2 Motor Control Center OB-45 and OB-46

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Motor Control Centers

1. Scope: ( ) NSSS (X) BOP
2. Model Number: Gould 5600 Series Motor Control Centers
3. Vendor: Gould, Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: Refer to qualification report for list of devices.
5. Physical Description a. Appearance Rectangular cabinets

   b. Dimensions 90" H x 20" W x (Various) L

   c. Weight (Varies)
6. Location: Building: Aux. Bldg, Diesel Gen. Bldg, Service Water Pump Struct.

   Elevation: Varies
7. a. System in which located: Various

   b. Functional Description: Provide 460V power

   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown

   (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:

   Bechtel Spec. 7220 - E-7

III. Equipment Qualfication Method:

(X) Test ( ) Analysis ( ) Combination of Test and Analysis

Qualification Report*: SC-140, Seismic Certification Report for

(No., Title and Date) Class 1E Equipment, July, 1981

Bechtel Document No. : 7220 - E7 - 58 - 11

Company that Prepared Report: Gould, Inc. (Wyle Laboratories)

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg. - Control Tower, El. 685'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

SSE S/S = .27g F/B = .24g V = .13g

6. Were fatigue effects or other vibration loads considered?

( ) Yes (X) No

If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. (X) Single Frequency ( ) Multi-Frequency: ( ) random / (X) sine beat / ( ) ________

2. ( ) Single Axis (X) Multi-Axis

3. No. of Qualification Tests: OBE 15 SSE 29 Other Sine Sweep-2 (specify)

4. Frequency Range: Sine beats at 8.75, 10 & 35 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 10 cps F/B = 8.75 cps V = 35 cps

6. Method of Determining Natural Frequencies

   (X) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test (N/A) Yes (Attach TRS & RRS graph

8. Input g-level Test:

   SSE S/S = 1.55g F/B = 0.88g V = 1.20g

9. Functional operability verified: (X) Yes ( ) No ( ) Not Applicable

10. Test Results including modifications made: The MCC were qualified for the SSE, but a base support angle broke during testing. The welding detail was revised to preclude the same failure.

11. Other test performed (such as aging or fragility test, including results):

    None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

Table VII-A-3

SUMMARY OF VENDOR SEISMIC QUALIFICATION

MOTOR CONTROL CENTERS

B23, B24, B54, B55, B56, B43, B44, B63, B64, B65, B66

B68, B69, B79, B80, B89, B90, Units 1 and 2

Table VII-A-3 Motor Control Centers

B23, B24, B53, B54, B55, B56, B43, B44, B63, B64, B65, B66, B68, B69, B79, B80, B89, B90, Units 1 and 2

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Motor Control Centers

1. Scope: (   ) NSSS   (X) BOP
2. Model Number: Gould 5600 Series Motor Control Centers
3. Vendor: Gould, Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: Refer to qualification report for list of devices.
5. Physical Description a. Appearance Rectangular cabinets
   b. Dimensions 90" H x 20" W x (Various) L
   c. Weight (Varies)
6. Location: Building: Aux. Bldg., Diesel Gen. Bldg., Service Water Pump Structure
   Elevation: Varies
7. a. System in which located: Various
   b. Functional Description: Provide 460V power
   c. Is the equipment required for (   ) Hot Shutdown (   ) Cold Shutdown (X) Both (   ) Neither
8. Pertinent Reference Design Specifications: Bechtel Spec. 7220-E-7

III. Equipment Qualfication Method:

(X) Test ( ) Analysis ( ) Combination of Test and Analysis

Qualification Report*: SC-140, Seismic Certification Report for

(No., Title and Date) Class IE Equipment, July, 1981

Bechtel Document No. : 7220-E7-58-11

Company that Prepared Report: Gould, Inc. (Wyle Laboratories)

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Varies

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .27g F/B = .27g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. ( ) Single Frequency (X) Multi-Frequency: (X) random ( ) sine beat ( ) ________

2. ( ) Single Axis (X) Multi-Axis

3. No. of Qualification Tests: OBE 15 SSE 11 Other Sine Sweep - 3 (specify)

4. Frequency Range: 1-50 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 10 cps F/B = 8.75 cps V = 35 cps

6. Method of Determining Natural Frequencies

   (X) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test (X) Yes (Attach TRS & RRS grap

8. Input g-level Test:

   SSE S/S = 2.95g F/B = 2.1g V = 1.1g

9. Functional operability verified: (X) Yes ( ) No ( ) Not Applicable

10. Test Results including modifications made: The MCC were qualified for the SSE but a base support angle broke during testing. The welding detail was revised to preclude the same failure.

11. Other test performed (such as aging or fragility test, including results):

    None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

FIGURE VII-A-3-1 TRS VS SME RRS FOR MOTOR CONTROL CENTERS
NORTH-SOUTH DIRECTION

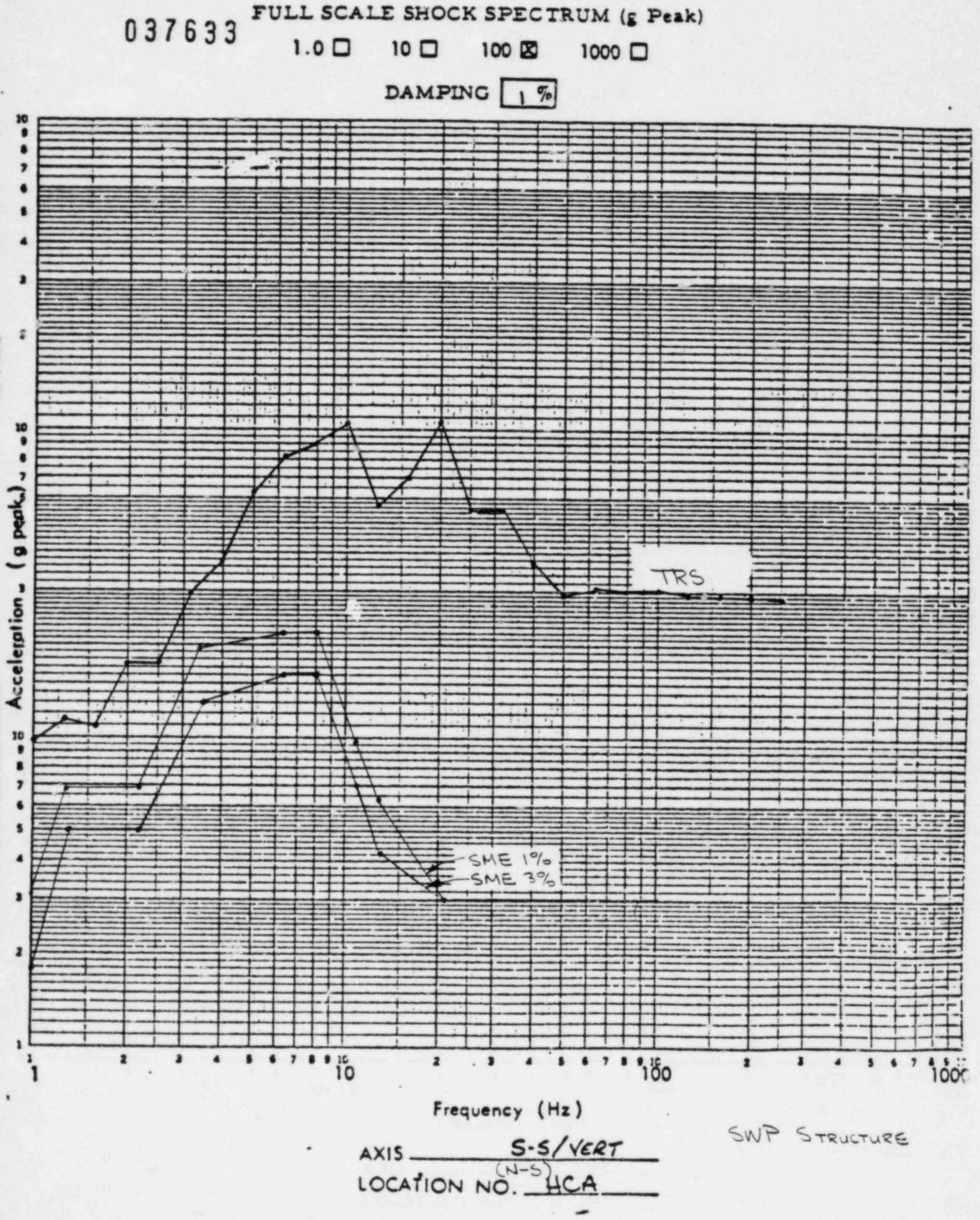


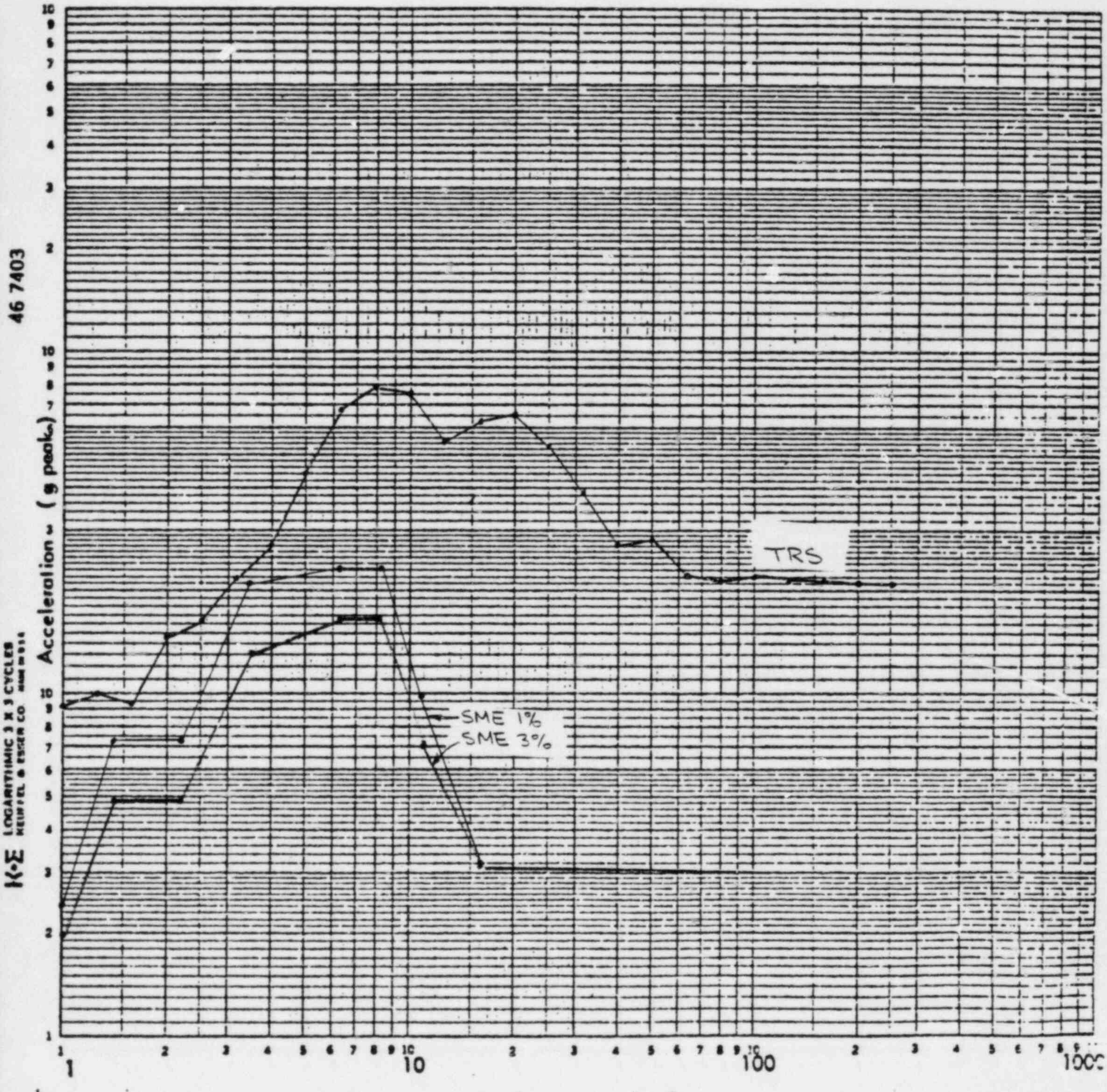
FIGURE VII-A-3-2 TRS VS SME RRS FOR MOTOR CONTROL CENTERS EAST-WEST DIRECTION

037633

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING [1 %]



AXIS F-B/VERT (E-W)

LOCATION NO. HCA

TEST RUN NO 16

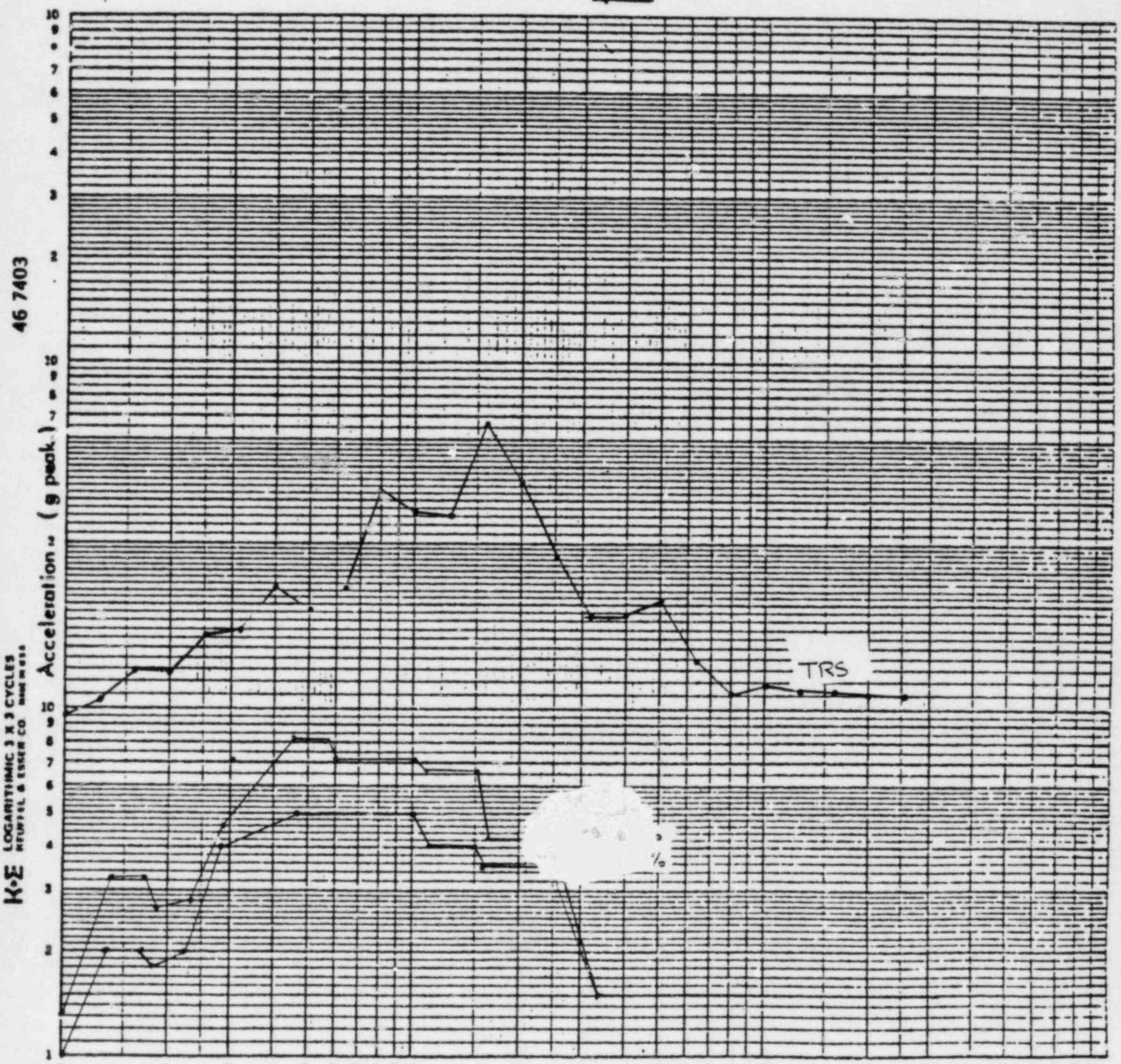
SWP STRUCTURE

FIGURE VII-A-3-3 TRS VS SME RRS FOR MOTOR CONTROL CENTERS
VERTICAL DIRECTION

037633 FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING [1 %]



AXIS F-B / VERT

LOCATION NO. VCB

Table VII-A-4

SUMMARY OF VENDOR SEISMIC QUALIFICATION

125 VOLT DC BATTERIES AND RACKS

Table VII-A-4 125 Volt DC Batteries and Racks

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name:

1. Scope: ( ) NSSS (X) BOP
2. Model Number: Type GN Batteries & High Seismic Racks
3. Vendor: Exide Power Systems Division
4. If the component is a cabinet or panel, name and model No. of the devices included: NA
5. Physical Description a. Appearance 16 Battery cells on a two-step rack
   b. Dimensions 12'-0" L x 49" W x 35" H
   c. Weight Approx. 10,000 lbs.
6. Location: Building: Aux. Bldg. - Control Tower
   Elevation: 614'-0"
7. a. System in which located: Various
   b. Functional Description: Provides emergency stand-by DC power
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   Bechtel Spec 7220-E-12

BATTERY RACK

III. Equipment Qualfication Method:

( ) Test ( ) Analysis (X) Combination of Test and Analysis

(Rack) Qualification Report*: No. A-5-80 to A-7-80, Qual. Reports for Exide
(No., Title and Date) "G" Size, Two Step High Seismic Battery Racks, May, 1980

Bechtel Document No. : 7220-E-12-83-3

Company that Prepared Report: Flight Dynamics, Inc.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only
   b. ( ) Hydrodynamic only
   c. ( ) Combination of (a) and (b)
2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)
3. Required Response Spectra : Aux. Bldg. - Control Tower, El. 614'-0"
4. Damping Corresponding to RRS: OBE 1% SSE 1%
5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

DESIGN VALUES (ZPA)

SSE S/S = 1.0 g F/B = 1.0 g V = 0.75g

6. Were fatigue effects or other vibration loads considered?

( ) Yes (X) No

If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. ( ) Single Frequency (X) Multi-Frequency: (X) random ( ) sine beat ( ) ________

2. ( ) Single Axis (X) Multi-Axis

3. No. of Qualification Tests: OBE 10 SSE 2 Other Sine Sweep-3 (specify)

4. Frequency Range: 1-40 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 8.5 cps F/B = 12.0 cps V = 26 cps

6. Method of Determining Natural Frequencies

   (X) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test (X) Yes (Attach TRS & RRS grap

8. Input g-level Test:

   SSE S/S = 4.5 g F/B = 4.5g V = 3.5g

9. Functional operability verified: ( ) Yes ( ) No (X) Not Applicable

10. Test Results including modifications made: Test results were used for comparison with analytical results. The frequency correlations were very good

11. Other test performed (such as aging or fragility test, including results):

    None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

   ( ) Static Analysis ( ) Equivalent Static Analysis

   (x) Dynamic Analysis: ( ) Time-History (X) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 7.6 cps F/B = 10.41 cps V = 22.12 cps

3. Model Type: (X) 3D ( ) 2D ( ) 1D

   (X) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (x) Computer Codes: SAP IV

   Frequency Range and No. of modes considered: 7.6 - 35 cps, 60 modes

   ( ) Hand Calculations: ________

5. Method of Combining Dynamic Responses: ( ) Absolute Sum (X) SRSS

   ( ) Other: ________ (specify)

6. Damping: OBE — SSE 1% Basis for the damping used: Bechtel Spec. requirement

7. Support Considerations in the model: Pinned supports at anchor bolt locations.

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
L3x2½x¼ (Support Angle)		D+E'		.9736	1.0

(Total Stress / Stress Allowable: combined stresses criteria)

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
N.A.		

BATTERIES

III. Equipment Qualfication Method:

(X) Test ( ) Analysis ( ) Combination of Test and Analysis

(Battery)
Qualification Report*: No. 45001-1, NEQ Program on Type GN Lead
(No., Title and Date) Acid Electrical Storage Batteries, Nov. 30, 1981

Bechtel Document No. : 7220-E-12-89-1

Company that Prepared Report: Wyle Laboratories

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) NA (Other, specify)

3. Required Response Spectra : Aux. Bldg - Control Tower, El. 614'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = 1.0 g F/B = 1.0 g V = 1.0 g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. ( ) Single Frequency (X) Multi-Frequency: (X) random; ( ) sine beat; ( ) ________

2. ( ) Single Axis (X) Multi-Axis

3. No. of Qualification Tests: OBE 10 SSE 2 Other Sine Sweep-3 (specify)

4. Frequency Range: 1 - 40 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 11.0 cps F/B = 16.0 cps V = 33 cps

6. Method of Determining Natural Frequencies

   (X) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test (X) Yes (Attach TRS & RRS grap

8. Input g-level Test:

   SSE S/S = 1.9g F/B = 2.3g V = 2.35g

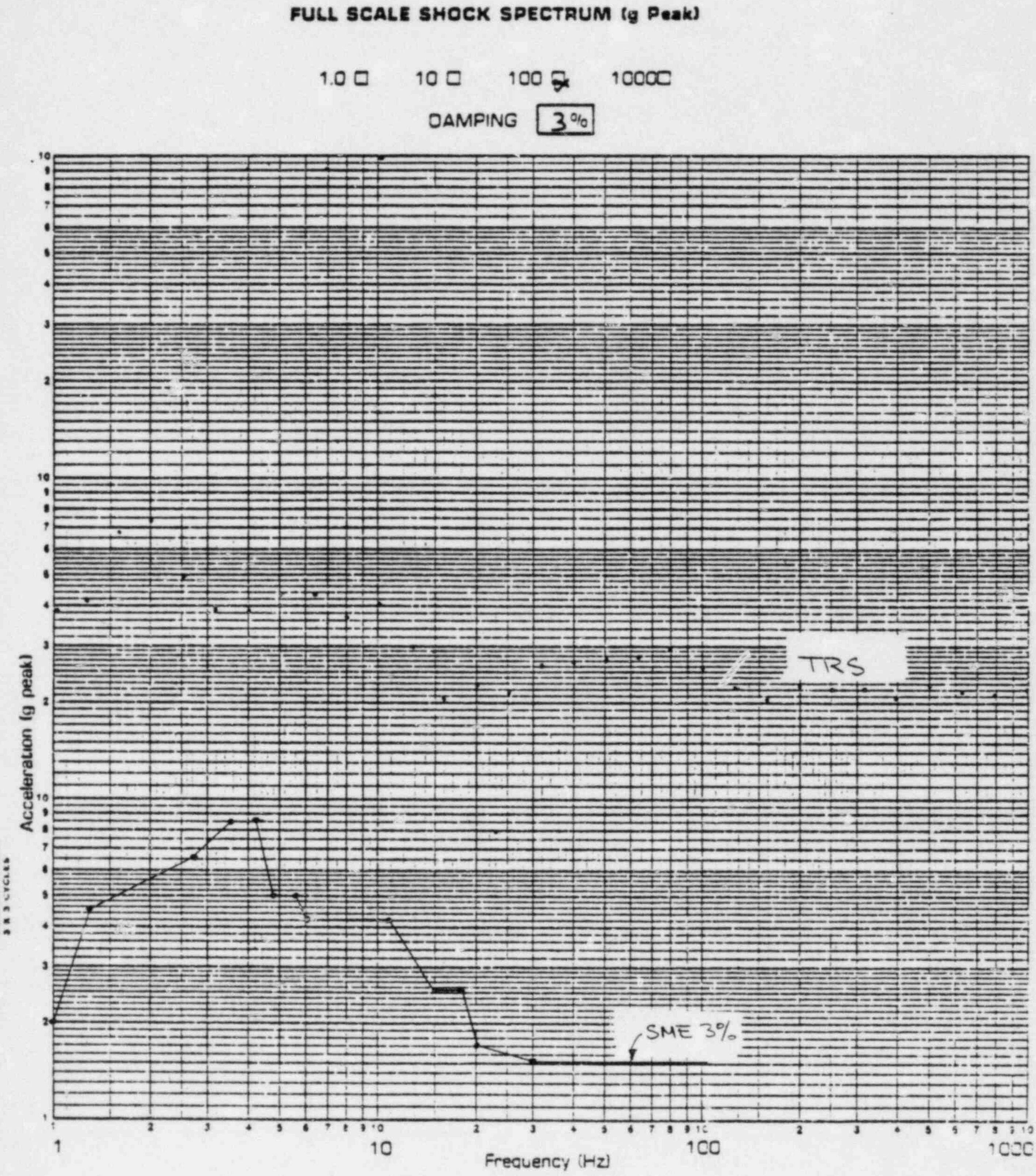
9. Functional operability verified: (X) Yes ( ) No ( ) Not Applicable

10. Test Results including modifications made: The battery and rack will withstand the SSE, both functionally and structurally.

11. Other test performed (such as aging or fragility test, including results): Radiation Exposure and Thermal Aging - batteries were aged to 10, 15 and 20 years. The 20 year batteries were used in the seismic testing and were qualified.

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

FIGURE VII-A-4-1 TRS VS SME RRS, 125 V DC BATTERIES
NORTH-SOUTH DIRECTION



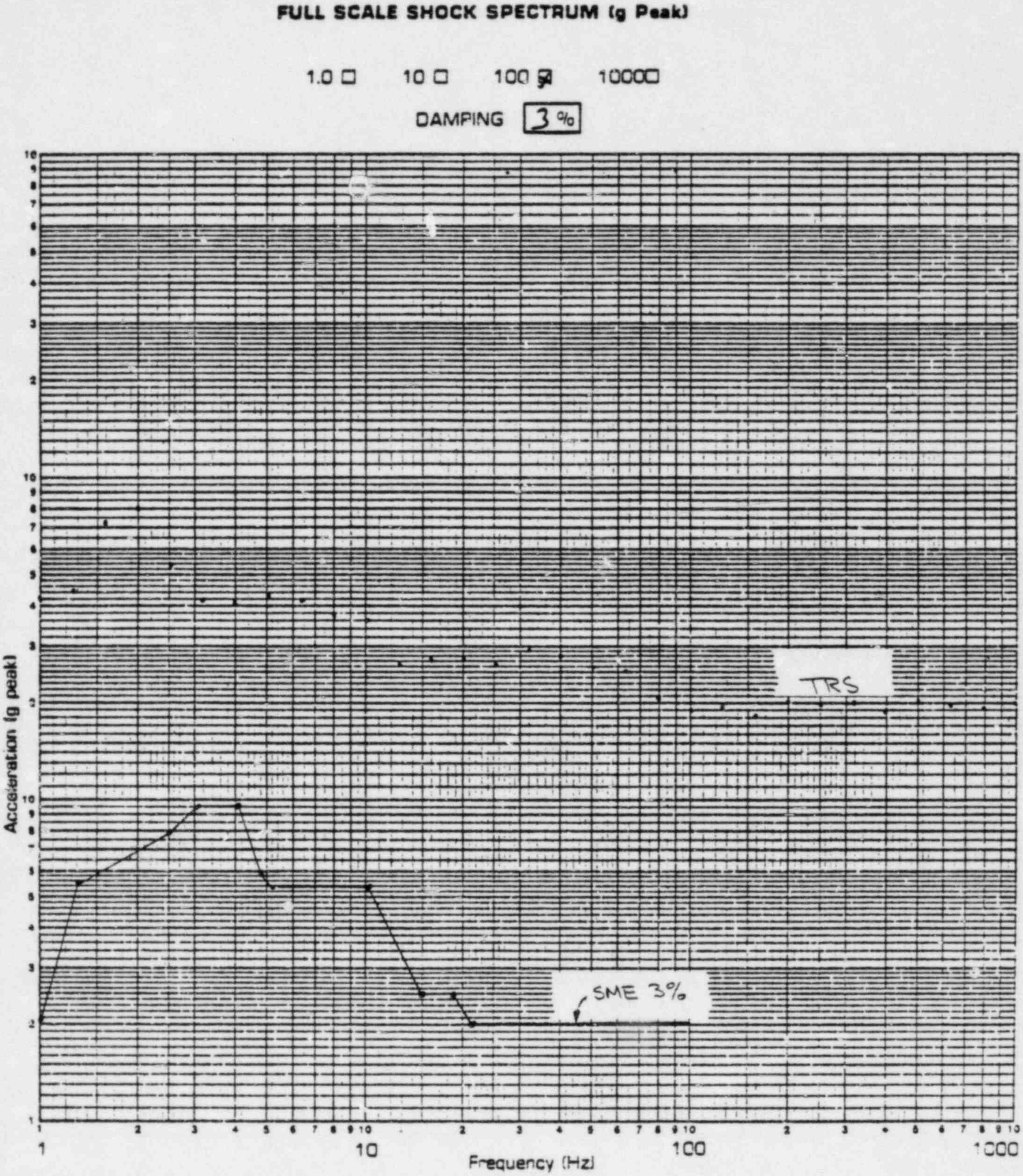
LOCATION NO. HCA

AXIS FB/V (N-S)

TEST RUN NO. 9

7220-512-89-1

FIGURE VII-A-4-2 TRS VS SME RRS, 125 V DC BATTERIES
EAST-WEST DIRECTION



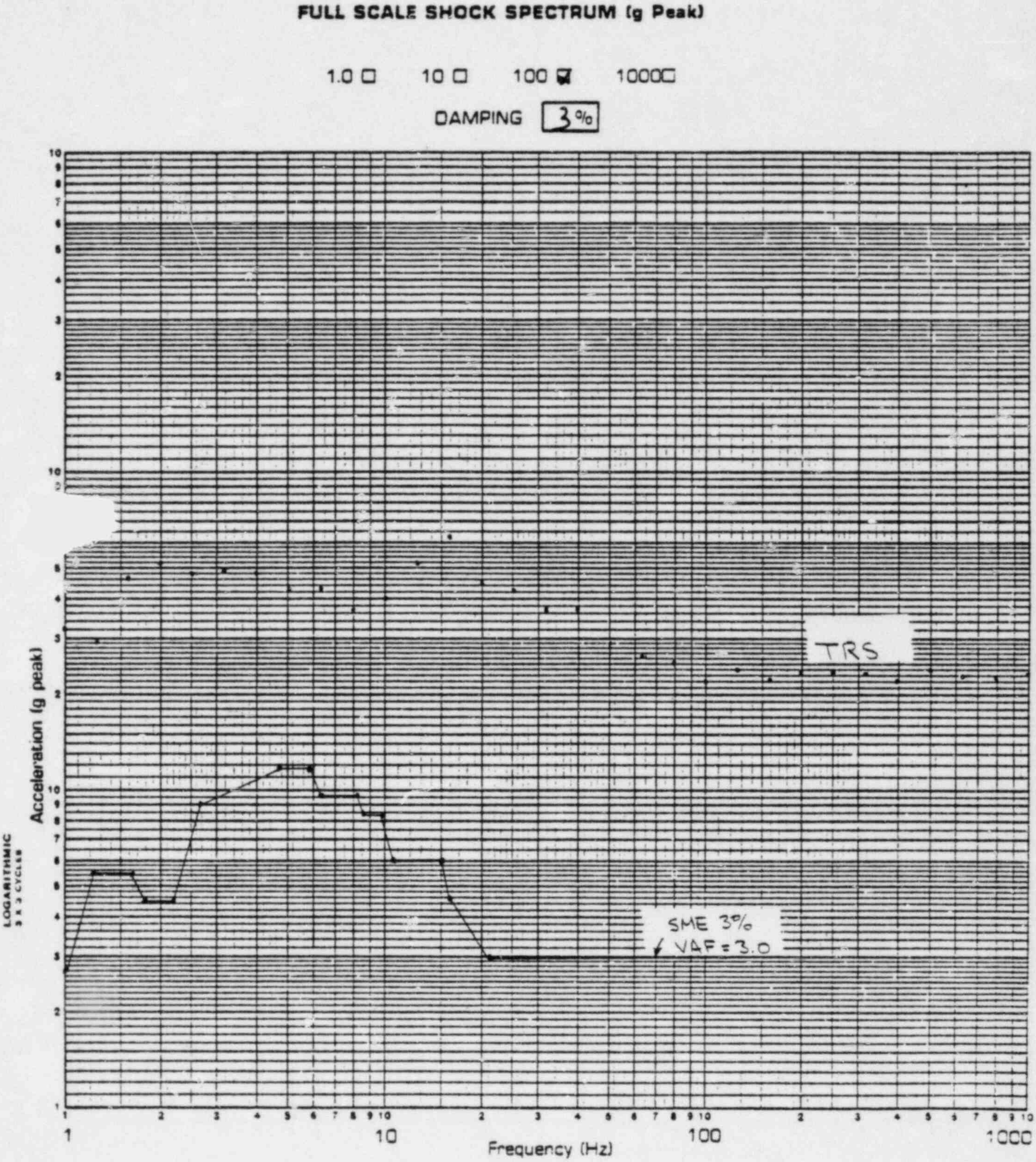
LOCATION NO. HCA

AXIS SS/V (E-W)

TEST RUN NO. 16

7220-E12-89-1

FIGURE VII-A-4-3 TRS VS SME RRS, 125 V DC BATTERIES
VERTICAL DIRECTION



LOCATION NO. VCA

AXIS FB/V

TEST RUN NO. 9

7220-E12-89-1

Table VII-A-5-1

SUMMARY OF VFNDOR SEISMIC QUALIFICATION

DIESEL ENGINE AND AUXILIARIES 1G-11, 1G-12, 2G-11, 2G-12

Table VII-A-5-1 Diesel Engine and Auxiliaries 1G-11, 1G-12, 2G-11, 2G-12

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Diesel Engine and Auxiliaries

1. Scope: ( ) NSSS (X) BOP
2. Model Number: DSRV-12-4 Diesel Generator Set
3. Vendor: Delaval Turbine Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Diesel Engine
   b. Dimensions Approx. 161"L X 136"W X 113"H
   c. Weight Approx. 200,000 lbs.
6. Location: Building: Diesel Generator Building
   Elevation: 634'-6"
7. a. System in which located: Emergency AC Power
   b. Functional Description: Provides emergency power to equipment required for safe shutdown.
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   Bechtel Spec. 7220-M18

III. Equipment Qualfication Method:

( ) Test ( ) Analysis (X) Combination of Test and Analysis

Qualification Report*: Final Report Volume I, Seismic Qualification of
(No., Title and Date) Delaval Turbine Inc., Diesel Generator Sets, May, 1978

Bechtel Document No. : 7220-M18-370-3

Company that Prepared Report: Structural Dynamics Research Corp.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only
   b. ( ) Hydrodynamic only
   c. ( ) Combination of (a) and (b)
2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)
3. Required Response Spectra: Diesel Generator Bldg. El. 634'-6" & 664'-0"
4. Damping Corresponding to RRS: OBE 1% SSE 1%
5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .12g F/B = .12g V = .08g
6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*: (Engine)

1. (x) Single Frequency ( ) Multi-Frequency: ( ) random ( ) sine beat ( ) ________

2. (x) Single Axis ( ) Multi-Axis

3. No. of Qualification Tests: OBE ________ SSE ________ Other Resonance Search-1 (specify)

4. Frequency Range: 1- 40 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = — F/B = 10 cps ** V = —

6. Method of Determining Natural Frequencies

(X) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test (N/A) Yes (Attach TRS & RRS graph

8. Input g-level Test:

SSE S/S = ________ F/B = ________ V = ________

9. Functional operability verified: ( ) Yes ( ) No (X) Not Applicable

10. Test Results including modifications made: Engine block behaves as a rigid body during seismic excitation

11. Other test performed (such as aging or fragility test, including results):

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

** Engine responded as rigid body. 10 Hz mode was due to mounting skid flexibility. For installation at Midland, a skid is not used. Engine and foundation were shown by analysis to have a fundamental frequency in excess of 40 Hz.

V. If Qualification by Test, then Complete*: (Engine Appendages) (X) random

1. ( ) Single Frequency (X) Multi-Frequency: ( ) sine beat
   ( ) ________

2. ( ) Single Axis (X) Multi-Axis

3. No. of Qualification Tests: OBE 10 SSE 2 Other ________ (specify)

4. Frequency Range: 1-40 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical): Varies for each component. Most are above 33cps.
   S/S = ________ F/B = ________ V = ________

6. Method of Determining Natural Frequencies
   (X) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test (X) Yes (Attach TRS & RRS graph

8. Input g-level Test: Greater than 1.5g in all directions
   SSE S/S = ________ F/B = ________ V = ________

9. Functional operability verified: (X) Yes ( ) No ( ) Not Applicable

10. Test Results including modifications made: All components were qualified functionally and structurally

11. Other test performed (such as aging or fragility test, including results):
   None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

** All appendages had fundamental frequencies above 33 Hz except Turbocharger, Fuel Filter and Lube Oil Strainer, Those components were modified to increase frequency above 33 Hz.

VI. If Qualification by Analysis, then complete: (Engine)

1. Method of Analysis:

   ( ) Static Analysis (X) Equivalent Static Analysis (Bolts)

   (X) Dynamic Analysis: ( ) Time-History ( ) Response Spectrum
   (Determined engine natural frequency on concrete foundation)

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = – F/B = 42 cps V = –

3. Model Type: (X) 3D ( ) 2D ( ) 1D

   (X) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (X) Computer Codes: ANSYS

   Frequency Range and No. of modes considered: –

   ( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: ( ) Absolute Sum (X) SRSS

   ( ) Other: ______ (specify)

6. Damping: OBE 1% SSE 1% Basis for the damping used: Per Bechtel Spec.

7. Support Considerations in the model: Pinned supports at anchor bolts

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Anchor Bolt		Normal + E'	7409 psi	*	60,000 psi
			3095 psi	*	34,000 psi

* operational loads not given.

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability

Table VII-A-5-2

SUMMARY OF VENDOR SEISMIC QUALIFICATION

NEUTRAL GROUNDING CABINET

Table VII-A-5-2 NEUTRAL GROUNDING CABINET

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Neutral Grounding Cabinet

1. Scope: ( ) NSSS (X) BOP
2. Model Number: "none"
3. Vendor: Delaval Turbine Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: Not given
5. Physical Description a. Appearance Rectangular cabinet
   b. Dimensions Not specified in test report
   c. Weight Not specified in test report
6. Location: Building: Diesel Generator Building
   Elevation: El. 652"-0"
7. a. System in which located: Emergency AC Power
   b. Functional Description:
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   Bechtel Spec. 7220-M18

III. Equipment Qualfication Method:

(X) Test ( ) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 58203, Seismic Testing of One Neutral
(No., Title and Date) Grounding Cabinet and One Generator Control Panel April, 1978.

Bechtel Document No. : 7220 - M18 - 371-3

Company that Prepared Report: Wyle Laboratories

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only
   b. ( ) Hydrodynamic only
   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Diesel Gen. Bldg - El. 664'0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .12g F/B = .12g V = .08g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. ( ) Single Frequency (X) Multi-Frequency: (X) random / ( ) sine beat / ( ) ______

2. ( ) Single Axis (X) Multi-Axis

3. No. of Qualification Tests: OBE 12 SSE 3 Other Sine Sweep-3 (specify)

4. Frequency Range: 1-35 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 10 cps F/B = 9 cps V = 15cps

6. Method of Determining Natural Frequencies

   (X) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test ( ) Yes (Attach TRS & RRS graph

8. Input g-level Test:

   SSE S/S = .65g F/B = .80g V = .30g

9. Functional operability verified: ( ) Yes (X) No ( ) Not Applicable

10. Test Results including modifications made: Cabinet was structurally qualified.

11. Other test performed (such as aging or fragility test, including results):

    None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

FIGURE VII-A-5-2-1 TRS VS SME RRS, NEUTRAL GROUNDING CABINET NORTH-SOUTH DIRECTION

WYLE LABORATORIES

Report No. 58203

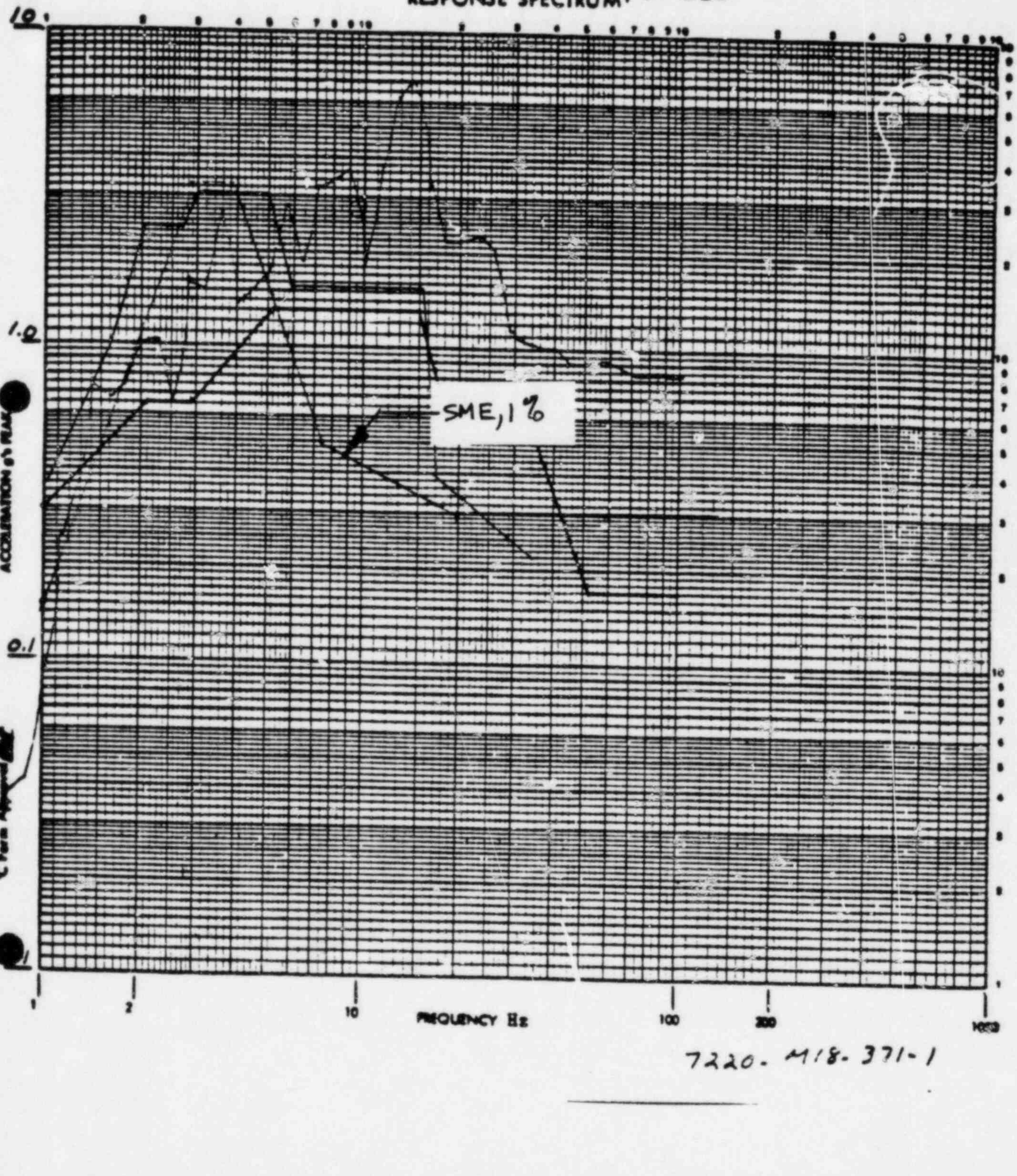
CUSTOMER DELAVAL Job No. 58203 Page No. 51

Full Scale 10 g Accel. No. 1 Control (✓) Response ( )

Operator MEEHAN Specimen NEUTRAL GROUNDING CABINET

Date 4-3-79 Damping 1 % Axis of Test 2-Y HORIZ

RESPONSE SPECTRUM 1ST SSE



7220-M18-371-1

FIGURE VII-A-5-2-2 TRS VS SME RRS, NEUTRAL GROUNDING CABINET EAST-WEST DIRECTION

WYLE LABORATORIES

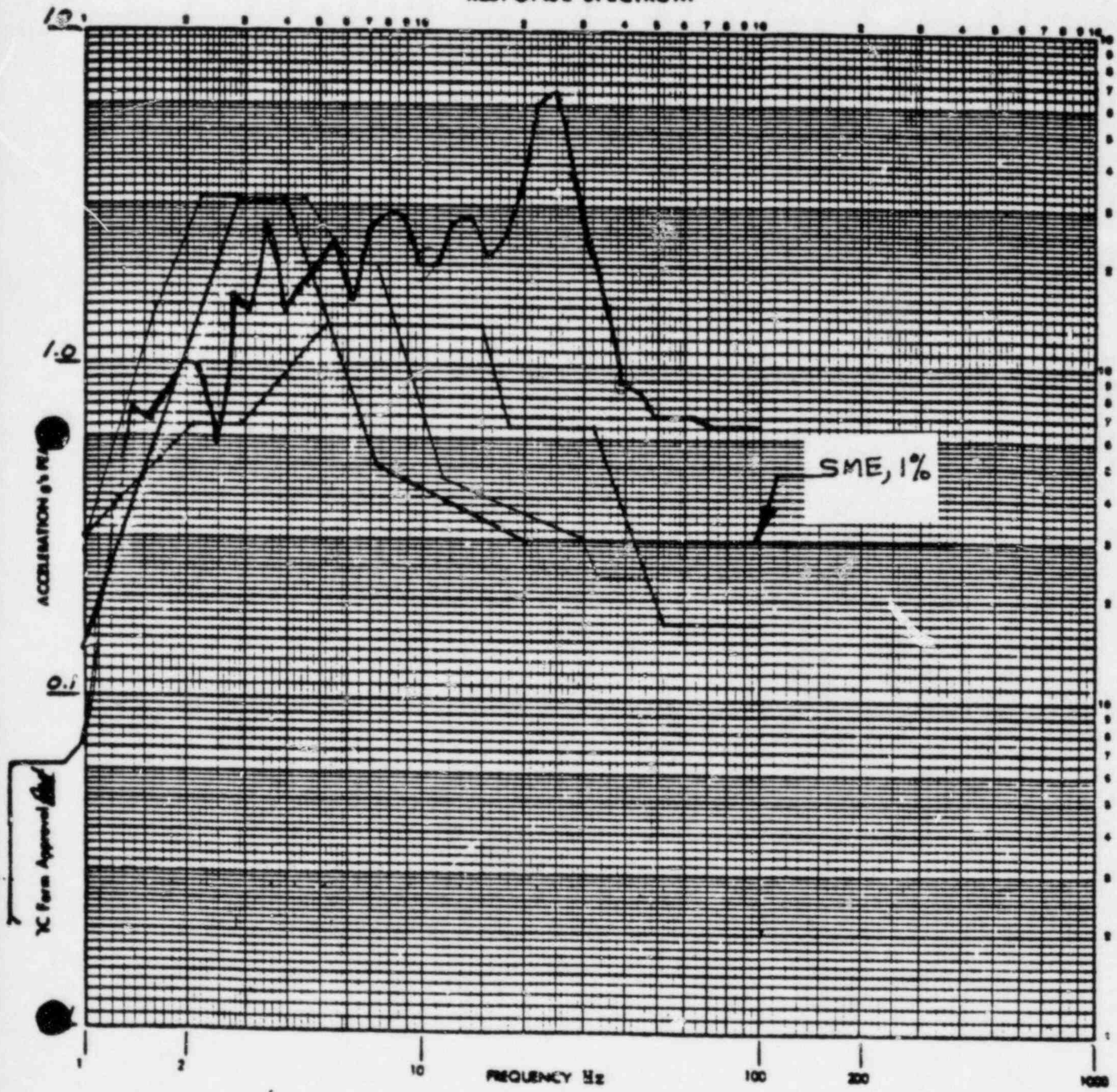
Report No. 58285

CUSTOMER DELAVAL Job No. 58203 Page No. 33

Full Scale 10 g Accel. No. 1 Control (✓) Response ( )

Operator MEEHAN Specimen NEUTRAL GROUNDING CABINET

Date 4-3-78 Damping 1 % Axis of Test (X) Y HORIZ



7220-M18-371-1

FIGURE VII-A-5-2-3 TRS VS SME RRS, NEUTRAL GROUNDING CABINET VERTICAL DIRECTION

WYLE LABORATORIES

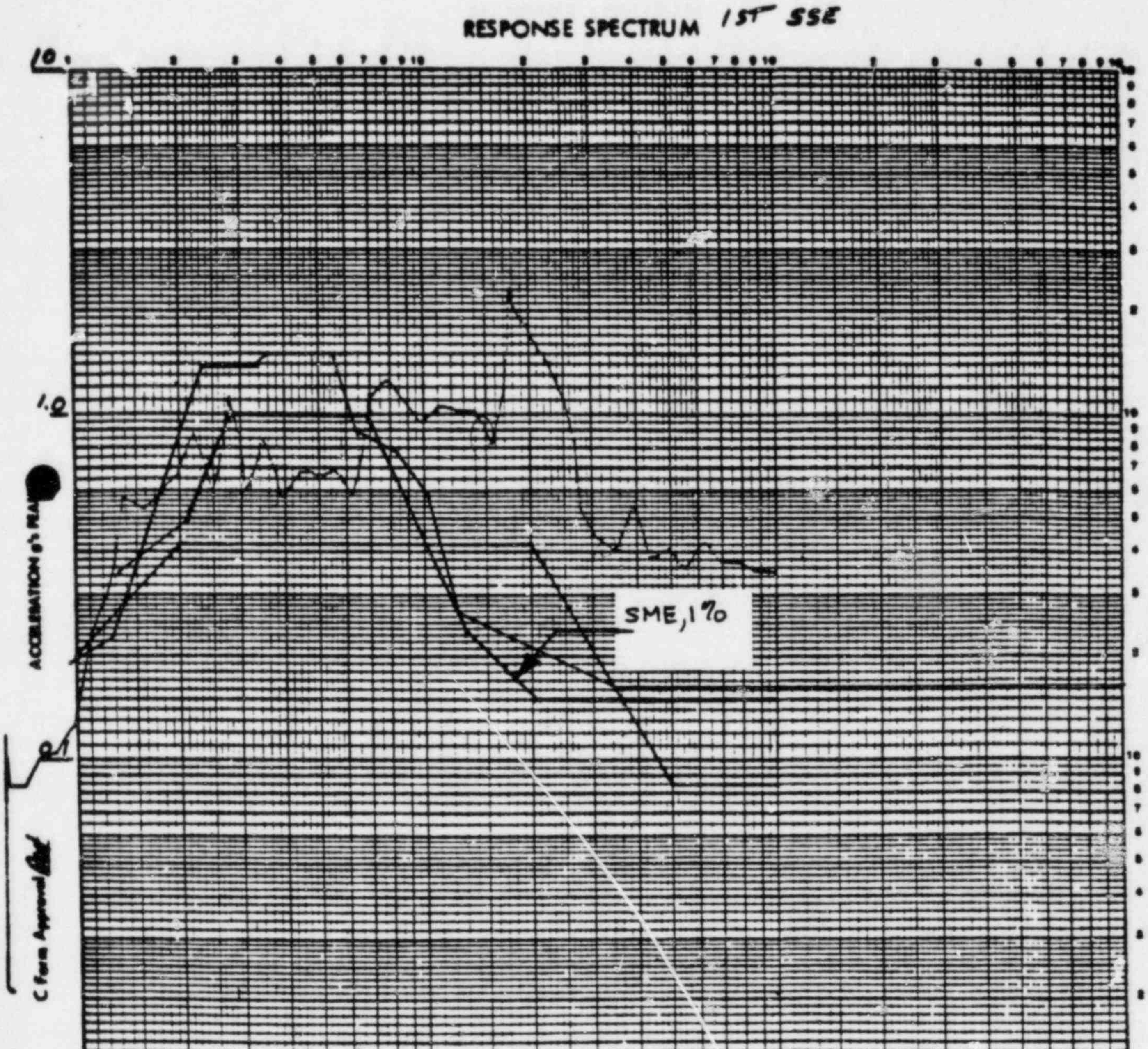
Report No. 58203

CUSTOMER DELAVAL Job No. 58203 Page No. 34

Full Scale 10 g Accel. No. 2 Control (→) Response ( )

Operator MEEHAN Specimen NEUTURAL GROUNDING CABINET

Date 4-3-79 Damping 1 % Axis of Test X-Y VERT



7220 M.8-371-1

Table VII-A-5-3

SUMMARY OF VENDOR SEISMIC QUALIFICATION

GENERATOR CONTROL PANEL

Table VII-A-5-3 Generator Control Panel

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Generator Control Panel

1. Scope: ( ) NSSS (x) BOP
2. Model Number: "none"
3. Vendor: Delaval Turbine Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: Not given
5. Physical Description a. Appearance Rectangular cabinet
   b. Dimensions Not delineated in qualification report
   c. Weight not delineated in qualification report
6. Location: Building: Diesel Generator Building
   Elevation: 634'-6"
7. a. System in which located: Emergency AC Power
   b. Functional Description:
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown
   (x) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   Bechtel Spec. 7220-M18

III. Equipment Qualfication Method:

(X) Test ( ) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 58203, Seismic Testing of One Neutral

(No., Title and Date) Grounding Cabinet and One Generator Control Panel April, 1978.

Bechtel Document No. : 7220 - M18 - 371 - 3

Company that Prepared Report: Wyle Laboratories

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Diesel Gen. Bldg - El. 634'-6"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .12g F/B = .12g V = .08g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. ( ) Single Frequency (×) Multi-Frequency: (×) random ( ) sine beat ( ) ________

2. ( ) Single Axis (×) Multi-Axis

3. No. of Qualification Tests: OBE 12 SSE 6 Other Sine Sweep-3 (specify)

4. Frequency Range: 1-35 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = 7cps F/B = 9cps V = 14cps

6. Method of Determining Natural Frequencies

(×) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test (×) Yes (Attach TRS & RRS grap at panel's fundamental frequencies

8. Input g-level Test: ZPA

SSE S/S = .52g F/B = .60g V = .27g

9. Functional operability verified: (×) Yes ( ) No ( ) Not Applicable

10. Test Results including modifications made: Cabinet was structurally and functionally qualified.

11. Other test performed (such as aging or fragility test, including results): None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

FIGURE VII-A-5-3-1 TRS VS SME RRS, GENERATOR CONTROL PANEL NORTH-SOUTH DIRECTION

WYLE LABORATORIES

Report No. 58203

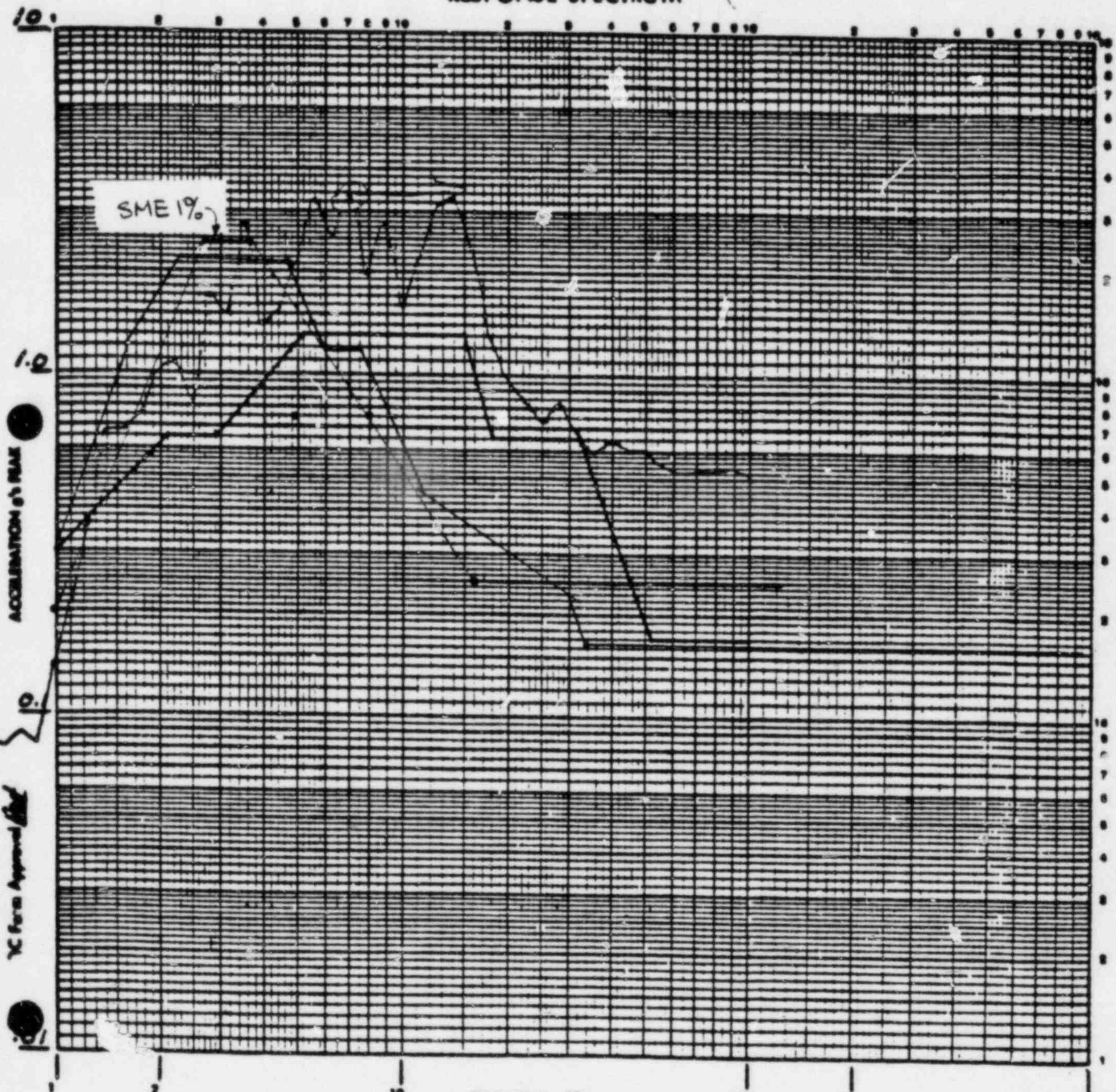
CUSTOMER DELAVAL Job No. 58203 Page No. 77

Full Scale 10 g Accel. No. 1 Control (✓) Response ( )

Operator MEEHAN Specimen GENERATOR CONTROL PANEL

Date 4-1-78 Damping 1 % Axis of Test (X)-Y HORIZ (N-S)

RESPONSE SPECTRUM of 1 (SSE)



7220-M18-371-1

FIGURE VII-A-5-3-2 TRS VS SME RRS, GENERATOR CONTROL PANEL
EAST-WEST DIRECTION

WYLE LABORATORIES

Report No. 58203

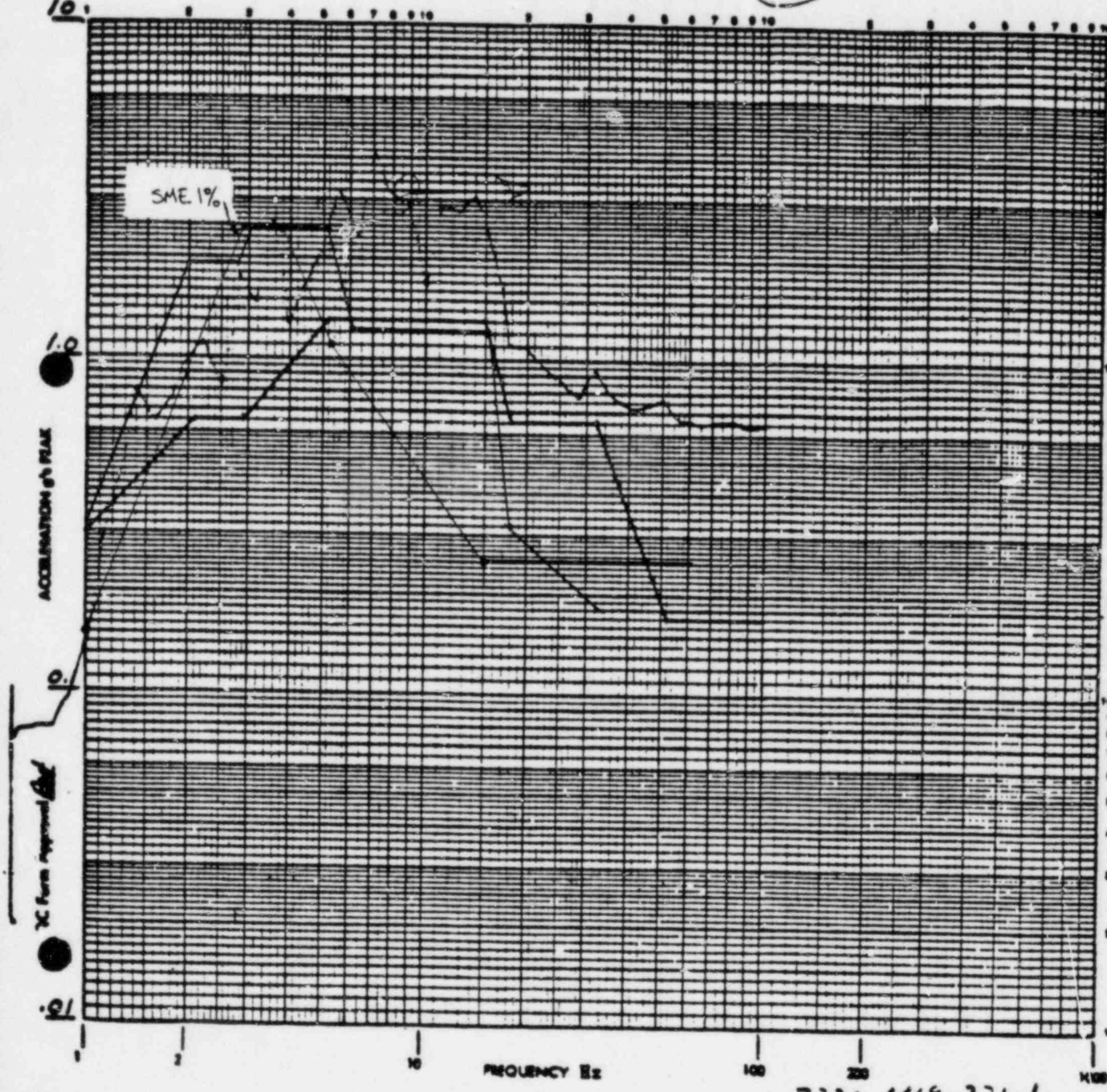
CUSTOMER DELAVAL ____ Job No. 58203 Page No. 113

Full Scale 10 g Accel. No. 1 Control ( ) Response ( )

Operator MEEHAN Specimen GENERATOR CONTROL PANEL

Date 4-1-78 Damping 1 % Axis of Test Z-Y
HORIZ (E-W)

RESPONSE SPECTRUM #3 SSE



7220-M18-371-1

FIGURE VII-A-5-3-3 TRS VS SME RRS, GENERATOR CONTROL PANEL VERTICAL DIRECTION

WYLE LABORATORIES Report No. 58203

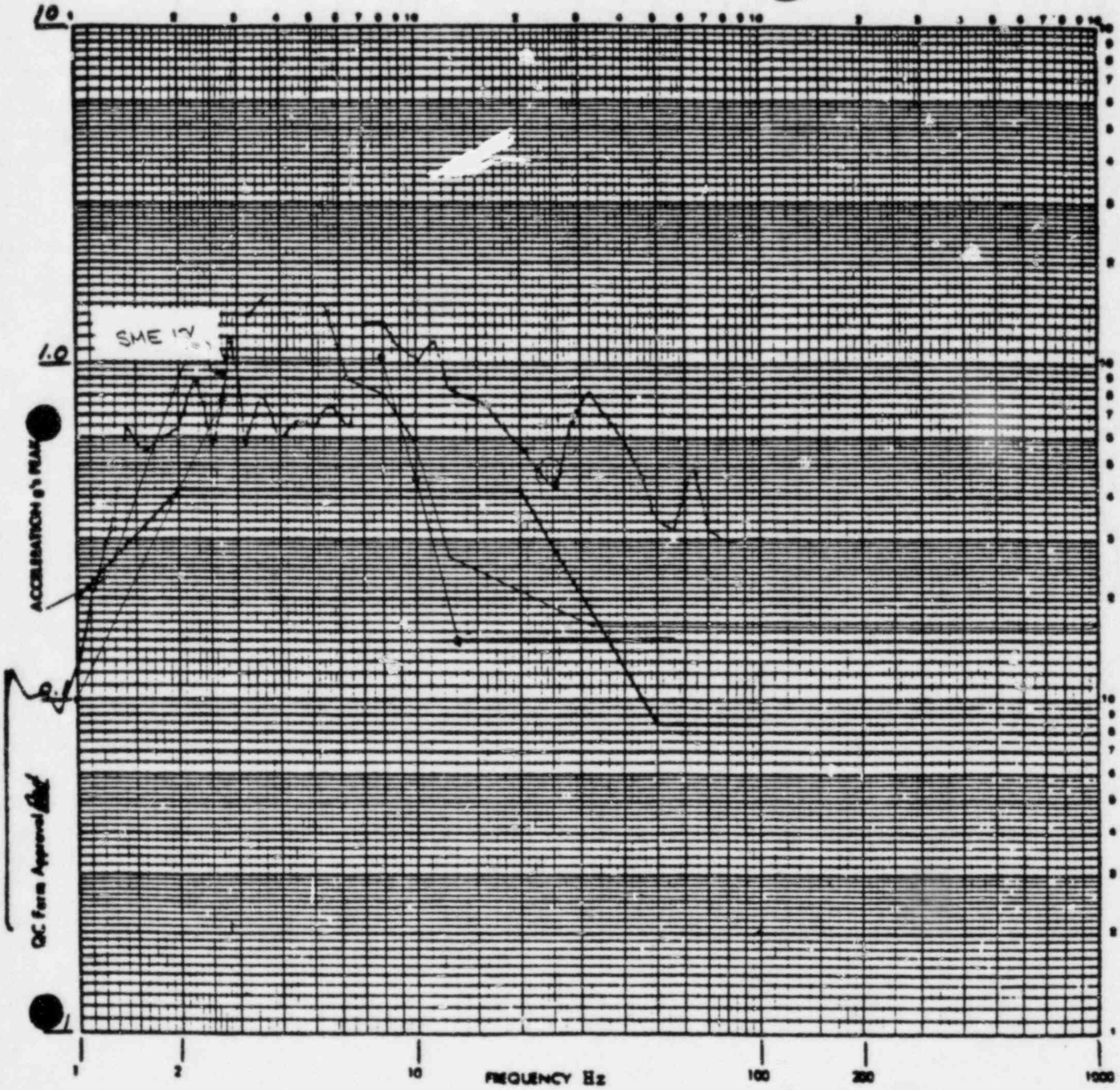
CUSTOMER DELAVAL Job No. 58203 Page No. 78

Full Scale 10 g Accel. No. 2 Control (✓) Response ( )

Operator MEEHAN Specimen GENERATOR CONTROL PANEL

Date 4-1-78 Damping 1 % Axis of Test X-Y (VERT)

RESPONSE SPECTRUM #1 (SSE)



7220-M18-371-1

Table VII-A-5-4

SUMMARY OF VENDOR SEISMIC QUALIFICATION

DIESEL ENGINE CONTROL PANEL

Table VII-A-5-4 Diesel Engine Control Panel

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II Component Name: Diesel Engine Control Panel

1. Scope: ( ) NSSS (X) BOP
2. Model Number: Assembly No. 1A-7009, 77001
3. Vendor: Delaval Turbine Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: Not given
5. Physical Description a. Appearance Rectangular cabinet
   b. Dimensions Not specified in qualification report
   c. Weight Not specified in qualification report
6. Location: Building: Diesel Generator Building
   Elevation: 634'-6"
7. a. System in which located: Emergency AC Power
   b. Functional Description: Engine control
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications: Bechtel Spec. 7220-M18

III. Equipment Qualfication Method:

(X) Test ( ) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 58203-1, Seismic Testing on One Engine

(No., Title and Date) Control Panel, Assembly No. 1A-7009 77001, June, 1978

Bechtel Document No. : 7220-M18-371-3

Company that Prepared Report: Wyle Laboratories

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Diesel Gen. Bldg - El. 634'-6"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .12g F/B = .12g V = .08g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. (   ) Single Frequency   (X) Multi-Frequency: (X) random   (   ) sine beat   (   ) ______

2. (   ) Single Axis   (X) Multi-Axis

3. No. of Qualification Tests: OBE 10 SSE 6 Other Sine Sweep-3 (specify)

4. Frequency Range: 1 - 35 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 14 cps F/B = 9 cps V = 10 cps

6. Method of Determining Natural Frequencies

   (X) Lab Test   (   ) In-Situ Test   (   ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test (X) Yes (Attach TRS & RRS grapl

8. Input g-level Test:

   SSE S/S = .46g F/B = .56g V = .25g

9. Functional operability verified: (X) Yes (   ) No (   ) Not Applicable

10. Test Results including modifications made: The panel is qualified structurally and functionally.

11. Other test performed (such as aging or fragility test, including results):

    None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

FIGURE VII-A-5-4-1 TRS VS SME RRS, ENGINE CONTROL PANEL NORTH-SOUTH DIRECTION

WYLE LABORATORIES Report No. 58203-1

CUSTOMER DELAVAL Job No. 58203 Page No. 44

Full Scale 10 g Accel. No. 1 Control ( ) Response ( )

Operator MEF'AN Specimen ENGINE CONTROL PANEL

Date 6-13-78 Damping 1 % Axis of Test X/Y HORIZ (N-S)(S-S)

SSE 3RD

RESPONSE SPECTRUM

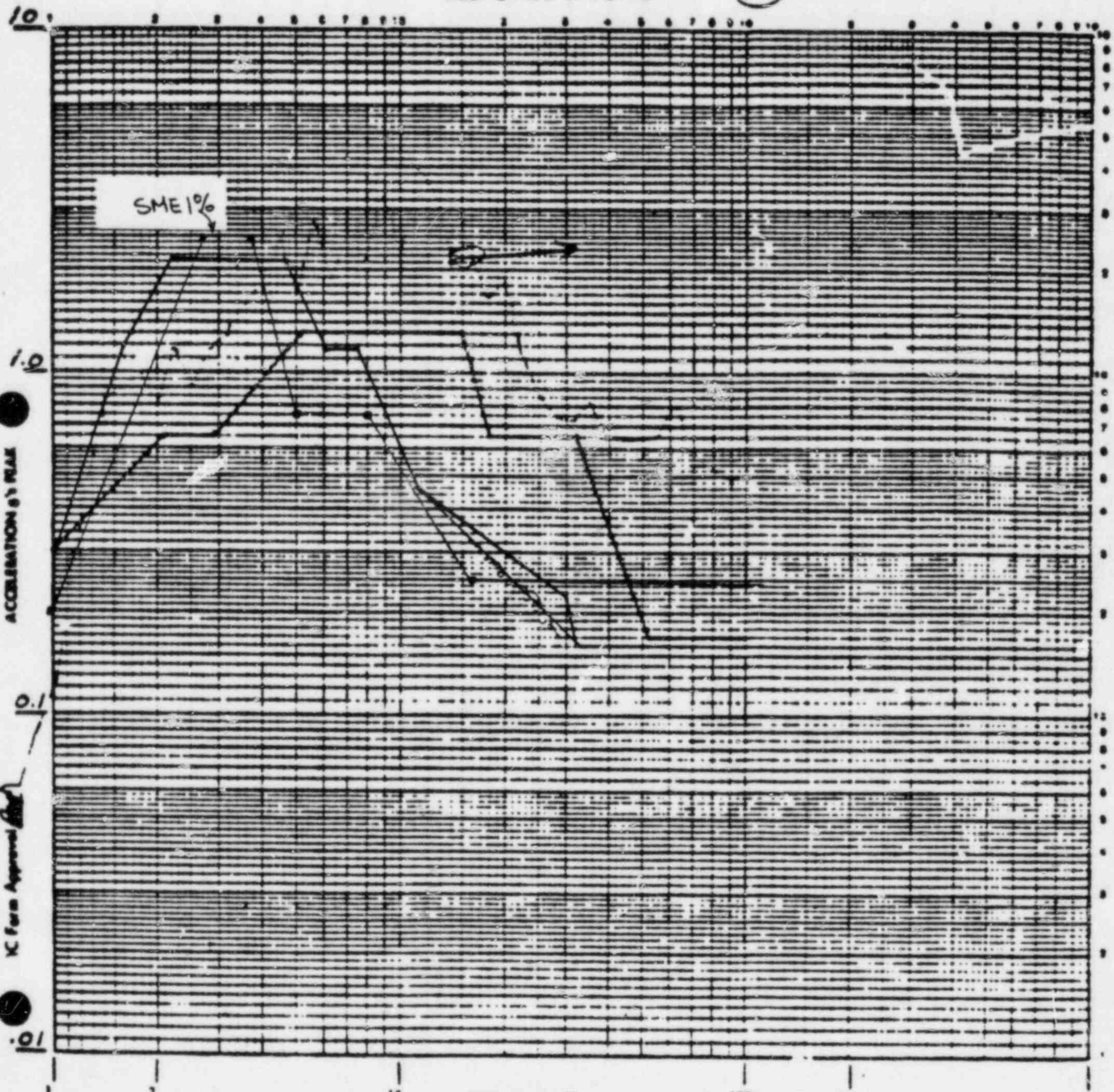


FIGURE VII-A-5-4-2 TRS VS SME RRS, ENGINE CONTROL PANEL EAST-WEST DIRECTION

WYLE LABORATORIES

Report No. [illegible]

CUSTOMER DELAVAL Job No. 58203 Page No [illegible]

Full Scale 10 g Accel. No. 1 Control ( ) Response ( )

Operator MEEHAN Specimen ENGINE CONTROL PANEL

Date 6-13-78 Damping 1 % Axis of Test Z-Y

HORIZ (E-W) (F-B)

SSE 2ND

RESPONSE SPECTRUM

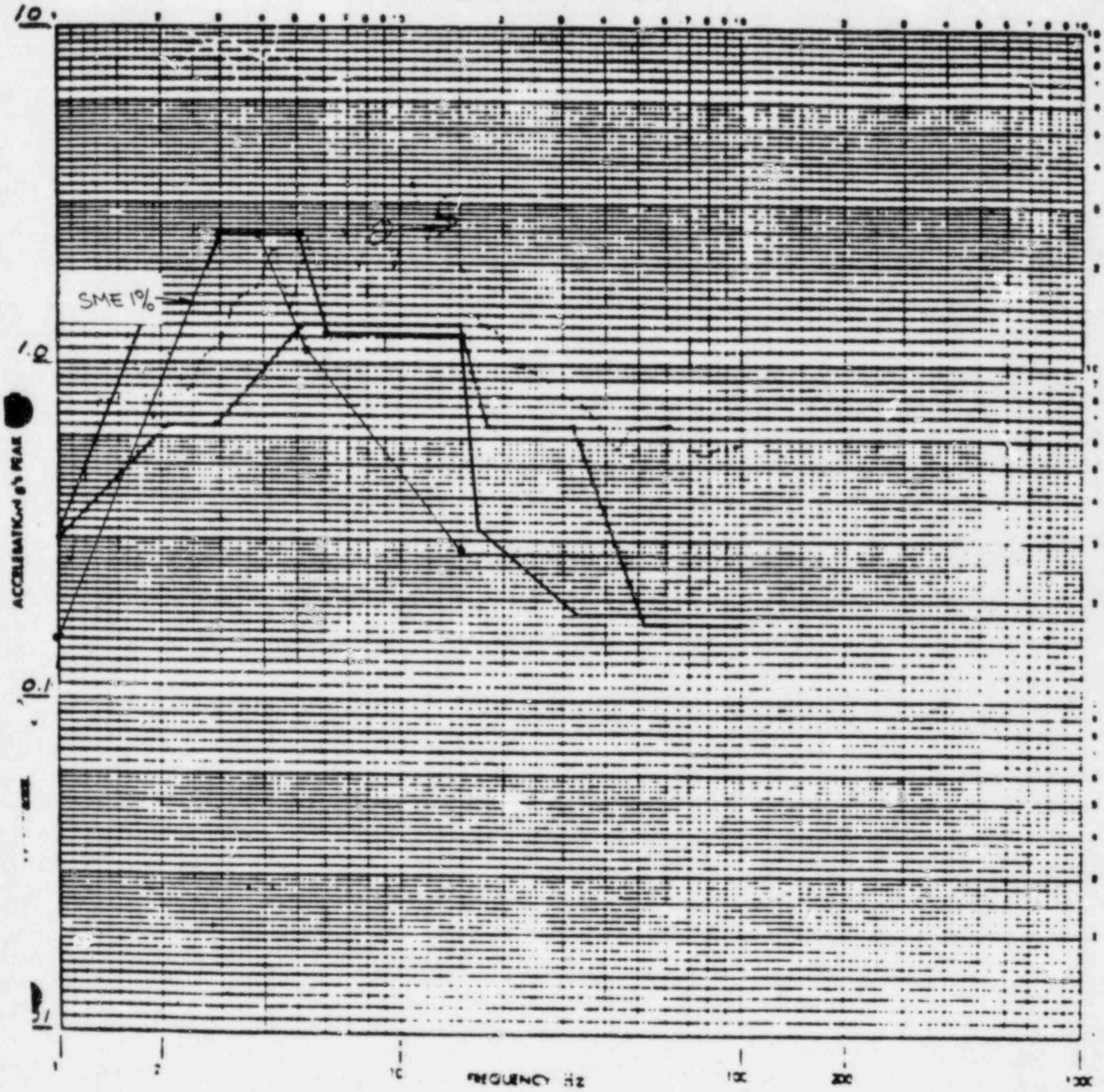


FIGURE VII-A-5-4-3 TRS VS SME RRS, ENGINE CONTROL PANEL
VERTICAL DIRECTION

WYLE LABORATORIES

Report No. ~~58203-1~~

CUSTOMER DELAVAL Job No. 58203 Page No. 15

Full Scale 10 g Accel. No. 2 Control (✓) Response ( )

Operator MEEHAN Specimen ENGINE CONTROL PANEL

Date 6-13-79 Damping 1 % Axis of Test X-Y (VERT)

RESPONSE SPECTRUM (SSE) 3RD

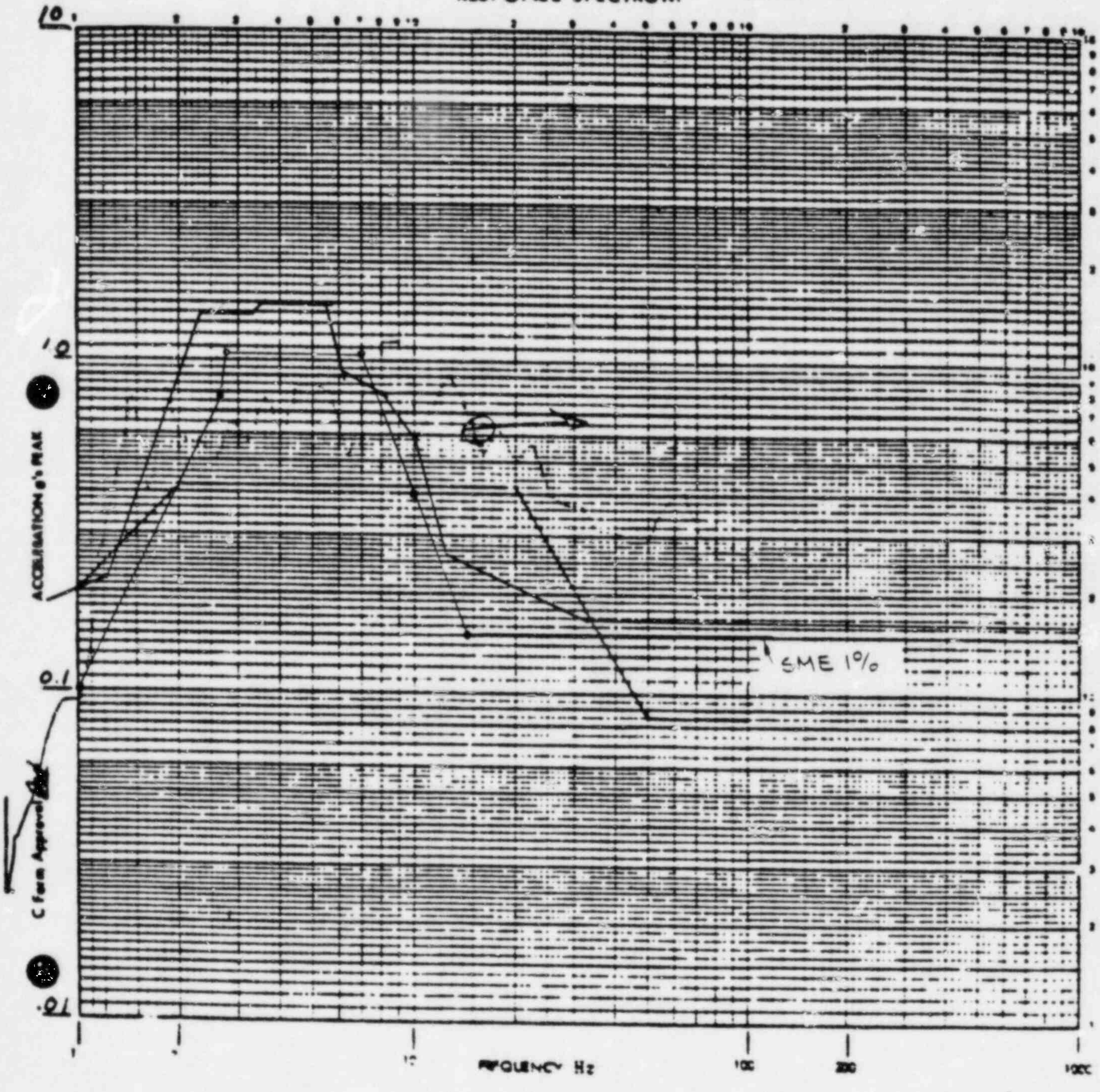


Table VII-A-5-5

SUMMARY OF VENDOR SEISMIC QUALIFICATION

DIESEL ENGINE GENERATOR

Table VII-A-5-5 Diesel Engine Generator

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Diesel Engine Generator

1. Scope: ( ) NSSS (X) BOP
2. Model Number: 6562.5 KVA, 450 RPM Generator
3. Vendor: Delaval Turbine Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Horizontal Generator

   b. Dimensions 137" L x 113" W x 137½" H

   c. Weight 58,350 lbs.
6. Location: Building: Diesel Generator Bldg.

   Elevation: 634'-6"
7. a. System in which located: Emergency AC Power

   b. Functional Description: Generates AC power

   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:

   Bechtel Spec 7220-M18

III. Equipment Qualfication Method:

( ) Test (X) Analysis ( ) Combination of Test and Analysis

Qualification Report*: Seismic Analysis of 6562.5 KVA, 450 RPM -

(No., Title and Date) Sychronous Generator, January, 1978

Bechtel Document No. : 7220-M18-372-4

Company that Prepared Report: Portec Inc.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Diesel Gen. Bldg - El. 634'-6"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .12g F/B = .12g V = .08g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

(X) Static Analysis ( ) Equivalent Static Analysis

(X) Dynamic Analysis: ( ) Time-History (X) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical): (ROTOR)

S/S = 36 cps F/B = 14 cps V = 21 cps

3. Model Type: (X) 3D ( ) 2D ( ) 1D

(X) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (X) Computer Codes: ANSYS

Frequency Range and No. of modes considered: 14-2471 cps - Modes - 32

( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: ( ) Absolute Sum (X) SRSS

( ) Other: ______ (specify)

6. Damping: OBE 1% SSE 1% Basis for the damping used: Per Bechtel Spec.

7. Support Considerations in the model: Pinned supports

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Stator: Beam adjacent to Footpad connecting end plate		D+E'	8742 psi	10,207 psi	32,400 psi

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
N/A		

Table VII-A-6

SUMMARY OF VENDOR SEISMIC QUALIFICATION

AUXILIARY SHUTDOWN PANEL

Table VII-A-6 Auxiliary Shutdown Panel

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Auxiliary Shutdown Panel

1. Scope: (X) NSSS (X) BOP
2. Model Number: Panel 1C-114 & 2C-114 for Midland
3. Vendor: Harlo Corp.
4. If the component is a cabinet or panel, name and model No. of the devices included: Refer to Bechtel device lists: DL-J-908 and DL-J-909
5. Physical Description a. Appearance Rectangular panel

   b. Dimensions 120"L x 30"W x 90"H

   c. Weight 2215 lbs.
6. Location: Building: Aux. Bldg - Penetration Wings

   Elevation: 659'-0"
7. a. System in which located: Multiple systems

   b. Functional Description: Remote Auxiliary Shutdown Station

   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications: Bechtel Spec. 7220-J-202

III. Equipment Qualfication Method:

( ) Test (X) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 76072-2, Seismic Analysis of Electrical Control
(No., Title and Date) Panel 1C114/2C114, 1-16-78

Bechtel Document No. : 7220 - J202 - 104 - 2

Company that Prepared Report: Analytical Engineering Associates, Inc.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg.-Penetration Wings-El. 659-

4. Damping Corresponding to RRS: OBE 2% SSE 2%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ____ (specify)

   SSE S/S = .20 g F/B = .23 g V = .13 g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ____

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

( ) Static Analysis ( ) Equivalent Static Analysis

(X) Dynamic Analysis: ( ) Time-History (X) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = 13.3 cps F/B = 13.3 cps V = 13.3 cps

3. Model Type: (X) 3D ( ) 2D ( ) 1D

(X) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (X) Computer Codes: Stardyne Computer Program

Frequency Range and No. of modes considered: 13-87cps - 20 modes

( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: (X) Absolute Sum ( ) SRSS

( ) Other: ______ (specify)

6. Damping: OBE 2% SSE 2% Basis for the damping used: per Bechtel Spec.

7. Support Considerations in the model: Pinned supports at panel's welded connections to embeds.

8. Critical Structural Elements:

A. Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Section #18	Barrier terminal support box angle	D+E'	3200 psi	3441 psi	21,600 psi

B. Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
N/A		

Table VII-A-7

SUMMARY OF VENDOR SEISMIC QUALIFICATION

HVAC CONTROL CABINET, 1C-175A-B and 2C-175A-B

Table VII-A-7 HVAC Control Cabinet, 1C 175A-B and 2C 175A-B

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name:

1. Scope: ( ) NSSS (X) BOP
2. Model Number: Panel 1C-175A/B & 2C-175A/B for Midland
3. Vendor: Harlo Corp.
4. If the component is a cabinet or panel, name and model No. of the devices included: Refer to Bechtel device lists: DL-J-939, DL-J-940, DL-J-941 & DL-J-942
5. Physical Description a. Appearance Wall mounted rectangular cabinet
   b. Dimensions 30"L x 10"W x 48"H
   c. Weight 325 lbs.
6. Location: Building: Aux. Bldg.-Control Tower
   Elevation: 685'-0"
7. a. System in which located: HVAC system for Diesel Generator Bldg.
   b. Functional Description: Controls HVAC system
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications: Bechtel Spec. 7220-J-202

III. Equipment Qualfication Method:

( ) Test (X) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 76072-5, Seismic Analysis of Wall Mounted Elec.

(No., Title and Date) Control Panels 1C-175A/B, 2C-175A/B, Aug. 22, 1978

Bechtel Document No. : 7220- J2C2-125-1

Company that Prepared Report: Analytical Engineering Associates, Inc.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg.-Control Tower, El. 704'-0"

4. Damping Corresponding to RRS: OBE 2% SSE 2%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .27g F/B = .28g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

( ) Static Analysis ( ) Equivalent Static Analysis

(X) Dynamic Analysis: ( ) Time-History (X) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = 56.1 cps F/B = 12.4 cps V = 56.1 cps

3. Model Type: (X) 3D ( ) 2D ( ) 1D

(X) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (X) Computer Codes: Stardyne Computer Program

Frequency Range and No. of modes considered: 12.4 - 36.52 cps, 36 modes

( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: (X) Absolute Sum ( ) SRSS

( ) Other: ______ (specify)

6. Damping: OBE 2% SSE 2% Basis for the damping used: Per Bechtel Spec.

7. Support Considerations in the model: Pinned supports at anchor bolt locations

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Cabinet angle frame		D+E'	674 psi	3567 psi	21,600 psi

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
N/A		

Table VII-A-8

SUMMARY OF VENDOR SEISMIC QUALIFICATION

HVAC CONTROL PANEL OC-151

Table VII-A-8 HVAC Control Panel OC-151

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: HVAC Control Panel

1. Scope: ( ) NSSS (X) BOP
2. Model Number: Panel OC-151 for Midland
3. Vendor: Harlo Corp.
4. If the component is a cabinet or panel, name and model No. of the devices included: Refer to Bechtel device lists: DL-J-924
5. Physical Description a. Appearance Rectangular panel
   b. Dimensions 144"L x 48"W x 90"H
   c. Weight 4270 lbs.
6. Location: Building: Aux. Bldg - Control Tower
   Elevation: 685'-0"
7. a. System in which located: Aux. Bldg HVAC
   b. Functional Description: Aux. Bldg HVAC Control
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications: Bechtel Spec. 7220-J202

III. Equipment Qualfication Method:

( ) Test (X) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 76072-4, Seismic Analysis of Electrical Control

(No., Title and Date) Panel OC151, Midland Plant, Units 1 and 2, Oct, 1977

Bechtel Document No. : 7220-J202-103-1

Company that Prepared Report: Analytical Engineering Associates, Inc.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg.-Control Tower, El 685'-0"

4. Damping Corresponding to RRS: OBE 2% SSE 2%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .26g F/B = .24g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

( ) Static Analysis ( ) Equivalent Static Analysis

(X) Dynamic Analysis: ( ) Time-History (X) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = 12.9 cps F/B = 12.9 cps V = 12.9 cps

3. Model Type: (X) 3D ( ) 2D ( ) 1D

( ) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (X) Computer Codes: Stardyne Computer Program

Frequency Range and No. of modes considered: 12.9 - 14.5 cps, Modes - 20

( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: (X) Absolute Sum ( ) SRSS

( ) Other: ______ (specify)

6. Damping: OBE 2% SSE 2% Basis for the damping used: Per Bechtel spec.

7. Support Considerations in the model: Pinned supports at panel's welded connections to embeds.

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Section #9	Roof bar	D+E'	13,740 psi	18,498 psi	21,600 psi

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
N/A		

Table VII-A-9

SUMMARY OF VENDOR SEISMIC QUALIFICATION

ENGINEERED SAFETY FEATURES ACTUATION SYSTEM

Table VII-A-9 Engineered Safety Features Actuation System

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Engineered Safety Features Actuation Systems Cabinet

1. Scope: ( ) NSSS (X) BOP
2. Model Number: 1C-44 & 2C-44 for Midland
3. Vendor: Automation Industries, Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: Refer to qualification report.
5. Physical Description a. Appearance Rectangular cabinets
   b. Dimensions 136" L x 30" W x 90" H
   c. Weight 3370 lbs.
6. Location: Building: Aux. Bldg - Control Tower
   Elevation: 659'-0"
7. a. System in which located: ESFAS
   b. Functional Description: Plant safety equipment
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   Bechtel Spec. 7220-J-207

III. Equipment Qualfication Method:

(X) Test ( ) Analysis ( ) Combination of Test and Analysis

Qualification Report*: Seismic Qualification Report No 2717-1, Engineered
(No., Title and Date) Safety Features Actuation System, June 21, 1978

Bechtel Document No. : 7220 - J-207-85-3

Company that Prepared Report: Automation Industries, Inc. (Wyle Lab)

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only
   b. ( ) Hydrodynamic only
   c. ( ) Combination of (a) and (b)
2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)
3. Required Response Spectra : Aux. Bldg- Control Tower, El. 6[illegible]
4. Damping Corresponding to RRS: OBE 2% SSE 2%
5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .23g F/B = .22g V = .13g
6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. ( ) Single Frequency (X) Multi-Frequency: (X) random ( ) sine beat ( ) ________
2. ( ) Single Axis (X) Multi-Axis
3. No. of Qualification Tests: OBE 10 SSE 5 Other Sine Sweep-3 (specify)
4. Frequency Range: 1-40 cps
5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 6.1 cps F/B = 10.7 cps V = [illegible]
6. Method of Determining Natural Frequencies

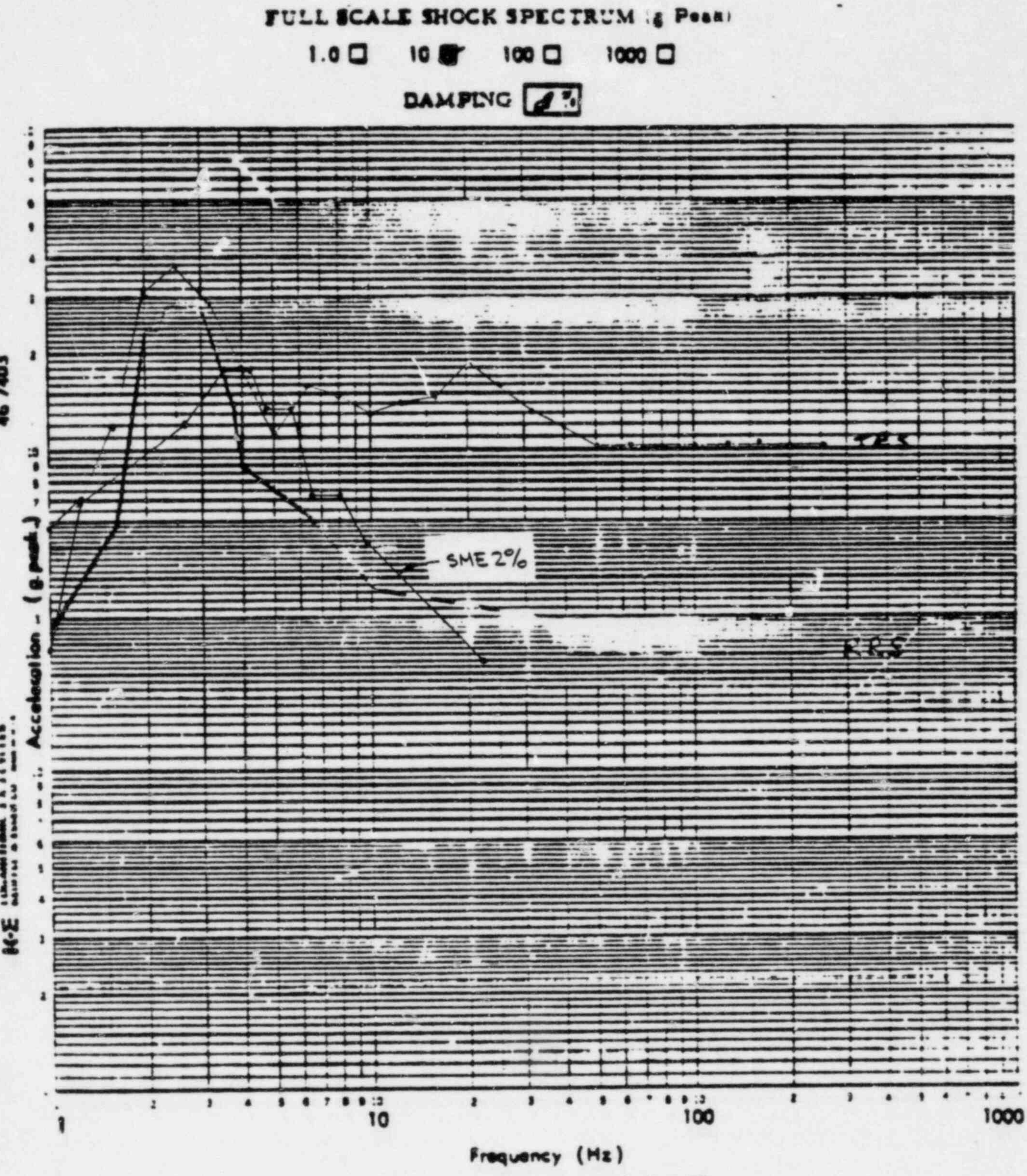
   (X) Lab Test ( ) In-Situ Test ( ) Analysis
7. TRS enveloping RRS using Multi-Frequency Test (X) Yes (Attach TRS & RRS graph
8. Input g-level Test:

   SSE S/S = 1.0g F/B = 1.0g V = .15 g
9. Functional operability verified: (X) Yes ( ) No ( ) Not Applicable
10. Test Results including modifications made: Cabinet was structurally and functionally qualified for the SSE.
11. Other test performed (such as aging or fragility test, including results):

    None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

FIGURE VII-A-9-1 TRS VS SME RRS, ESF ACTUATION SYSTEM CABINET
NORTH-SOUTH DIRECTION



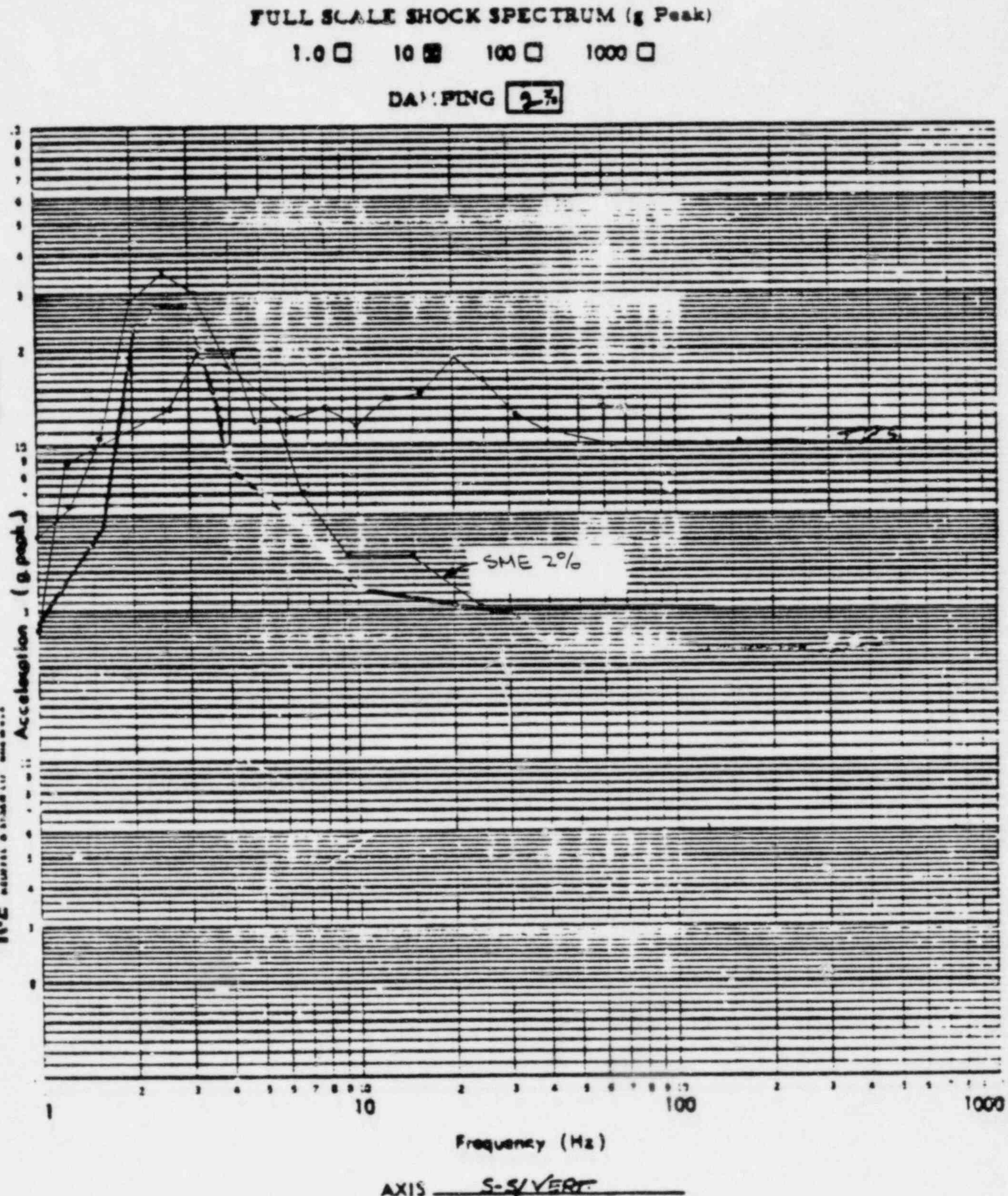
AXIS F-B/VERT

LOCATION NO. (N-S) 10A

TEST RUN NO. D

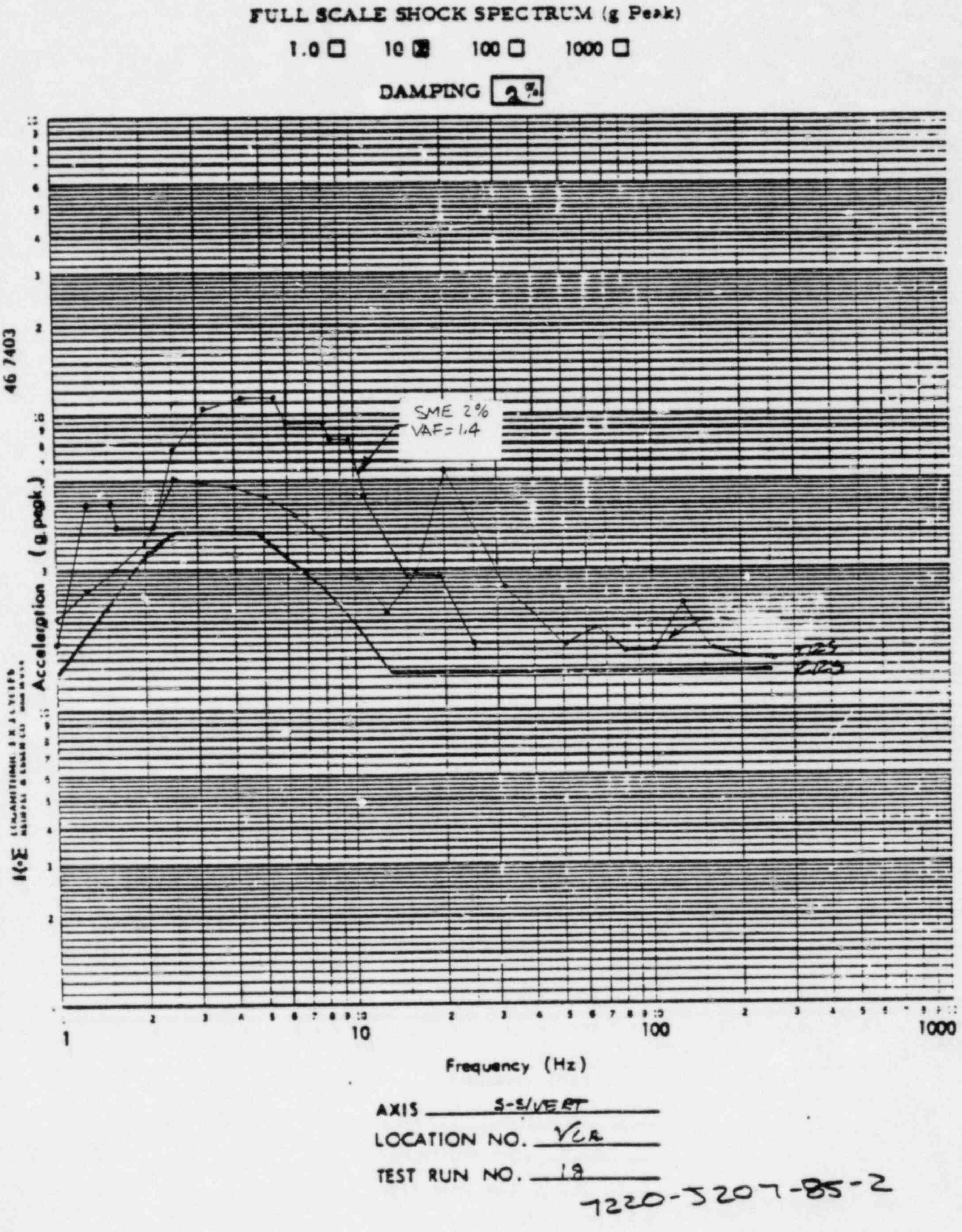
7220-3207-BS-2

FIGURE VII-A-9-2 TRS VS SME RRS, ESF ACTUATION SYSTEM CABINET EAST-WEST DIRECTION



7220-5207-85-2

FIGURE VII-A-9-3 TRS VS SME RRS, ESF ACTUATION SYSTEM CABINET VERTICAL DIRECTION



7220-5207-85-2

Table VII-A-10

SUMMARY OF VENDOR SEISMIC QUALIFICATION

BALANCE OF PLANT LOGIC CABINET, 1C-166 and 2C-166

Table VII-A-10 Balance of Plant Logic Cabinet, 1C-166 and 2C-166

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: BOP Logic Cabinet

1. Scope: ( ) NSSS (X) BOP
2. Model Number: N-2ES Style "A" Rack
3. Vendor: Foxboro Co.
4. If the component is a cabinet or panel, name and model No. of the devices included: Refer to devices qualification report
5. Physical Description a. Appearance Rectangular cabinets
   b. Dimensions 104"L X 36½"W X 89"H
   c. Weight (Not available)
6. Location: Building: Aux. Bldg - Penetration Wings
   Elevation: 659'-0"
7. a. System in which located: Multiple systems
   b. Functional Description: BOP System Control
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   Bechtel Spec. 7220-J204

III. Equipment Qualfication Method: (Rack)

(X) Test ( ) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. T4-1025, Seismic Vibration Test of
(No., Title and Date) N-2ES, Style A Spec 200 Rack, July, 1976

Bechtel Document No. : 7220 - J204 - 33 - 3

Company that Prepared Report: Foxboro Co.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg - Penetration Wings - El. 65?

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .23g F/B = .21g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. (X) Single Frequency ( ) Multi-Frequency: ( ) random / (X) sine beat / ( ) ________

2. (X) Single Axis ( ) Multi-Axis

3. No. of Qualification Tests: OBE 3 SSE 3 Other Resonance Search - 6 (specify)

4. Frequency Range: 1-35 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 8 cps F/B = 15 cps V = ~33 cps

6. Method of Determining Natural Frequencies

   (X) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test ( ) Yes (Attach TRS & RRS grap

8. Input g-level Test:

   SSE S/S = 2.0g F/B = 2.0g V = 2.0g

9. Functional operability verified: (X) Yes ( ) No ( ) Not Applicable

10. Test Results including modifications made: The rack mounting base and door supports were redesigned to prevent damage during an SSE. Otherwise the rack maintained its structural integrity.

11. Other test performed (such as aging or fragility test, including results):

    None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

III. Equipment Qualfication Method: (Devices)

(X) Test ( ) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. QOAAB11 to QOAAB61, Foxboro Co.

(No., Title and Date) Corporate Quality Assurance Lab., Type Test Report, 1978

Bechtel Document No. : 7220-J204-302-1

Company that Prepared Report: Foxboro Co.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. ( ) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg-Penetration Wings-El. 655'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ____ (specify)

   SSE S/S = .23g F/B = .21g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ____

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. ( ) Single Frequency (X) Multi-Frequency: (X) random ( ) sine beat ( ) ________

2. ( ) Single Axis (X) Multi-Axis

3. No. of Qualification Tests: OBE 10 SSE 2 Other ________ (specify)

4. Frequency Range: 1-100 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):
   S/S = (None determined) F/B = ________ V = ________

6. Method of Determining Natural Frequencies N/A
   ( ) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test (No) Yes (Attach TRS & RRS grap
   TRS were marginally low.

8. Input g-level Test:
   SSE S/S = 15g. F/B = 10g. V = 5g.

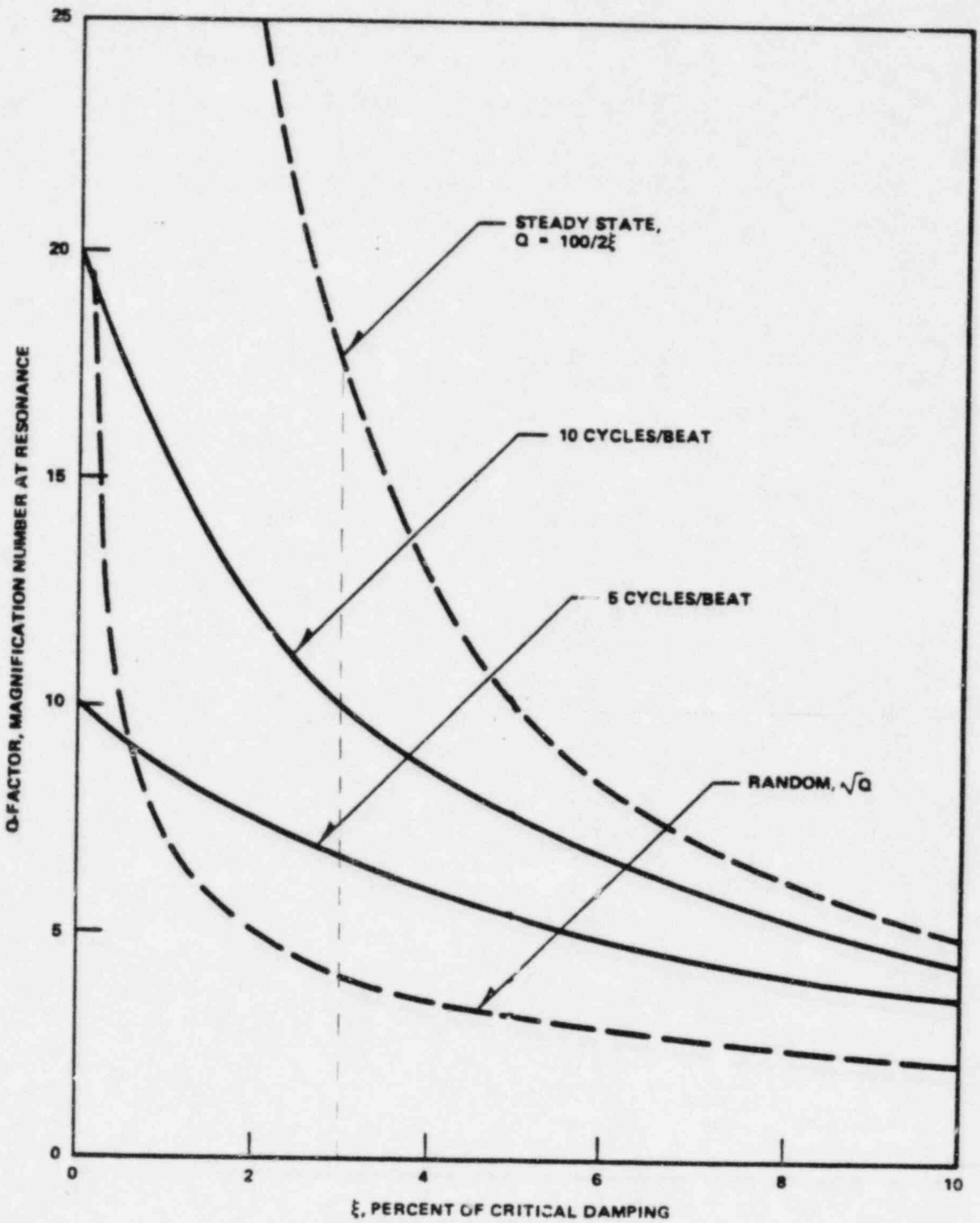
9. Functional operability verified: (X) Yes ( ) No ( ) Not Applicable

10. Test Results including modifications made: All devices were functional after testing.

11. Other test performed (such as aging or fragility test, including results):
    None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

FIGURE VII-A-10-1 AMPLIFICATION FACTOR FOR SINE BEAT TESTING



COMPARISON OF VIBRATION MAGNIFICATIONS AT RESONANCE

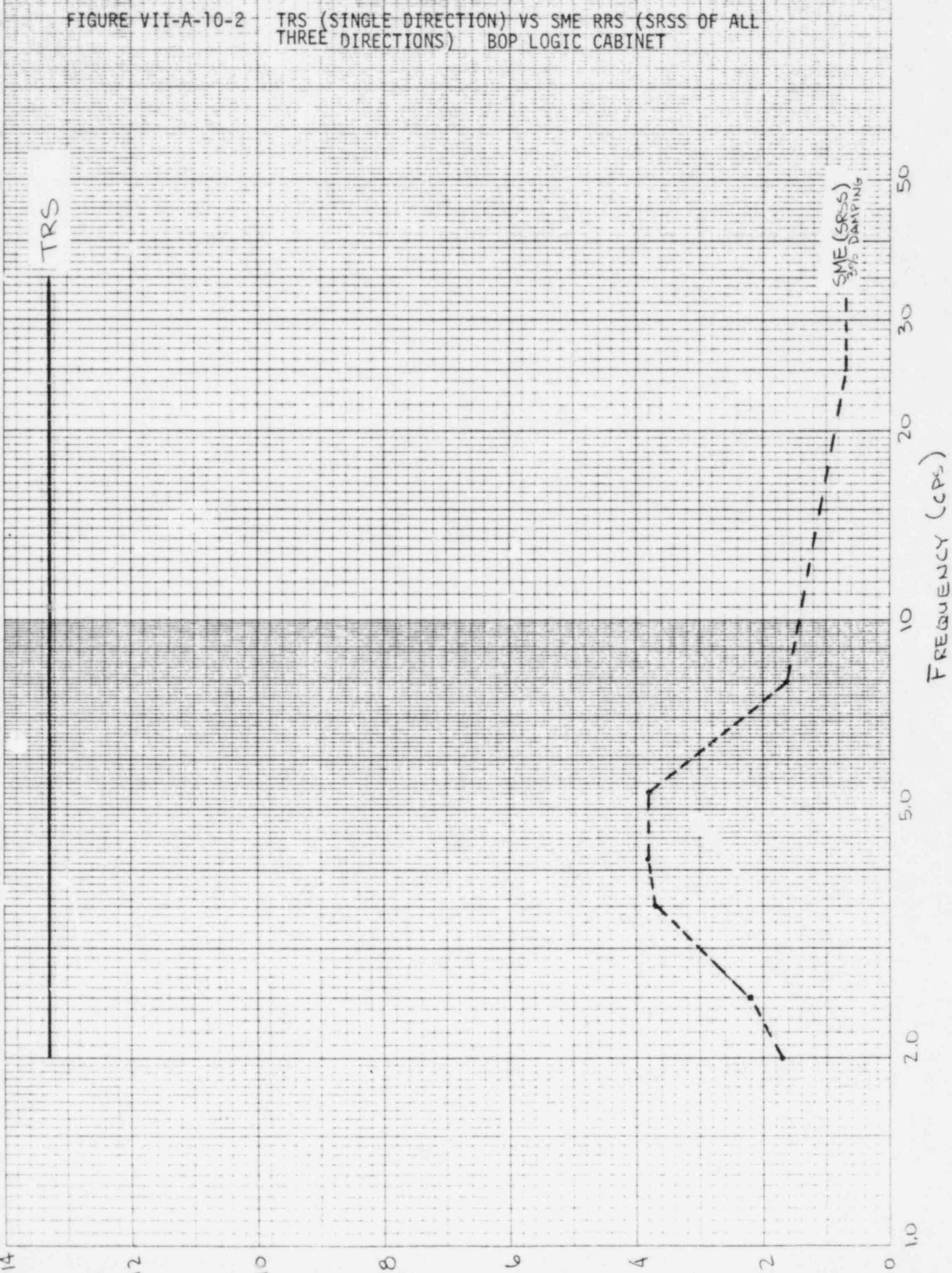


FIGURE VII-A-10-2 TRS (SINGLE DIRECTION) VS SME RRS (SRSS OF ALL THREE DIRECTIONS) BOP LOGIC CABINET

Table VII-A-11

SUMMARY OF VENDOR SEISMIC QUALIFICATION

SAFEGUARDS CHILLER 1VM-59A, 1VM-59B, 2VM-59A and 2VM-59B

Table ..I-A-11 Safeguards Chiller 1VM-59A, 1VM-59B, 2VM-59A and 2VM-59B

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Safeguard Chiller

1. Scope: ( ) NSSS (X) BOP
2. Model Number: Centrifugal liquid chillers
3. Vendor: Carrier Air Conditioning Company
4. If the component is a cabinet or panel, name and model No. of the devices included: Refer to qualification report
5. Physical Description a. Appearance Horizontal Heat Exchanger

   b. Dimensions ________

   c. Weight 26000 lbs (Approx)
6. Location: Building: Auxiliary Building

   Elevation: 645'-0"
7. a. System in which located: Auxiliary Building HVAC

   b. Functional Description: Provides chilled water to Safeguards HVAC

   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown

   (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:

   Bechtel Spec. 7220-M146

III. Equipment Qualfication Method:

( ) Test (x) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 1603, Seismic Analysis of Hermetic Centrifugal

(No., Title and Date) Liquid Chillers for Consumers Power's Midland Plant, April, 1976

Bechtel Document No. : 7220-M146-33-1

Company that Prepared Report: NUS Corporation

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (x) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (x) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg. 645'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (x) ZPA ( ) Other ________ (specify)

   SSE S/S = .19g F/B = .20g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (x) No

   If yes, describe loads considered and how they were treated in overall qualification program: ____________________

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*:

1. (X) Single Frequency ( ) Multi-Frequency: ( ) random (X) sine beat (X) Resonance Sweep

2. ( ) Single Axis (X) Multi-Axis

3. No. of Qualification Tests: OBE ______ SSE 1 Other 5 beats, 10 cycles per beat (specify)

4. Frequency Range: 1- 48 Hz

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = Not reported. F/B = ______ V = ______

6. Method of Determining Natural Frequencies (Resonance sweep conducted but natural frequencies not reported)

(X) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test (X) Yes (Attach TRS & RRS graphs

8. Input g-level Test: 0.5 to 1.77g, all three directions

SSE S/S = ______ F/B = ______ V = ______

9. Functional operability verified: (X) Yes ( ) No ( ) Not Applicable

10. Test Results including modifications made: Panel is considered qualified, both structure and function, for SME

11. Other test performed (such as aging or fragility test, including results):

None

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

( ) Static Analysis ( ) Equivalent Static Analysis

(x) Dynamic Analysis: ( ) Time-History (X) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = >24.6 cps F/B = 24.6 cps V = >24.6 cps

3. Model Type: (x) 3D ( ) 2D ( ) 1D

(X) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (x) Computer Codes: STARDYNE, SANSAR, DISCOM

Frequency Range and No. of modes considered: Not given

( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: ( ) Absolute Sum (X) SRSS

( ) Other: ______ (specify)

6. Damping: OBE ½% SSE ½% Basis for the damping used: Conservative assumption

7. Support Considerations in the model: Anchor bolts are pinned supports

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Cooler Shell		Normal + E'	(Not given)	10,922 psi	24000 psi
Cooler Shell at Economizer Liquid Outlet Pipe		Normal + E'	(Not given)	18,655 psi	32,880 psi

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
N/A		

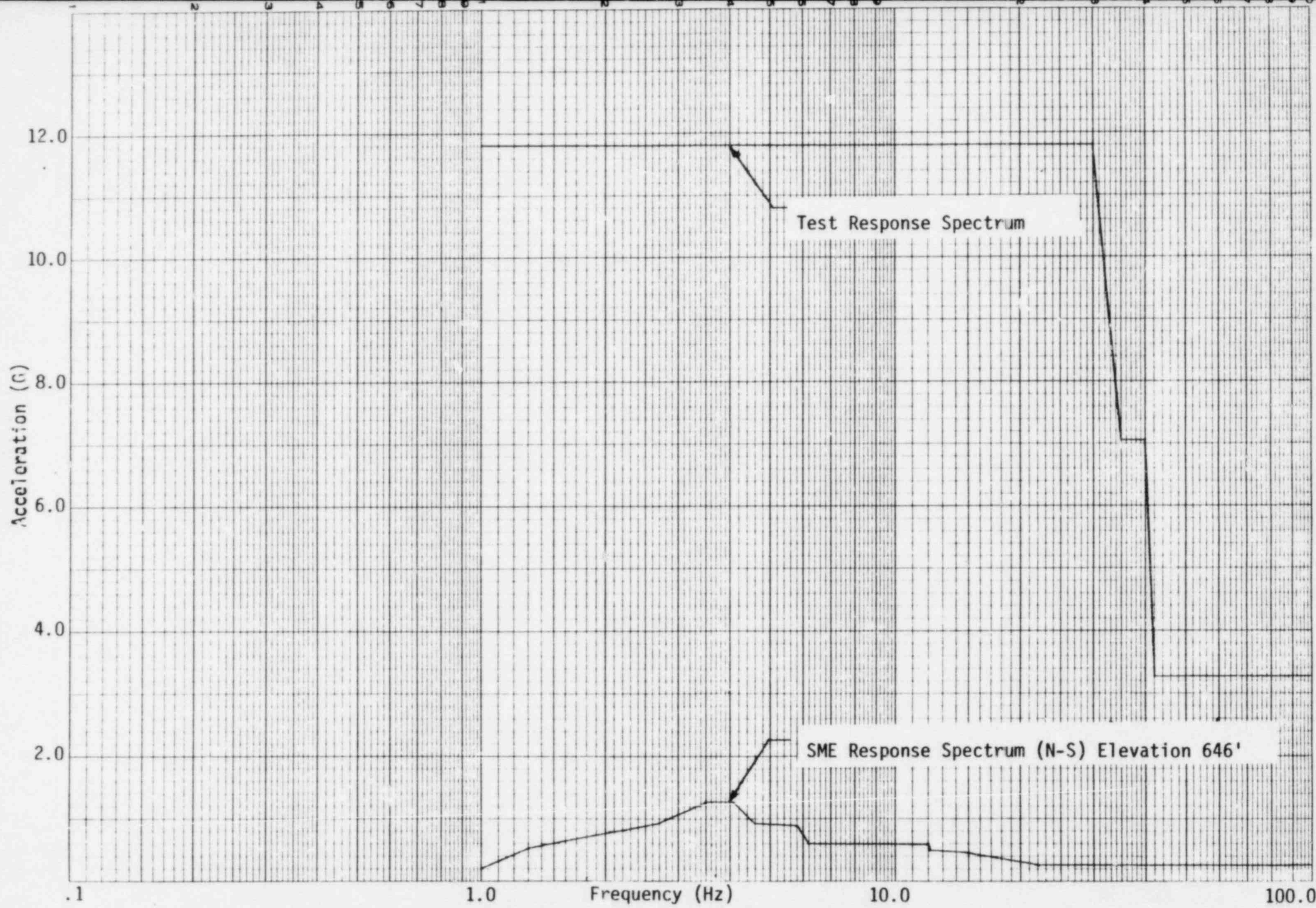


FIGURE VII-A-11-1. COMPARISON OF 3% DAMPED SME SPECTRA WITH TEST RESPONSE SPECTRA FOR MIDLAND CHILLER CONTROL PANELS

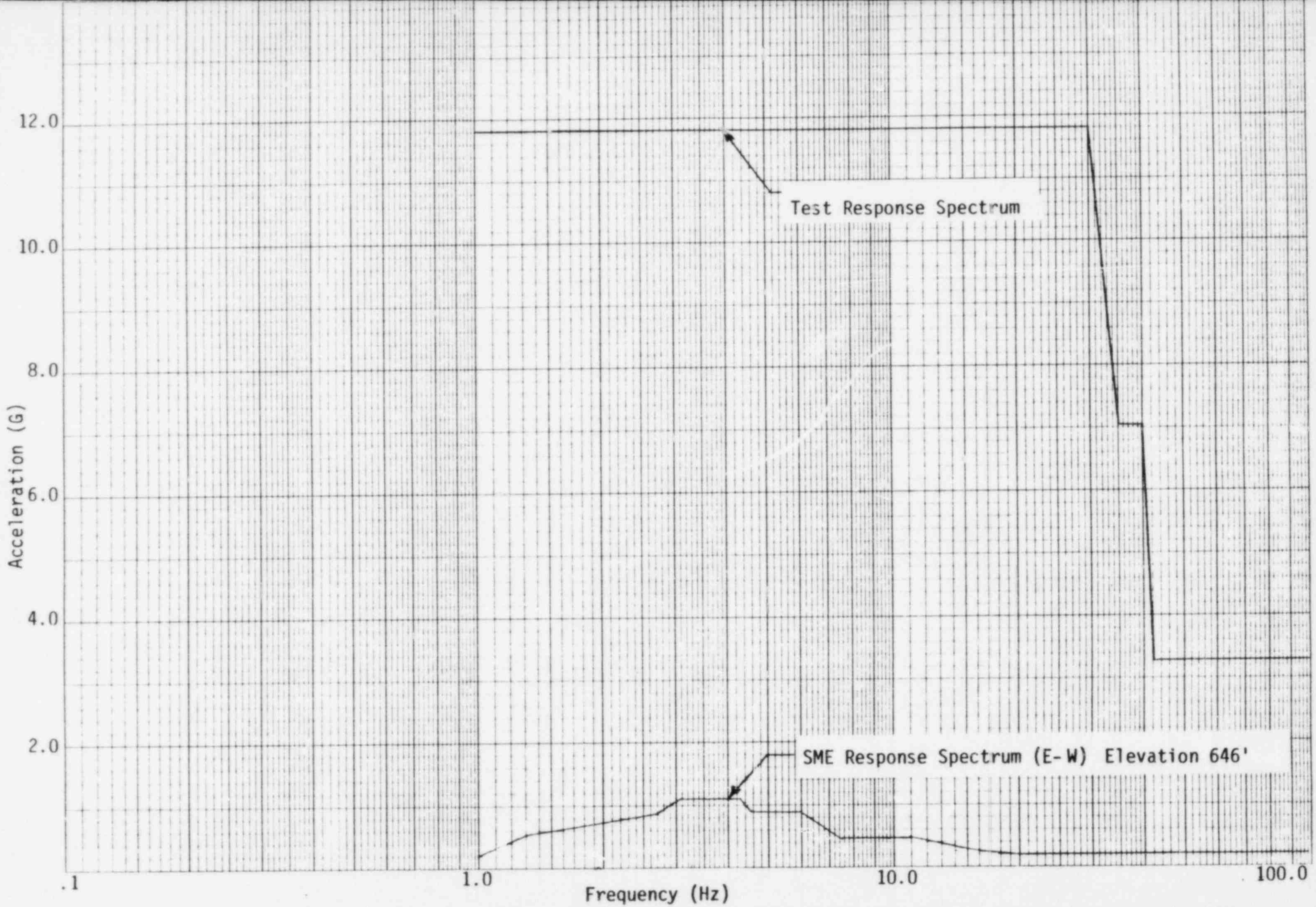


FIGURE VII-A-11-2. COMPARISON OF 3% DAMPED SME SPECTRA WITH TEST RESPONSE SPECTRA FOR MIDLAND CHILLER CONTROL PANELS

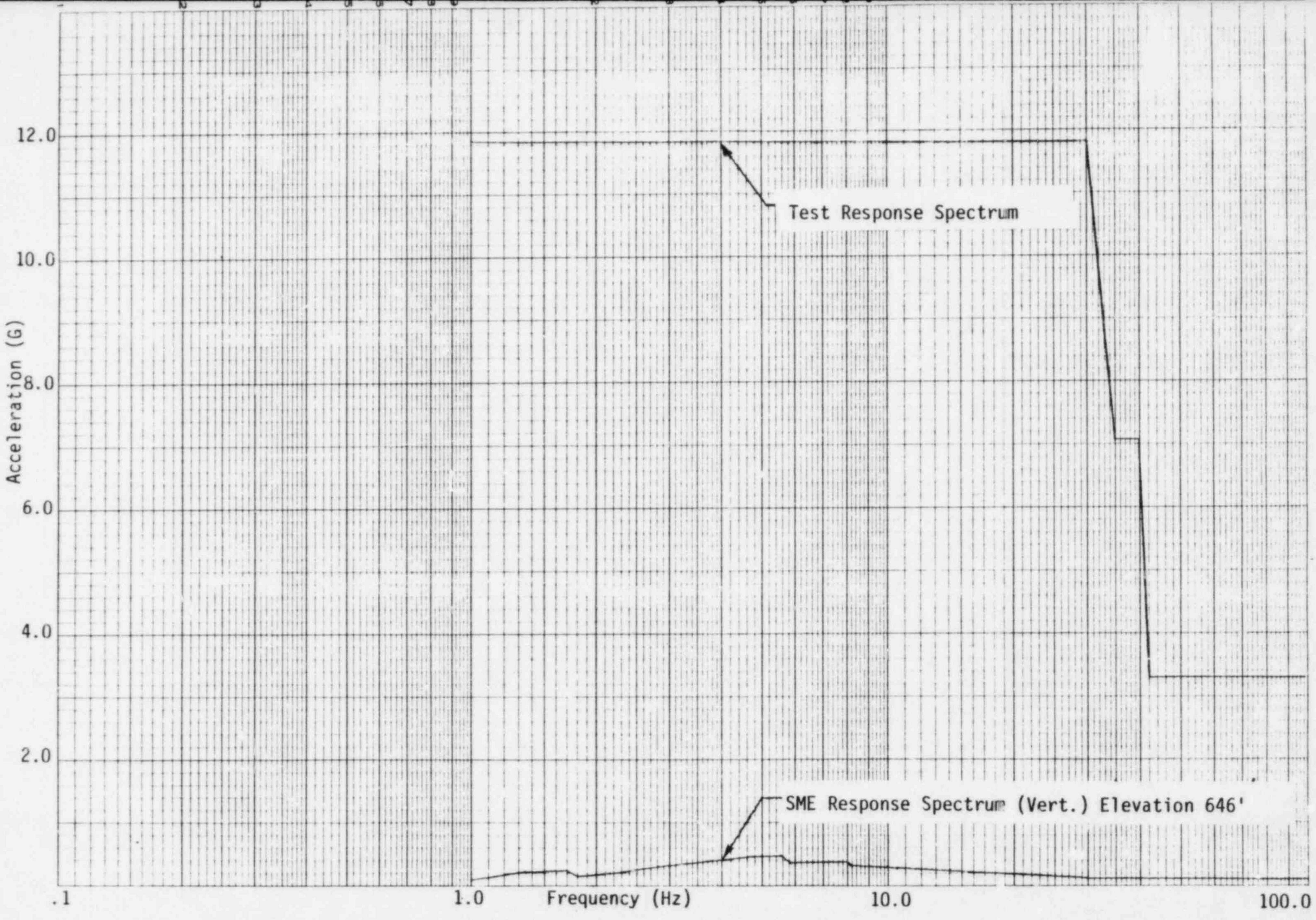


FIGURE VII-A-11-3. COMPARISON OF 3% DAMPED SME SPECTRA WITH TEST RESPONSE SPECTRA FOR MIDLAND CHILLER CONTROL PANELS

Table VII-A-12

SUMMARY OF VENDOR SEISMIC QUALIFICATION

CONTROL ROOM HVAC OVM-01A and OVM-01B

Table VII-A-12 Control Room HVAC OVM-01A and OVM-01B

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Control Room HVAC

1. Scope: ( ) NSSS (X) BOP
2. Model Number: 35 Medium Pressure Vertical Climate Changer
3. Vendor: Trane Co.
4. If the component is a cabinet or panel, name and model No. of the devices included: Refer to qualification report
5. Physical Description a. Appearance Rectangular cabinet
   b. Dimensions 121"L X 100"W X 120"H
   c. Weight 6393 lbs.
6. Location: Building: Aux. Bldg - Control Tower
   Elevation: 685'-0"
7. a. System in which located: Control room HVAC system
   b. Functional Description: Provides HVAC
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   Bechtel Spec. 7220-M149

III. Equipment Qualfication Method:

( ) Test ( ) Analysis (X) Combination of Test and Analysis

Qualification Report*: No. 1421, Seismic Analysis of 35 Medium Pressure

(No., Title and Date) Vertical Climate Changer, Tag No. OVM-1A, OVM-1B, June, 1976

Bechtel Document No. : 7220-M149-63-7

Company that Prepared Report: Dynatech R/D Company

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg. - Control Tower - El. 685'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .26g F/B = .24g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

V. If Qualification by Test, then Complete*: (Heater Controls)

1. ( ) Single Frequency (x) Multi-Frequency: ( ) random ( ) sine beat (x) Sine Sweep

2. ( ) Single Axis (x) Multi-Axis

3. No. of Qualification Tests: OBE _______ SSE _______ Other Not specified (specify)

4. Frequency Range: 5 - 100 cps

5. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = >33 cps F/B = > 33cps V = >33cps

6. Method of Determining Natural Frequencies

   (x) Lab Test ( ) In-Situ Test ( ) Analysis

7. TRS enveloping RRS using Multi-Frequency Test ( ) Yes (Attach TRS & RRS grap

8. Input g-level Test:

   SSE S/S = 4.0g F/B = 4.0g V = 4.0g

9. Functional operability verified: (x) Yes ( ) No ( ) Not Applicable

10. Test Results including modifications made: Components remained functional after testing except the SCR which is qualified to 50cps.

11. Other test performed (such as aging or fragility test, including results):

    None.

*NOTE: If qualification by a combination of test and analysis, also complete Item VI.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

( ) Static Analysis ( ) Equivalent Static Analysis

(X) Dynamic Analysis: ( ) Time-History (X) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = 4.8 cps F/B = 5.0 cps V = 7.0 cps

3. Model Type: (X) 3D ( ) 2D ( ) 1D

(X) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (X) Computer Codes: STARDYNE

Frequency Range and No. of modes considered: 4.8-18.9 cps, Modes-8

( ) Hand Calculations:

5. Method of Combining Dynamic Responses: (X) Absolute Sum ( ) SRSS

( ) Other: ______ (specify)

6. Damping: OBE 1% SSE 1% Basis for the damping used: per Bechtel spec.

7. Support Considerations in the model: Stiffnesses of isolators input at support points.

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Isolator Bolts		D+E'	(TENSION) 20,501 psi (SHEAR) 12,140 psi	20,501 psi 12,140 psi	25,276 psi 15,000 psi
Isolator Channel		D+E'	30,415 psi	30,415 psi	32,400 psi
Motor		D+E'	4.2g	4.2g	5.0g
coils		D+E'	2.2g	2.2g	2.2g

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability

Table VII-A-13

SUMMARY OF VENDOR SEISMIC QUALIFICATION

COMPONENT COOLING WATER SURGE TANK 1T-173 A&B, 2T-173 A&B

Table VII-A-13 Component Cooling Water Surge Tank
1T-173 A&B, 2T-173 A&B

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Component Cooling Water Surge Tank

1. Scope: ( ) NSSS (X) BOP
2. Model Number: 1T-173A/B & 2T-173A/B for Midland
3. Vendor: Graver Energy Systems, Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Rectangular tank
   b. Dimensions 96"L X 72"W X 116"H (Approx)
   c. Weight 43,000 lbs (Approx)
6. Location: Building: Aux. Bldg - Main Aux Area
   Elevation: 673'-0"
7. a. System in which located: CCW System
   b. Functional Description: Accomodates System Expansion
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   Bechtel Spec 7220-C18

III. Equipment Qualfication Method:

( ) Test (X) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 61598N, Design Calculation, Rev. 1, Dated

(No., Title and Date) 10/13/81, for Component Cooling Water Surge Tanks

Bechtel Document No. : 7220-C18-199-2

Company that Prepared Report: Graver Energy System, Inc.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg - El. 673'-6"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .23g F/B = .24g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

   ( ) Static Analysis (X) Equivalent Static Analysis

   ( ) Dynamic Analysis: ( ) Time-History ( ) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 24.1 cps F/B = 24.9 cps V = >24 cps

3. Model Type: ( ) 3D (X) 2D ( ) 1D

   ( ) Finite Element ( ) Beam (Lumped Mass) (X) Closed Form Solution

4. ( ) Computer Codes: ______

   Frequency Range and No. of modes considered: >24 cps

   (X) Hand Calculations: Uniform beam formulas

5. Method of Combining Dynamic Responses: (X) Absolute Sum ( ) SRSS

   ( ) Other: ______ (specify)

6. Damping: OBE 1% SSE 1% Basis for the damping used:

   per Bechtel spec.

7. Support Considerations in the model: N/A

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Tank Leg		Normal + E'	6.96 ksi	14.92 ksi	18.75 ksi

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
N/A		

Table VII-A-14

SUMMARY OF VENDOR SEISMIC QUALIFICATION

SERVICE WATER PUMPS OP-75 A-E

Table VII-A-14 Service Water Pumps OP-75 A-E

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Service Water Pumps

1. Scope: ( ) NSSS (X) BOP
2. Model Number: Model VIT, Size 30x36 DHC 1 STG.
3. Vendor: Gould Pumps, Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Vertical Pumps
   b. Dimensions 48'x11" Long, includes disch. head & 30" ⌀ column
   c. Weight 19,500 lbs.
6. Location: Building: Service Water Pump Structure
   Elevation: 634'-6"
7. a. System in which located: Service water system
   b. Functional Description: Supply cooling water to safety and non-safety-related equipment.
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications: Bechtel Spec. 7220-M-75

III. Equipment Qualfication Method:

( ) Test (X) Analysis ( ) Combination of Test and Analysis

Qualification Report*: ME-337, Seismic Stress Analysis of ASME Section
(No., Title and Date) III Class 3 Pumps, Model VIT, Size 30x36, DHC 1 Stg, June, 1976.

Bechtel Document No. : 7220-M75-21-6

Company that Prepared Report: McDonald Engineering Analysis Co.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only
   b. ( ) Hydrodynamic only
   c. ( ) Combination of (a) and (b)
2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)
3. Required Response Spectra : Service Water Pump Structure - El. 6'3"
4. Damping Corresponding to RRS: OBE 1% SSE 1%
5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .234 g F/B = .234 g V = .089 g
6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

( ) Static Analysis ( ) Equivalent Static Analysis

(X) Dynamic Analysis: ( ) Time-History (X) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = 9.7 cps F/B = 9.7 cps V = 31.1 cps

3. Model Type: ( ) 3D (X) 2D ( ) 1D

( ) Finite Element (X) Beam (Lumped Mass) ( ) Closed Form Solution

4. (X) Computer Codes: ICES - STRUDL

Frequency Range and No. of modes considered: 9.7 - 198 cps ; Modes - 11

( ) Hand Calculations: ____________

5. Method of Combining Dynamic Responses: ( ) Absolute Sum (X) SRSS

( ) Other: ____________ (specify)

6. Damping: OBE 1% SSE 1% Basis for the damping used: Per Bechtel Spec.

7. Support Considerations in the model: Pump support is partially fixed & column supports are pinned.

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Nozzle		NORMAL + E'	14,726 psi	32,097 psi	42,000 psi
Column		D + E'	12,953 psi	16,490 psi	32,880 psi
Anchor Bolt		NORMAL + E'	34,437 psi	34,728 psi	51,763 psi

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
.044"	Shaft	.1"
.0017"	Impeller	.016"

Table VII-A-15

SUMMARY OF VENDOR SEISMIC QUALIFICATION

COMPONENT COOLING WATER PUMP 1P-73 A&B, 2P-73 A&B

Table VII-A-15 Component Cooling Water Pump
1P-73 A&B, 2P-73 A&B

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Component Cooling Water Pump

1. Scope: ( ) NSSS (X) BOP
2. Model Number: 10x12x17 Cap Pump
3. Vendor: Bingham-Willamette Co.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Centrifugal Pump
   b. Dimensions 48" L x 19" W x 53" H (Approx.)
   c. Weight 1450 lbs.
6. Location: Building: Auxiliary Building
   Elevation: 584'-0" & 599'-0"
7. a. System in which located: Component cooling water
   b. Functional Description: Circulate water in cooling system
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications: Bechtel Spec. 7220-M53

III. Equipment Qualfication Method:

( ) Test (X) Analysis ( ) Combination of Test and Analysis

Qualification Report*: Seismic Analysis of Bingham-Willamette Co.
(No., Title and Date) 10x12x17 Cap Pump, Serial No 1A251/5, Dec, 1975

Bechtel Document No. : 7220 - M53 - 24 - 5

Company that Prepared Report: Van Gulik & Associates, Inc.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only
   b. ( ) Hydrodynamic only
   c. ( ) Combination of (a) and (b)
2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)
3. Required Response Spectra : Aux. Bldg - El. 599'-0"
4. Damping Corresponding to RRS: OBE 1% SSE 1%
5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .16g F/B = .13g V = .14g
6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

   ( ) Static Analysis (x) Equivalent Static Analysis

   ( ) Dynamic Analysis: ( ) Time-History ( ) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = >33cps F/B = 90.3cps V = >33 cps

3. Model Type: ( ) 3D (X) 2D ( ) 1D

   ( ) Finite Element ( ) Beam (Lumped Mass) (x) Closed Form Solution

4. ( ) Computer Codes: ______

   Frequency Range and No. of modes considered: >33cps

   (X) Hand Calculations: Cantilever beam - f= 90.3cps

5. Method of Combining Dynamic Responses: (x) Absolute Sum ( ) SRSS

   ( ) Other: ______ (specify)

6. Damping: OBE 1% SSE 1% Basis for the damping used: per Bechtel Spec.

7. Support Considerations in the model: Pinned supports at anchor bolts

8. Critical Structural Elements:

A. Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Pump Suction Nozzle		Normal + E'	*	19,564 psi	28,000 psi

* Not separated

B. Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
.0075"	Shaft	.011"
.001"	Pump Case	.0047"

Table VII-A-16

SUMMARY OF VENDOR SEISMIC QUALIFICATION

COMPONENT COOLING WATER HEAT EXCHANGER
1E-73 A&B, 2E-73 A&B

Table VII-A-16 Component Cooling Water Heat Exchanger
1E-73 A&B, 2E-73 A&B

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Component Cooling Water Heat Exchanger

1. Scope: ( ) NSSS (X) BOP
2. Model Number: 74-N-011-1-1A
3. Vendor: Yuba Heat Transfer Corp.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Cylindrical horizontal heat exchanger

   b. Dimensions $53\frac{7}{8}$" O.D. 39'-0$\frac{11}{16}$" LONG

   c. Weight 96,800 lbs (Full)
6. Location: Building: Aux. Bldg.

   Elevation: 584'-0" & 599'-0"
7. a. System in which located: Component cooling water

   b. Functional Description: Remove plant waste heat from component cooling water.

   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown

   (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:

   Bechtel Spec. 7220-M51

III. Equipment Qualfication Method:

( ) Test (X) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. N-011-1-S, Rev.3, Seismic Analysis on Yuba

(No., Title and Date) Component Cooling Heat Exchanger, Dec., 1975

Bechtel Document No. : 7220-M15-51-4

Company that Prepared Report: Yuba Heat Transfer Corp.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux Bldg - El. 599'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .16g F/B = .13g V = .15g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. <u>If Qualification by Analysis, then complete</u>:

1. Method of Analysis:

   ( ) Static Analysis (x) Equivalent Static Analysis

   ( ) Dynamic Analysis: ( ) Time-History ( ) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 32.5 cps F/B = 18.3 cps V = 18.4 cps

3. Model Type: ( ) 3D (x) 2D ( ) 1D

   ( ) Finite Element (X) Beam (Lumped Mass) ( ) Closed Form Solution

4. (x) Computer Codes: Yuba "Frame Analysis" Program

   Frequency Range and No. of modes considered: 18-33 cps - Mode 1

   ( ) Hand Calculations: ____________

5. Method of Combining Dynamic Responses: ( ) Absolute Sum (X) SRSS

   ( ) Other: ____________ (specify)

6. Damping: OBE 1% SSE 1% Basis for the damping used: per Bechtel Spec.

7. Support Considerations in the model: Fixed & sliding supports

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Shell	Rear Support	Normal + E'	15411 psi	22,275 psi	42,000 psi
Shell	N2 Nozzle	Normal + E'	25,853 psi	31,278 psi	42,000 psi
Anchor Bolt		Normal + E'	22,363 psi	22,363 psi	35,200 psi

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
N/A		

Table VII-A-17

SUMMARY OF VENDOR SEISMIC QUALIFICATION

AUXILIARY FEEDWATER PUMP (MOTOR DRIVEN) 1P-05A, 2P-05A

Table VII-A-17 Auxiliary Feedwater Pump (Motor Driven) 1P-05A, 2P05-A

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Auxiliary Feedwater Pump (Electric)

1. Scope: ( ) NSSS (X) BOP
2. Model Number: 4x8x10½ MSD-D 7 Stage
3. Vendor: Bingham-Willamette Co.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Horizontal pump
   b. Dimensions 152"L x 42"W x 43"H
   c. Weight 12,770 lbs
6. Location: Building: Auxiliary Building
   Elevation: 584'-0"
7. a. System in which located: Feedwater + Condensate System
   b. Functional Description: Backup source of feedwater
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:

   Bechtel Spec. 7220-M14

III. Equipment Qualfication Method:

( ) Test   (x) Analysis   ( ) Combination of Test and Analysis

Qualification Report*: ME-613, Seismic-Stress Analysis of Motor

(No., Title and Date) Driven Pumps, March, 1981

Bechtel Document No. : 7220-M14-124-3

Company that Prepared Report: McDonald Engineering Analysis Co.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg - El. 584'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .12g F/B = .13g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

   (x) Static Analysis   (x) Equivalent Static Analysis

   (x) Dynamic Analysis: (Natural Frequencies)   ( ) Time-History ( ) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 46.2 cps F/B = >50.5 cps V = 50.5 cps

3. Model Type: (x) 3D   ( ) 2D   ( ) 1D

   (x) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (x) Computer Codes: ICES - STRUDL

   Frequency Range and No. of modes considered: 46.2 - 50.5 cps - Modes - 2 (For eigensolution only)

   ( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: ( ) Absolute Sum (x) SRSS

   ( ) Other: ______ (specify)

6. Damping: OBE 1% SSE 1% Basis for the damping used: Per Bechtel spec.

7. Support Considerations in the model: Pinned supports at anchor bolts

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Anchor Bolt		Normal + E'	*	14,408 psi	22,490 psi
Nozzle (Discharge)		Normal + E'	13,818 psi	16,282 psi	28,000 psi
Nozzle Flange		Normal + E'	*	20,057 psi	33,600 psi

* Not Separated

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
.003"	Flexible Coupling Lateral Deflection	.003
.0036"	Impeller	.0055"

Table VII-A-18

SUMMARY OF VENDOR SEISMIC QUALIFICATION

AUXILIARY FEEDWATER PUMP (TURBINE DRIVEN) 1P-05B, 2P-05B

Table VII-A-18 Auxiliary Feedwater Pump (Turbine Driven)
1P-05B, 2P-05B

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Auxiliary Feedwater Pump (Turbine)

1. Scope: ( ) NSSS (X) BOP
2. Model Number: 4x8x10½ MSD-D 7 Stage
3. Vendor: Bingham-Willamette Co.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Horizontal pump

   b. Dimensions 165½" L x 34" W x 48" H

   c. Weight 10,635 lbs.
6. Location: Building: Auxiliary Building

   Elevation: 584'-0"
7. a. System in which located: Condensate + Feedwater

   b. Functional Description: Backup source of feedwater

   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown

   (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:

   Bechtel Spec. 7220-M14

III. Equipment Qualfication Method:

( ) Test (x) Analysis ( ) Combination of Test and Analysis

Qualification Report*: ME-614, Seismic-Stress Analysis of Turbine

(No., Title and Date) Driven Pumps, March, 1981

Bechtel Document No. : 7220-M14-125-3

Company that Prepared Report: McDonald Engineering Analysis Co.

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg - El. 584'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .12g F/B = .13g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (x) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

   (X) Static Analysis (X) Equivalent Static Analysis

   (X) Dynamic Analysis: ( ) Time-History ( ) Response Spectrum
   (Natural Frequencies)

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = 48.7 cps F/B = > 48.7 cps V = 41.3 cps

3. Model Type: (X) 3D ( ) 2D ( ) 1D

   (X) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (X) Computer Codes: ICES-STRUDL

   Frequency Range and No. of modes considered: 41.3 - 48.7 cps - Modes - 2
   (Eigensolution only)

   ( ) Hand Calculations: ________

5. Method of Combining Dynamic Responses: ( ) Absolute Sum (X) SRSS
   ( ) Other: ________ (specify)

6. Damping: OBE 1% SSE 1% Basis for the damping used:
   Per Bechtel Spec.

7. Support Considerations in the model: Pinned supports at anchor bolt.

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Anchor Bolt		Normal + E'	*	17,501 psi	26,000 psi
Nozzle (Discharge)		Normal + E'	13,818 psi	16,282 psi	28,000 psi
Nozzle Flange		Normal + E'	*	20,057 psi	33,600 psi

* Not separated

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
.003"	Flexible Coupling Lateral Deflection	.003"
.0036"	Impeller	.0055"

Table VII-A-19

SUMMARY OF VENDOR SEISMIC QUALIFICATION

AIR FILTRATION UNITS OVM-79A & OVM-79B

Table VII-A-19 Air Filtration Units OVM-79A & OVM-79B

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company

2. Type: PWR

3. NSSS: B & W

4. A/E: Bechtel

II. Component Name: Air Filtration Unit

1. Scope: ( ) NSSS (X) BOP

2. Model Number: 4000 CFM Air Filtration Unit

3. Vendor: Mine Safety Appliance Company

4. If the component is a cabinet or panel, name and model No. of the devices included: ____________________

5. Physical Description a. Appearance Rectangular sheet metal filter housing

b. Dimensions 357"L x 71"W x 80"H

c. Weight 15,100 lbs.

6. Location: Building: Aux. Bldg - Control Tower

Elevation: 685'-0"

7. a. System in which located: Control room supply, recirculation & exhaust system

b. Functional Description: Filters control room exhaust air

c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown ( ) Both (X) Neither

8. Pertinent Reference Design Specifications:

Bechtel Spec. 7220-M150

III. Equipment Qualfication Method:

( ) Test (x) Analysis ( ) Combination of Test and Analysis

Qualification Report*: Report on Seismic Analysis of the 4000 CFM Air

(No., Title and Date) Filtration Unit, Item 1-OVM79A & 79B, July, 1976

Bechtel Document No. : 7220-M150-51-4

Company that Prepared Report: Mine Safety Appliance Company

Company that Reviewed Report: Bechtel

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg-Control Tower, El. 685'0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .26g F/B = .24g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis,* then complete:

1. Method of Analysis:

( ) Static Analysis ( ) Equivalent Static Analysis

(X) Dynamic Analysis: ( ) Time-History (X) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):
(First frequency = 28.9 cps, direction not given)
S/S = ______ F/B = ______ V = ______

3. Model Type: (X) 3D ( ) 2D ( ) 1D

(X) Finite Element ( ) Beam (Lumped Mass) ( ) Closed Form Solution

4. (X) Computer Codes: ANSYS

Frequency Range and No. of modes considered: Not given

( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: ( ) Absolute Sum ( ) SRSS
(X) Other: Not given (specify)

6. Damping: OBE 1% SSE 1% Basis for the damping used: Per Bechtel Spec.

7. Support Considerations in the model: Not given

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Vertical Door Frame		D+P+E'	*	23,029 psi	32,000 psi
End Plates		D+P+E'	*	15,668 psi	32,000 psi

* Not separated from total stress

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
.00294"	HEPA Filter Rack	.167"

*Note: Full report was not received from vendor.

Table VII-A-20

SUMMARY OF VENDOR SEISMIC QUALIFICATION

DECAY HEAT REMOVAL HEAT EXCHANGERS 1E-60 A&B, 2E-60 A&B

TABLE VII-A-20 Decay Heat Removal Heat Exchangers 1E60 A&B, 2E60 A&B

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: DECAY HEAT REMOVAL HEAT EXCHANGERS

1. Scope: ( ) NSSS (X) BOP
2. Model Number: "None"
3. Vendor: Atlas Industrial Mfg. Co.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Horizontal heat exchanger
   b. Dimensions 22'-7" L x 5'-0" H x 3'-8" W
   c. Weight 35,700 lbs.
6. Location: Building: Auxiliary Building
   Elevation: 584'-0"
7. a. System in which located: Decay heat and core flooding system
   b. Functional Description: Heat Exchanger to remove residual heat from RCS
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown
   (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   B&W Spec. 08-1024000010-04

III. Equipment Qualfication Method:

( ) Test   (X) Analysis   ( ) Combination of Test and Analysis

Qualification Report*: No. 1192, Seismic Analysis of Decay Heat
(No., Title and Date) Cooler, May 20, 1974.

Bechtel Document No. : B&W No. 32-0441-001

Company that Prepared Report: Dynatech R/D Company

Company that Reviewed Report: B&W

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only
   b. ( ) Hydrodynamic only
   c. ( ) Combination of (a) and (b)
2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)
3. Required Response Spectra : Aux. Bldg. - El. 584'-0"
4. Damping Corresponding to RRS: OBE ½% SSE ½%
5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .12g   F/B = .13g   V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes   (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

   ( ) Static Analysis (X) Equivalent Static Analysis

   ( ) Dynamic Analysis: ( ) Time-History ( ) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = (None Calculated) F/B = ______ V = ______

3. Model Type: ( ) 3D ( ) 2D ( ) 1D

   ( ) Finite Element ( ) Beam (Lumped Mass) (X) Closed Form Solution

4. (X) Computer Codes: Program NOZZLE & Program REACT

   Frequency Range and No. of modes considered: N/A

   ( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: (X) Absolute Sum (2 components) ( ) SRSS

   ( ) Other: ______ (specify)

6. Damping: OBE ½% SSE ½% Basis for the damping used: (Assumed)

7. Support Considerations in the model: Pinned supports at anchor bolts

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Tubeside Nozzle		Normal + E'	1507 psi	14,885 psi	30,000 psi
Shellside Nozzle		Normal + E'	2822 psi	14355 psi	27,450 psi
Shell Stress @ Supports		Normal + E'	11610 psi	23143 psi	27450 psi
Foundation Bolts		Normal + E'	28192 psi	28192 psi	40000 psi

Note: Stresses reported are for a factor of 4 increase in nozzle loads later requested by Bechtel.

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
N/A		

Table VII-A-21

SUMMARY OF VENDOR SEISMIC QUALIFICATION

MAKEUP PUMPS 1P-58 A,B&C, 2P-58 A,B&C

TABLE VII-A-21 Makeup Pumps 1P-58 A,B&C
2P-58 A,B&C

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: Makeup Pumps

1. Scope: ( ) NSSS (X) BOP
2. Model Number: HMBS 4x4x9L - 12 Stage
3. Vendor: Babcock & Wilcox Canada, Ltd.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Horizontal pump
   b. Dimensions Not included in qualification report
   c. Weight 9050 lbs.
6. Location: Building: Auxiliary Building
   Elevation: 599'-0"
7. a. System in which located: Makeup and purification system
   b. Functional Description: Primary coolant makeup + HP Injection
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown
   (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   B&W Contract Spec. 11-1107000005-02 & 08-1130000009-07
   dated, Feb. 12, 1973

III. Equipment Qualfication Method: PUMP

( ) Test (X) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 7036-23.8/1.0 Rev. 1, Seismic Analysis

(No., Title and Date) Report, 3/27/75

Bechtel Document No. : N/A

Company that Prepared Report: Babcock & Wilcox Canada Ltd.

Company that Reviewed Report: Babcock & Wilcox

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg. - El. 599'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .15g F/B = .13g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

( ) Static Analysis (x) Equivalent Static Analysis

( ) Dynamic Analysis: ( ) Time-History ( ) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = > 100 Hz F/B = >100 Hz V = > 100 Hz

3. Model Type: ( ) 3D ( ) 2D ( ) 1D

( ) Finite Element ( ) Beam (Lumped Mass) (x) Closed Form Solution

4. (x) Computer Codes: B&W ASME III Program & NASTRAN

Frequency Range and No. of modes considered: ______

( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: ( ) Absolute Sum (x) SRSS

( ) Other: ______ (specify)

6. Damping: OBE "Not given" SSE ______ Basis for the damping used: ______

7. Support Considerations in the model: Pinned supports at anchor bolts

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Foundation Bolts		Normal + E'	f_v = 10,203 psi	10,203 psi	12,500 psi
Suction Nozzle		Normal + E'	14,570 psi	15,541 psi	17,800 psi

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
.00136"	Shaft	.022"

III. Equipment Qualfication Method: GEAR BOX

( ) Test (X) Analysis ( ) Combination of Test and Analysis

Qualification Report*: No. 20168, Seismic Analysis, Q Gear

(No., Title and Date) Drive & Lubrication System, July 17, 1974

Bechtel Document No. : N/A

Company that Prepared Report: Terry Steam Turbine Co.

Company that Reviewed Report: B&W

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg - El. 599'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

   SSE S/S = .15g F/B = .13g V = .13g

6. Were fatigue effects or other vibration loads considered?

   ( ) Yes (X) No

   If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. <u>If Qualification by Analysis, then complete</u>:

1. Method of Analysis:

   ( ) Static Analysis (x) Equivalent Static Analysis

   ( ) Dynamic Analysis: ( ) Time-History ( ) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S = "None calculated" F/B = ______ V = ______

3. Model Type: ( ) 3D ( ) 2D ( ) 1D

   ( ) Finite Element ( ) Beam (Lumped Mass) (x) Closed Form Solution

4. ( ) Computer Codes: ______

   Frequency Range and No. of modes considered: ______

   (x) Hand Calculations: Equivalent static analysis

5. Method of Combining Dynamic Responses: ( ) Absolute Sum ( ) SRSS

   (X) Other: 3-component not considered (specify)

6. Damping: OBE "None given" SSE ______ Basis for the damping used: ______

7. Support Considerations in the model: Pinned supports at anchor bolts

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Q Gear Taper Pin		D+E'	14,076psi	14,076psi	21,450psi
Bull Gear Thrust Bearings		D+E'	120psi	120psi	150psi

B.

Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
.00014"	Bull Gear Shaft	"None specified"

Table VII-A-22

SUMMARY OF VENDOR SEISMIC QUALIFICATION

DECAY HEAT REMOVAL PUMP 1P-58 A&B, 2P-58 A&B

Table VII-A-22 Decay Heat Removal Pump 1P-58 A&B, 2P-58 A&B

SEISMIC MARGIN EARTHQUAKE

SUMMARY OF EQUIPMENT

I. Plant Name: MIDLAND

1. Utility: Consumers Power Company
2. Type: PWR
3. NSSS: B & W
4. A/E: Bechtel

II. Component Name: DECAY HEAT REMOVAL PUMP

1. Scope: ( ) NSSS (X) BOP
2. Model Number: KSMK-10X12X21
3. Vendor: Babcock & Wilcox Canada Ltd.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Horizontal pump
   b. Dimensions Not specified in report
   c. Weight Not specified in report
6. Location: Building: Auxiliary Building
   Elevation: 568'-0"
7. a. System in which located: Decay heat and core flooding system
   b. Functional Description: ______
   c. Is the equipment required for ( ) Hot Shutdown ( ) Cold Shutdown (X) Both ( ) Neither
8. Pertinent Reference Design Specifications:
   B&W Contract Spec. 08-130000009-02, dated 2-21-73

III. Equipment Qualfication Method:

( ) Test   (X) Analysis   ( ) Combination of Test and Analysis

Qualification Report*: No.32-0187-00, Appendix 1 to Pump Seismic

(No., Title and Date) & ASME Analysis, 9/25/73

Bechtel Document No. : N/A

Company that Prepared Report: Babcock & Wilcox Canada Ltd.

Company that Reviewed Report: B&W

IV. Vibration Input:

1. Loads considered: a. (X) Seismic only

   b. ( ) Hydrodynamic only

   c. ( ) Combination of (a) and (b)

2. Method of Combining RRS: ( ) Absolute Sum ( ) SRSS (X) N/A (Other, specify)

3. Required Response Spectra : Aux. Bldg. - El. 568'-0"

4. Damping Corresponding to RRS: OBE 1% SSE 1%

5. Required Acceleration in Each Direction: (X) ZPA ( ) Other ______ (specify)

SSE S/S = .13g F/B = .12g V = .12g

6. Were fatigue effects or other vibration loads considered?

( ) Yes (X) No

If yes, describe loads considered and how they were treated in overall qualification program: ______

*NOTE: If more than one report, complete items III thru VI for each report.

VI. If Qualification by Analysis, then complete:

1. Method of Analysis:

( ) Static Analysis (X) Equivalent Static Analysis

( ) Dynamic Analysis: ( ) Time-History ( ) Response Spectrum

2. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

S/S = >60cps F/B = >60cps V = >60cps

3. Model Type: ( ) 3D ( ) 2D ( ) 1D

( ) Finite Element ( ) Beam (Lumped Mass) (X) Closed Form Solution

4. (X) Computer Codes: B&W ASME III Program

Frequency Range and No. of modes considered: ______

( ) Hand Calculations: ______

5. Method of Combining Dynamic Responses: ( ) Absolute Sum (X) SRSS

( ) Other: ______ (specify)

6. Damping: OBE "Not given" SSE ______ Basis for the damping used: ______

7. Support Considerations in the model: Pinned supports at anchor bolts

8. Critical Structural Elements:

A. Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Foundation Bolts		Normal + E'	f_v = 14,423 psi	14,423 psi	15,000 psi
Suction Flange		Normal + E'	S_H = 2691 psi	16,147 psi	20,850 psi
Discharge Flange		Normal + E'	S_H = 3869 psi	17,599 psi	20,850 psi

B. Max. Critical Deflection	Location	Maximum Allowable Deflection to Assure Functional Operability
.0023"	Shaft & Impeller	.014"

50-329
50-330

SMA 13701.05R003(VOLUME VII)

SEISMIC MARGIN REVIEW
MIDLAND ENERGY CENTER PROJECT

VOLUME VII

ELECTRICAL, CONTROL, INSTRUMENTATION AND MECHANICAL EQUIPMENT MARGINS

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Jackson, Michigan

February, 1983

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