Consumers Power Company

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June 28, 1984

Mr Harold R Denton, Director
Office of Nuclear Reactor Regulation
Division of Licensing
US Nuclear Regulatory Commission
Washington, DC 20555

MIDLAND ENERGY CENTER
MIDLAND DOCKET NOS 50-329, 50-330
NRC REQUEST FOR ADDITIONAL INFORMATION ON THE
SEISMIC MARGIN REVIEW REPORT
FILE B3.7.1 SERIAL 29815

REFERENCE: (1) LETTER FROM J W COOK TO H R DENTON
DATED FEBRUARY 4, 1983, SERIAL 21010

(2) LETTER FROM E G ADENSAM (NRC) TO J W COOK
DATED APRIL 30, 1984

ATTACHMENT RESPONSE TO NRC QUESTIONS ON VOLUME VII OF CONSUMERS
POWER COMPANY SEISMIC MARGIN REVIEW REPORT

In Reference (1), Consumers Power Company submitted Volume VII of the Seismic Margin Review Report titled, "Electrical Control Instrumentation and Mechanical Equipment Margins," for the Staff's review. Subsequently, in Reference (2) the NRC requested additional information on Volume VII. As an attachment to this letter, Consumers Power Company is submitting the responses to the questions contained in Reference (2).

James W. Cook

JWC/DRW/bjw

CC JGKeppler, Administrator, NRC Region III
DSHood, Midland Project Manager, Washington, DC
Midland NRC Resident Inspector's Office
LJAuge, Manager, ETEC

oc0584-0859a100

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CONSUMERS POWER COMPANY
Midland Units 1 and 2
Docket No 50-329, 50-330

Letter Serial 29815 Dated June 28, 1984

At the request of the Commission and pursuant to the Atomic Energy Act of 1954, and the Energy Reorganization Act of 1974, as amended and the Commission's Rules and Regulations thereunder, Consumers Power Company submits additional information on the Seismic Margin Review Report Volume VII titled, "Electrical Control Instrumentation and Mechanical Equipment Margins."

CONSUMERS POWER COMPANY

By James W. Cook
James W Cook, Vice President
Projects, Engineering and Construction

Sworn and subscribed before me this 3rd day of July, 1984.

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires Sept 8, 1984

oc0584-0859a100

RESPONSE TO NRC QUESTIONS ON VOLUME VII OF

CONSUMERS POWER CO. SEISMIC MARGIN REVIEW REPORT

DOCKET NOS. 50-329 OM,OL and 50-330 OM,OL

Question (1) Table VII-5-5 Diesel Engine Generator, Part VI. 8.B shows "Max. Critical Deflection" N/A. Explain why this maximum critical deflection was not included, as part of the required assurance of operability.

Answer (1)

The Diesel Engine Generator deflection is not the critical SME margin, and was not reported on the basis that only the most critically stressed elements would be addressed. The seismic margin as defined in Volume VII is greater than 21.5.

To illustrate the "SSE" margin, the attached Figure 3 from Delaval Turbine Inc. report 7220-M18-372-1 is attached. From this table, the maximum out-of-phase displacement is 0.0167", while the "air gap" between rotor and stator is stated in the report to be 0.36." Therefore:

$$S.F.\ (SSE) = \frac{0.36}{0.0167} = 21.56$$

The SME acceleration was enveloped by the SSE acceleration and the S.F. (SME) would be larger than 21.56.

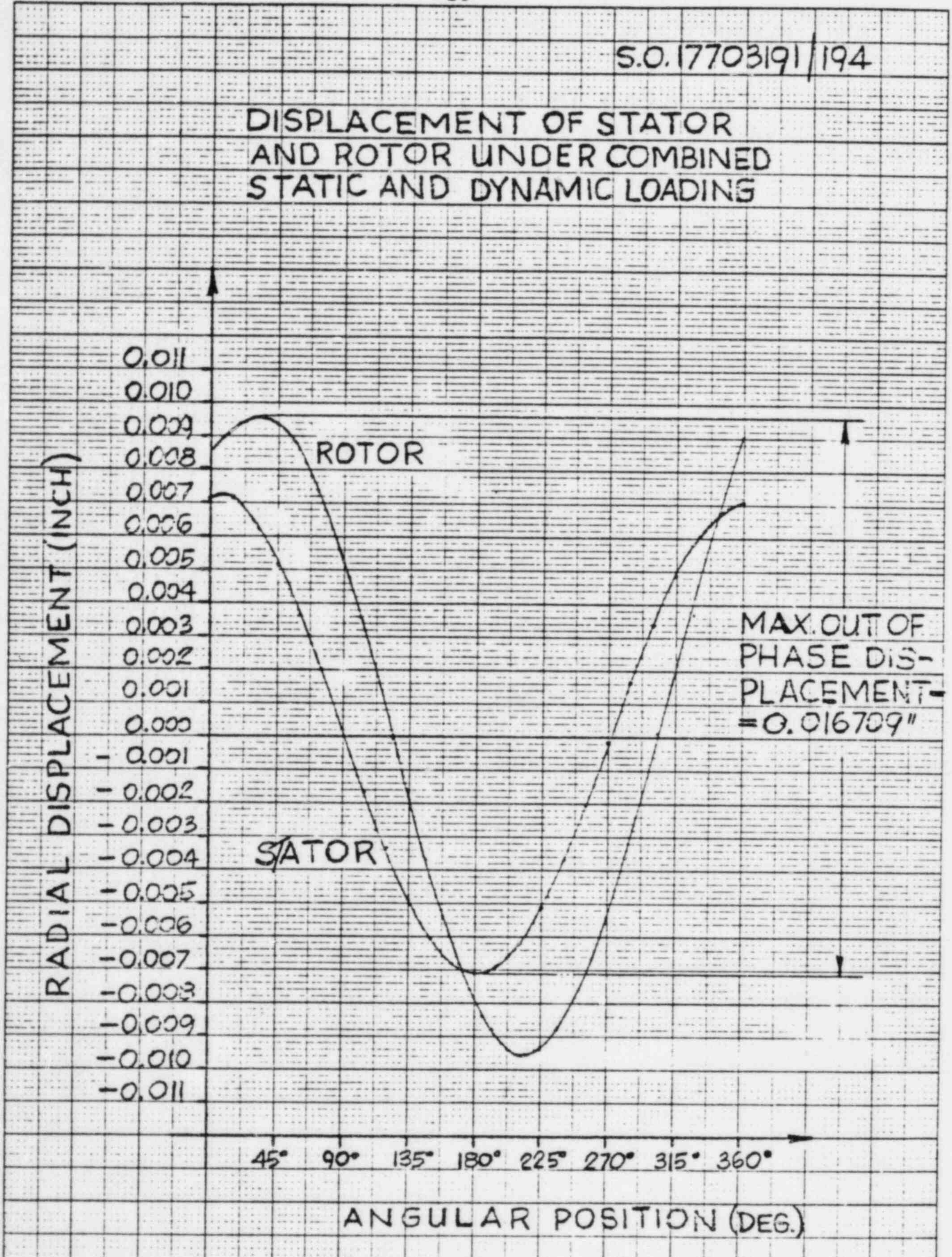


FIGURE 3

7220-M18-372-1
pg 34

Question (2) Page VII-7-5 states:

"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."

The test, for these cabinets, is described in Appendix A, Table VII-A-9 as multi-axis and multi-frequency. Figure VII-A-9-3 presents the seismic spectra for the side-side/vertical axes of excitation for SME and TRS spectra. This figure shows at the fundamental side-side frequency for the sensor cabinet (6.1 Hz) and the ECCAS cabinet (8.1 Hz), the SME is 1.88 and 2.38, respectively, greater than the TRS accelerations. Clarify the above statement to account for the multi-axis aspect of this test versus the single axis presentation.

Answer (2)

The tests were biaxial with input motion applied front-to-back plus vertical and side-to-side plus vertical. Control accelerometers were attached to the shake table and additional accelerometers were attached to the cabinets. Control accelerometers recorded motion in all three axes resulting from the biaxial forcing motions. Figure VII-A-9-2 presents the horizontal acceleration spectrum for a side-side/vertical axis input. Figure VII-A-9-3 presents a vertical acceleration spectrum for the same side-side/vertical axis input. Figure VII-A-9-1 presents a horizontal acceleration spectrum for front-back/vertical axis input. A fourth acceleration spectrum showing a vertical response spectrum resulting from front-to-back/vertical axis input was enveloped by Figure

VII-A-9-3 and was not reported. The control accelerometers record coupled response between the horizontal and vertical inputs, but only in the specified axis of interest. Thus, for each biaxial input, the response in each of the three principal axes is recorded.

The manufacturer's test report states the ECCAS has natural frequencies of S/S 6.1 Hz; F/B 10.7 Hz; and V 35.0 Hz. Using these directional frequencies and referring to the corresponding control accelerometer spectrum, S/S response is Figure VII-9-2 (horizontal motion), F/B response is Figure VII-9-1 (horizontal motion) and V response is Figure VII-9-3 (vertical motion).

At the cabinet natural frequencies, the control accelerometer shows the following factors of safety (TRS/RRS(SME)):

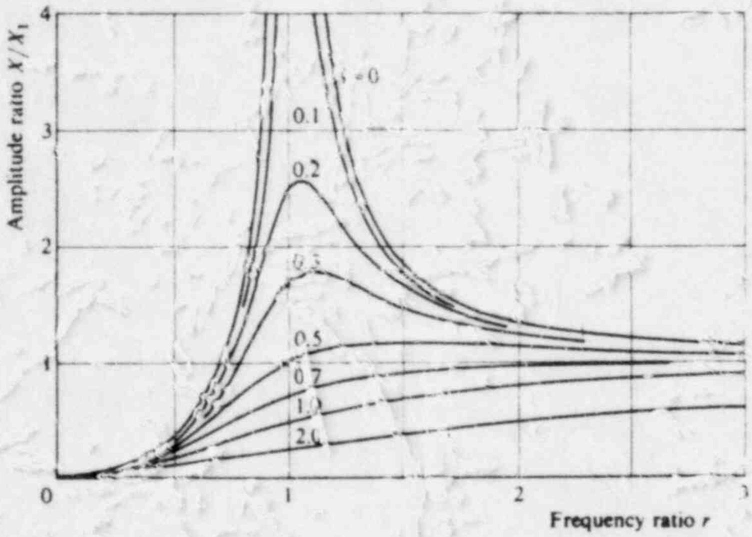
Direction	Frequency	F.S.
S/S	6.1	1.33
F/B	10.7	5.00
V	35.0	1.41

The uneveloped regions of the SME spectra occur at frequencies lower than the natural frequencies of the cabinet.

Figure	Direction	Natural Frequency	Uneveloped Frequency	fn/f
VII-9-2	S/S	6.1	<4.2	1.45
VII-9-1	F/B	10.7	<5.7	1.88
VII-9-3	V	35.0	<11.3	3.10

The lower frequency content of the RRS has very little effect on the response of the cabinet at its natural frequencies.

As an example, refer to the SME vertical response spectrum plot, Figure VII-9-3. The spectrum shows that although the SME contains significant low frequency motion in the vertical direction, the vertical response of an oscillator with a frequency (vertical) of 35.0 Hz will show only minor amplification. This point is further illustrated by the figure below taken from Mechanical Vibrations, Tse, Morse & Hinkle, 1964.



The figure shows the steady-state response amplification of a single degree-of-freedom oscillator subjected to a harmonic base motion. The frequency ratio, r, is the ratio of the oscillator natural frequency to the forcing function frequency. For the cabinet in question here, the ratio of the vertical fundamental frequency to the frequency at which the SME spectrum is first unenveloped is 3.1. From the figure, it is seen that at a frequency ratio of 3.1, response amplification is negligible. Thus, it can be concluded that the low frequency vertical motion in the SME has negligible importance, and the fact that the SME is not enveloped in this region does not present a qualification concern. Any contribution to the vertical response from this low frequency motion could, therefore, only arise if the horizontal modes (6.1 and 10.7 Hz) have coupled vertical response with large mass participation factors. Large amounts of coupling between horizontal and vertical axes does not exist as demonstrated by the qualification tests.

Question (3) Table VII-A-12 (Control Room HVAC OVM-01A and 02A) shows that the unit was qualified by a combination of test and analysis. The natural frequencies for side-side, front-back and vertical by testing were all above 33 Hz (V.5), while the natural frequencies by dynamic analysis were 4.8 hz (side-side), 5.0 Hz (front-back) and 7.0 Hz (vertical) (VI.2). Explain (1) this discrepancy, (2) why the frequency range for the dynamic analysis did not consider the higher modes up to 33 Hz and (3) why the maximum critical deflection for the motor was not addressed.

Answer (3)

The test procedure was conducted on the individual components of the HVAC unit, and these components were found to have fundamental frequencies greater than 33 Hz. The dynamic analysis model represented the HVAC units' structure and internals with the main structure mounted on vibration isolators (springs). The frequencies reported for analysis are for the HVAC units' structure vibrating in a rigid body mode on the springs.

The dynamic analysis eigenvector solution was carried out for 99 modes up to a frequency of 2340.0 Hz. The manufacturer only considered those modes that were less than 33 Hz. The range of frequency from 4.8 to 18.9 Hz represented eight modes. The ninth mode had a frequency of 34.0 Hz. Almost all of the mass was felt to be participating in the eight modes less than 33 Hz, thus the cut-off at 18.9 Hz is justified.

The manufacturer states in their seismic qualification report that the "motor is satisfactory up to 10g's." This is significantly greater than the calculated 4.4g response of the HVAC unit for the SSE. Bechtel's review of the vendor report challenged the vendor to provide evidence of motor qualifications. The vendor responded stating that the Westinghouse motor was qualified within the guidelines of IEEE 344-1975 and conforms to the requirements of Bechtel specification 7220-M-149.

Specific qualification data were not provided. The Bechtel specification indicates a horizontal response spectrum peaking at 5.0g. The fundamental frequency of the unit lies within the broadened peak, thus we based our acceptance criteria of 5.0g on the required RRS for qualifying the motor. Note that the SME is less than the SSE used in the unit response analysis and the response to the SME is less than 4.4g. The calculated seismic margin for the motor is 1.8 as stated in the report and is based upon a 5.0g allowable acceleration and a SME response scaled downward from the 4.4g SSE response by the ratio of the SME/SSE spectral acceleration at the equipment fundamental frequency.

Question (4) Table VII-A-17 (Aux. Feedwater Pump - Motor Driven), Item VI, 8.B shows "the maximum critical deflection = .003 inches (for the flexible coupling lateral deflection) and the maximum allowable deflection to as re functional operability = .003 inches" for SSE seismic loading. The report, in Section 8.7, has only addressed the seismic margins for the high stress locations and not this critical operational deflection. Explain why this maximum deflection was not calculated for the SME spectra accelerations.

Question (5) Table A-18 (Aux. Feedwater Pump - turbine Driven), Item VI.8.B shows "the maximum critical deflection = .003 inches (for the flexible coupling lateral deflection) and the maximum allowable deflection to assure functional operability = .003 inches" for SSE seismic loading. The report, in Section 8.8, has only addressed the seismic margins for the high stress locations and not this critical operational deflection. Explain why this maximum deflection was not calculated for the SME spectra accelerations.

Answer (4) and (5)

In Volume VII, only the governing margins were delineated. The 0.003 inch displacement was calculated by the vendor for an equivalent static load of 1g in each direction combined with normal operating hydraulic loads. The zero period accelerations for the SME are only 0.2g NS, 0.18g EW, and 0.1g V compared to the 1.0g used in the analysis. The components are rigid and the ZPA is the appropriate seismic load. The allowable displacement by the vendor was actually 0.0036 instead of 0.003 as stated in the report. Most of the deflection arises from hydraulic loads rather than seismic and the computed margin from Equation 3-2 is 15.7.

Question (6) Page VII-8-9 for Section 8.7 (Aux. Feedwater Pump - Electric Motor Driven) states: "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", and for Section 8.8 (Aux. Feedwater Pump - Turbine Driven) states: "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." Since both of these pumps are located in the Auxiliary Building at Elevation 524'-0", explain why there is a difference in these two statements and present the appropriate horizontal and vertical seismic spectra.

Answer (6)

The two statements are the same, although the wording is structured differently, i.e., design ZPA greater than SME ZPA is the same as SME ZPA less than design ZPA. The horizontal and vertical spectra comparisons are enclosed as requested, Figures 1 through 3. Only the ZPA comparisons are made as the pump was determined by analysis to be rigid.

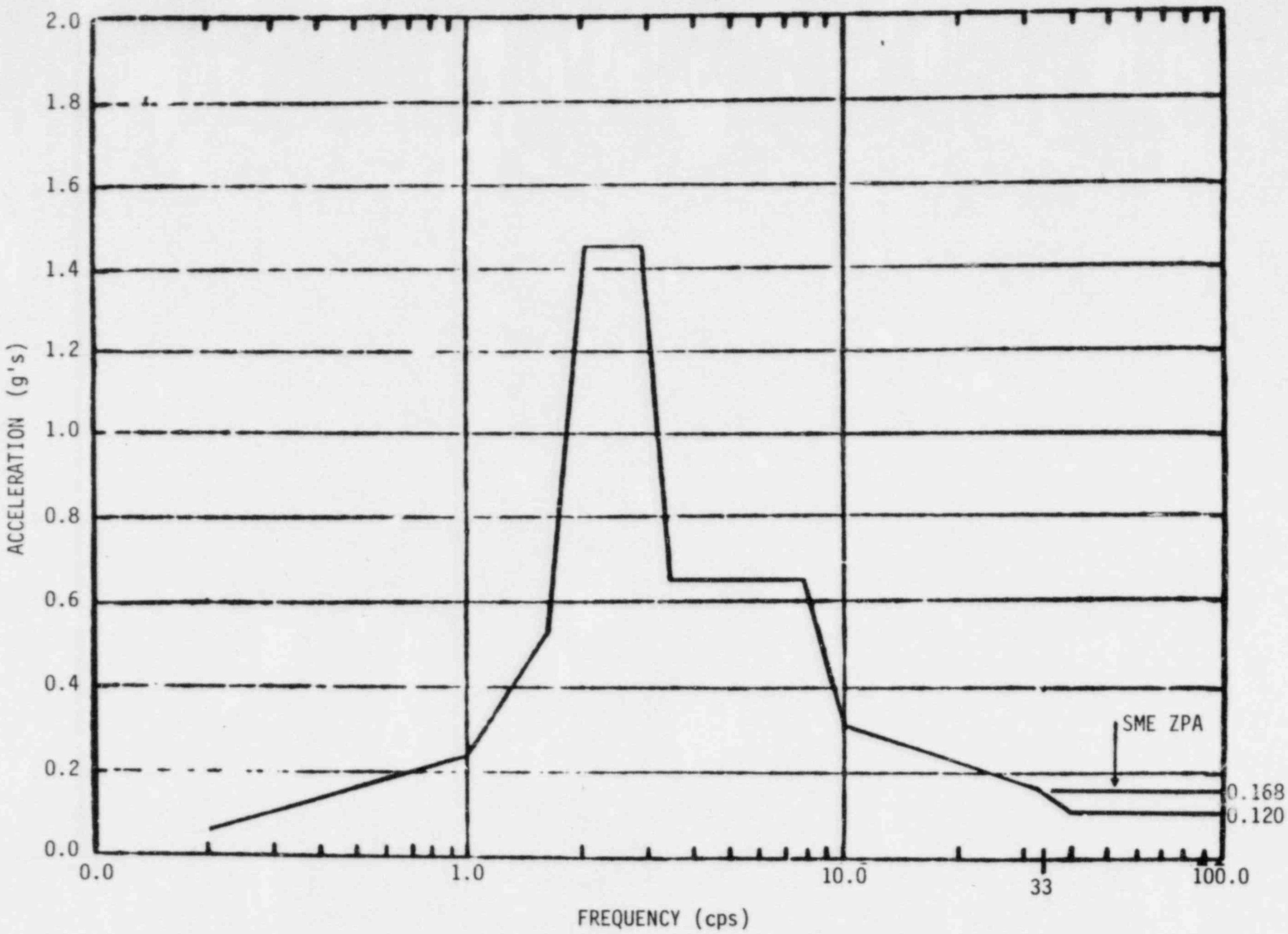


FIGURE 1. FLOOR RESPONSE SPECTRUM - AUXILIARY BUILDING, ELEVATION 584'-0", EAST-WEST DIRECTION, 1977 MIDLAND PLANT UNITS 1 & 2, 1.0% DAMPING

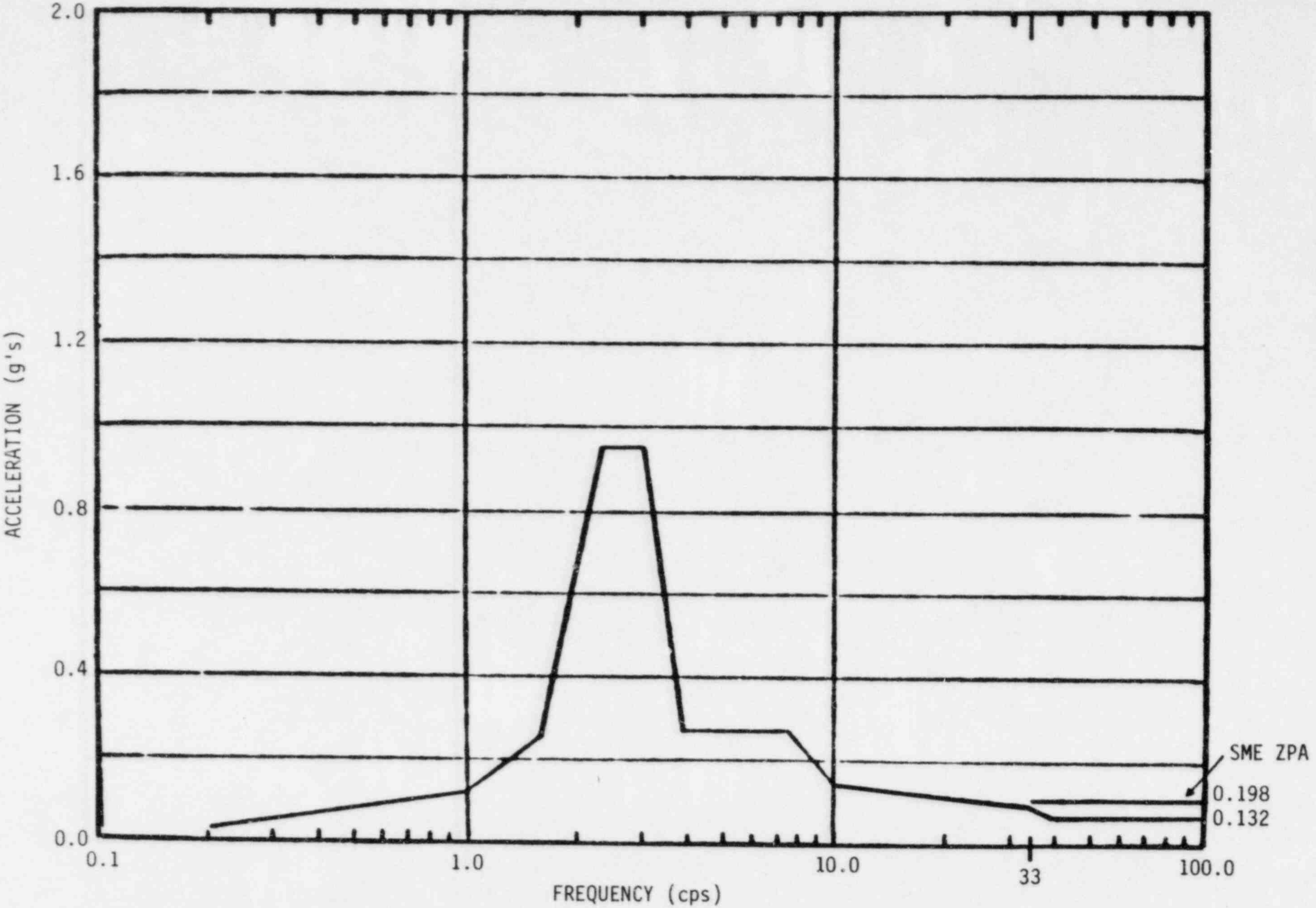


FIGURE 2. FLOOR RESPONSE SPECTRUM - AUXILIARY BUILDING, ELEVATION 584'-0", NORTH-SOUTH DIRECTION, 1977 MIDLAND PLANT UNITS 1 & 2, 1.0% DAMPING

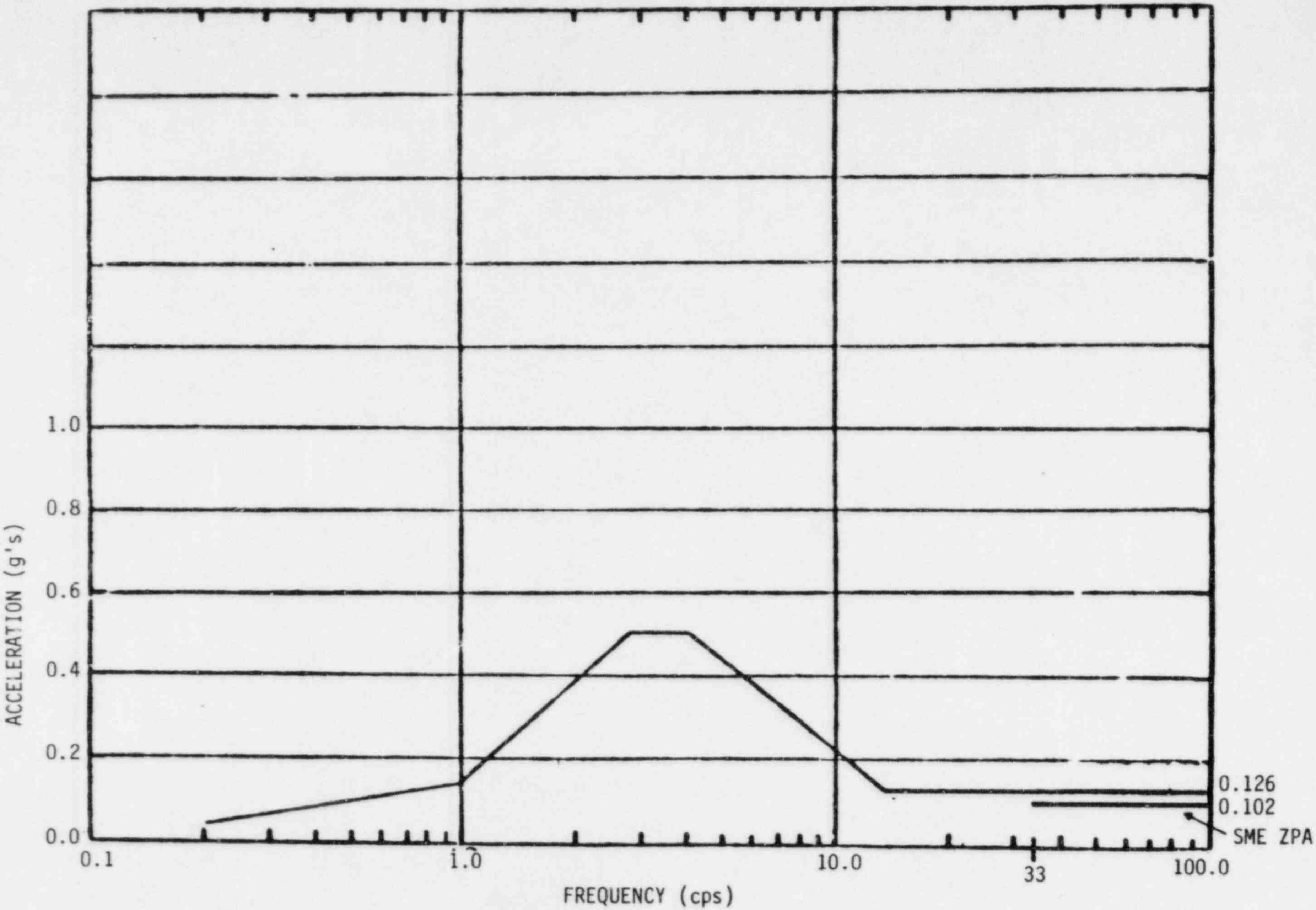


FIGURE 3. FLOOR RESPONSE SPECTRUM - AUXILIARY BUILDING, ELEVATION 584'-0", VERTICAL DIRECTION, 1977 MIDLAND PLANT UNITS 1 & 2, 1.0% DAMPING