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January 28, 1980

Dr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Byron Station Units 1 and 2 and Braidwood Station Units 1 and 2 Additional Response to Structural Engineering Branch Questions NRC Docket Nos. 50-454, 50-455, 50-456 and 50-457

Reference (a): May 15, 1979 letter from S. A. Varga to C. Reed

Dear Dr. Denton:

Enclosed are two (2) copies each of Commonwealth Edison Company's response to Questions 130.06 and 130.09 of Reference (a). These responses will be included in the next FSAR amendment to be submitted in February 1980.

In response to Question 130.06, the background to the present design is presented to highlight the basis of the present criteria. The conservatism associated with the design "g" levels, with the design response spectrum when the effect of earthquake wave passage is considered, with the use of elastic analysis and low damping values, and the use of minimum yield/ultimate strength for design are quantified to compare the response of deconvolution analysis with the conservative application of other seismic design parameters. The structural responses and floor response spectra obtained by applying the Regulatory Guide 1.60 spectrum at the foundation levels for selective and representative floors in the Containment and in the Auxiliary/Fuel Handling Building complex are also provided.

In response to Question 130.09, the structural responses and floor response spectra for the river screenhouse using the elastic half-space soil-structure interaction are presented. These responses are higher than those obtained using the finite element method. These higher responses are due to the conservative assumptions made in the soil structure interaction

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analysis using the half-space approach.

Please address any additional questions that you might have concerning this matter to this office.

Very truly yours,

William F. Naughton

William F. Naughton
Nuclear Licensing Administrators
Pressurized Water Reactors

enclosures (2)

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Question 130.06

The seismic analysis was performed by the response spectrum method. However, the response spectra at the foundation level generated by the synthetic time history have displayed a significant dip over a large range of frequencies, as compared with the design response spectra in RG 1.60 (Figures 3.7-1 thorugh 3.7-40). The use of such unconservative response spectra is unacceptable to the staff. The deconvolution procedure as described in the FSAR is not appropriate for the Byron/Braidwood sites due to the shallow soil overburden (16 ft to 38 ft) on bedrock. Therefore, it is requested that the analysis shall be based on RG 1.60 free field surface design response spectra applied at the foundation level and the design time history shall generate response spectra envelope the RG 1.60 design response spectra at the foundation level.

RESPONSE

I. Introduction

The seismic design process involves various steps. These include (i) determination of "g" level; (ii) specification of the shape of the design response spectra and design time history; (iii) analysis to obtain design response spectra at the base mat elevation; (iv) modeling of the structure; (v) calculation of structural response and floor response spectra; (vi) specification of load factors, load combinations, factors of safety, and allowable stresses; (vii) design of components to the combined effects of seismic and other loads. The overall safety of the plant is a function of the design parameters assumed at each stage. The margin in design for the various stages may vary, but good engineering design requires that the overall design be conservative.

In this response, the background to the present design is presented to highlight the bases of the present design criteria. The conservatism associated with the design "g" levels, with

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the design response spectrum when the effect of earthquake wave passage is considered, with the use of elastic analysis and low damping values, and the use of minimum yield/ultimate strength for design are quantified to show that any reduction in response due to the use of the deconvolution analysis is more than compensated for by the margins in design introduced by the conservative definitions of other seismic design parameters. To comply with the NRC request, the structural responses and floor response spectra obtained by applying the RG 1.60 spectra at the foundation levels are also presented.

Based on a composite evaluation of the above information, it is concluded that the present design of Byron/Braidwood is conservative.

II. Background to Present Design Criteria

In the present Byron/Braidwood design, a wide band Regulatory Guide 1.60 spectrum is specified at the grade elevation. One-dimensional deconvolution analysis is used to compute the foundation elevation spectra. The structural response and the floor response spectra are computed using the deconvolved foundation level spectra.

In the PSAR, it was our evaluation that for the Byron and Braidwood sites a 0.06 g OBE and a 0.12 g SSE level are conservative design bases. The NRC staff stated in Question 2.5.63 that the OBE and SSE levels should be 0.1 g and 0.20 g, respectively. In the ensuing discussions with the NRC staff, it was agreed that the OBE and SSE spectra at the foundation

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elevation will have 0.09 g and 0.20 g rigid period accelerations, respectively. The foundation level spectrum shape was to be obtained through a SHAKE deconvolution analysis with the wide band RG 1.60 spectra defined at the grade elevation. Consistent with the practice at that time (1974), mean soil properties were used in the deconvolution analysis. The PSAR was amended in November 1974 to reflect the above design bases. In December 1975, the construction permit was issued by the NRC. In September 1976, the NRC requested additional information, stating that:

> the current NRC staff position is that when the design response spectra are defined for the free field and applied at the finished grade level of the site, the SHAKE computer program is acceptable for deconvolution analysis to obtain a time history at the base of the idealized soil profile provided that appropriate soil properties, and variations thereof, are used in the analysis.
>
> In view of the uncertainty and variability of soil properties, the response spectra at the base of the soil-structure interaction system should envelope all response spectra of those deconvolved time histories within the range of variable soil properties, and should not be less than 60 percent of the free field surface spectra.

A reply to the above NRC concern was submitted on December 9, 1976 [2]. In the reply we stated:

> We found that a variation in soil properties of ±20% and a strict adherence to the requirements of Standard Review Plan 3.7.1 that the foundation spectrum be no less than 60% of the surface spectrum at any point would cause an increase in the design forces for Category I structures. Most of the increase in forces is due to the rather arbitrary 60% limit and not due to the ±20% soil property variation.
>
> There are several areas of conservatism in the seismic analysis for Byron/Braidwood. Areas such as the methods used for the determination of the maximum ground acceleration for the SSE and the OBE have a considerable amount of conservatism. The use of the wide band response

spectrum and the corresponding synthetic time history that envelopes the spectrum is another factor which results in higher forces than actual. Various items in the modeling and analysis, such as lower damping values, three simultaneous spatial components of equal strength, not accounting for the traveling nature of seismic waves are all areas of conservatism which are built into the analysis.

We have also reviewed the conservatism in many of the assumptions and methodology used in the design, compared the actual material strengths obtained in the field with the design strength used, and have concluded that the increases in the design forces are more than compensated for by these conservatisms. Therefore, the overall safety margin of the stations is not affected.

Since our response was accepted by the NRC and no further information was requested, the design and construction of the Byron/Braidwood plant proceeded, based on the design criteria as contained in the PSAR. At the present time, the structural design and construction of the plant structures are complete. The remaining electrical and mechanical components and equipment are either on site or at advanced stages of fabrication and qualification.

It is evident from the above that the present Byron/Braidwood design criteria were appropriately judged to be conservative by the NRC staff in 1974 and again in 1976. It is also clear that the judgment was based on an overall evaluation of the seismic design process. We feel that none of the parameters has changed since then to alter this conclusion.

III. Conservative Selection of Design Earthquakes

For the selection of design earthquakes, the maximum historical random earthquake of the entire seismotectonic province is assumed to occur at the site even if there is no history of seismic activity in the site vicinity. This is a very conservative assumption. In addition, the staff has required that a VII-VIII intensity earthquake be considered. In the case of the Byron/Braidwood sites, it is our conclusion that the maximum random earthquake should be of Intensity VII. Our reasons for this have been documented in detail in the Byron/Braidwood PSAR. Using Intensity VII, the Trifunac & Brady relationship gives a maximum acceleration of 0.13 g. A more recent NRC-sponsored study [3], performed by Computer Services Corporation (CSC), which was based on much more exhaustive data, yields an acceleration of 0.085 for the United States sites. Even for an Intensity VII-VIII earthquake, the CSC study gives only an 0.11 g level for United States sites. On the basis of the above reasoning, the value of 0.20 g for SSE is higher than necessary, and a value of 0.12 q, as proposed during the PSAR review stage, is more appropriate.

For the OBE, the design acceleration is 0.09 g. The bases used for this acceleration are extremely conservative when compared with the more recent projects. A seismic risk analysis for the Byron/Braidwood Stations showed that the return period for an Intensity VI earthquake would be 2150 years. This return period is high when compared to the return period used in the Koshkonong (1000 years) project, which is more recent. The return periods for Intensities IV and V at the Byron/Braidwood site would be 322 years and 833 years, respectively. These return periods are more comparable to the Koshkonong project. Thus, a more appropriate OBE intensity for Byron/Braidwood would be IV or at most V.

The acceleration values obtained from Trifunac & Brady and the CSC relationships for these Intensities are shown in Table 130.06-1.

It can be concluded from table 130.06-1 that 0.06 g is a more reasonable acceleration level for the OBE for the Byron/ Braidwood design. The 0.06 g level for OBE was proposed in the initial PSAR submittal.

Based on the above discussion, levels of 0.06 g for OBE and 0.12 g for SSE can be considered conservative design bases. Figures 130.06-1 and 130.06-2 provide a comparison of the Byron/Braidwood deconvolved design spectra to the 0.06 g OBE and 0.12 g SSE RG 1.60 spectra for horizontal and vertical motions, respectively. The comparison shows that the Byron/ Braidwood design bases envelope the RG spectra. Thus, the seismic forces obtained by applying a 0.06 g OBE and 0.12 g SSE RG 1.60 spectra would be smaller than those presently considered in the design for the containment, containment internal structures, and the auxiliary fuel handling building complex. Table 130.06-2 shows the comparison for overturning moment and base shear force for the containment shell structure. The total shear force and overturning moment from the RG 1.60

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input are lower than those used for design. Figures 130.06-9 through 130.06-36 provide a comparison of the present design floor response spectra with those obtained using 0.06 g OBE and 0.12 g SSE RG 1.60 spectra. OBE spectra are for 1% oscillator damping, whereas SSE spectra are presented for 2% oscillator damping. The comparison is provided for both horizontal and vertical responses in the containment and the auxiliary building complex. Table 130.06-3 lists the location and elevations for the spectra comparison. The comparison shows that the present design spectra are higher and, except for a few isolated instances, they envelope those obtained using the RG 1.60 spectra.

From the above discussion, it can be concluded that the Byron/Braidwood design is conservative. Any reduction in response due to deconvolution is more than compensated by the extremely conservative specification of the OBE and SSE levels.

IV. Design Spectra Considering Effect of Foundation Size

The observation has frequently been made that structures on large foundations appear to respond with less intensity to earthquakes than do smaller structures and, more specifically, than do free field instrumentations. Researchers who have attempted to give a rational explanation for this behavior have concluded that during an earthquake, not all particles under a large building foundation describe the same motion simultaneously; thus the relatively rigid structure-foundation system tends to average the ground motion, resulting in a reduced effective input excitation and consequently less damage.

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In a report to the NRC dated September 1976 and entitled "A Rationale for Development of Design Spectra for Diablo Canyon Reactor Facility," Dr. Newmark investigated the effect of foundation size on design spectrum [4]. His recommended reduced effective inputs, and the earthquake wave transit times, τ, for various structures, are given in Table 130.06-4.

It is recognized that the reduced effective spectra were developed by Dr. Newmark for the Diablo Canyon site and for a near-field earthquake on a rock site. However, it is our evaluation that the concept and the methodology proposed by Dr. Newmark are also applicable to the Byron/Braidwood seismic design. Our evaluation is based on a comparison of the seismic design parameters for the two plants. The Byron/Braidwood and Diablo Canyon building sizes and rock site conditions are comparable; wave transit times of 0.04 second for the containment and 0.067 second for the aux-turbine building complex are appropriate. For the Byron/Braidwood site, the maximum historical earthquake of the entire seismotectonic province is assumed to occur at the site. Thus, the earthquake is, by definition, a near-field earthquake and the reduced effective spectra due to wave transit times can be constructed using the reduction factors recommended by Dr. Newmark. It is possible that ground motions at the Byron/Braidwood site may occur due to seismic activity at distances greater than those considered for the reduced effective spectra at the Diablo Canyon

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plant. However, the ground motions in such an event are likely to be smaller than the design basis ground motions and would not control the design.

Figures 130.06-3 and 130.06-4 present a comparison of the 0.09 OBE and 0.20 SSE RG 1.60 spectra, the deconvolved Byron/Braidwood design spectra, and the reduced effective spectra (denoted as "r" spectra on the figures) for the containment and the aux-turbine building complex for OBE and SSE, respectively. The hatched area shows the frequency region where the Byron/Braidwood spectra are exceeded by the reduced effective spectra. It can be observed that for the aux-turbine building complex the Byron/Braidwood design spectra envelopes the reduced effective spectra. For the containment building, the Byron/Braidwood spectra do not fully envelope the reduced effective spectra, however, at the predominant structural period of 0.287 seconds, the Byron/Braidwood spectra are higher. Thus, it can be concluded that when the effect of the foundation size on the design spectra is considered, the present Byron/Braidwood seismic design is conservative.

V. Conservatism in Analysis

As in the seismic analysis of any complex structure, several conservative assumptions are used in the Byron/Braidwood (B/B) design. Many of these assumptions are regulatory requirements; others were necessary to simplify the analysis. These assumptions do provide additional margins of safety. They are briefly described below.

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The time history used for the Byron/Braidwood deconvolution analysis has a response spectrum which is 5% to 20% higher than the RG 1.60 spectrum in the range of significant structural frequencies (4-12 Hz). This is shown in Figures 130.06-5 and 130.06-6 for 4% and 7% damping, respectively.

In the B/B design, the two horizontal and the vertical simultaneous components of earthquake motion are assumed to have the same maximum accelerations as required by RG 1.60. However, recorded earthquake motions show that the three components do not have the same accelerations. Studies presented in References 5 and 6 indicate that a 1.0:0.87:0.70 ratio for the three components is more appropriate. Dr. Newmark, in a report [7] prepared for the NRC, recommends that the vertical acceleration be 2/3 of the horizontal.

In the seismic modeling of the containment and the auxiliary/fuel handling/turbine building below the grade level, the effect of the soil or rock on the sides of the exterior walls was neglected in computing the responses. However, the walls were designed for dynamic earth pressures. Consideration of the side soil/rock effect would tend to reduce the overturning moment on the shear walls and the foundation mat.

The maximum seismic response of the structure is strongly influenced by the energy absorption characteristics or damping of the structure. Low values of damping result in higher responses and are thus conservative. In the B/B design the damping values recommended in RG 1.61 were used. Newmark and Hall (8) in their recent report NUREG-0098, prepared for the NRC Systematic Evaluation Program, have recommended higher and more realistic damping values. A comparison of the RG 1.61 damping values and the NUREG-0098 damping values is provided in Table 130.06-5. Note that the NUREG damping values are higher and thus would lead to lower responses.

In considering the response of nuclear power plant structures to seismic motions, one must take into account the implications of various levels of damage short of impairment of the safety, and definitely short of the collapse of the structure. Some elements of plant structures must remain elastic or nearly elastic in order to perform their allocated safety function. However, in many instances, a purely linear elastic analysis may be unreasonably conservative when one considers that even up to the near yield-point range there are nonlinearities of amounts sufficient to reduce the required design levels significantly. Moreover, limited yielding of a structure may reduce the response of equipment located in the structure below those levels of response that would be excited were the structure to remain elastic. The concept of ductility factors [9] is a simple but effective means of accounting for small excursions into the inelastic range. A ductility of 1.3 for concrete and 3.0 for steel members was proposed for the Diablo Canyon Power Plant and for the NRC Systematic Evaluation Program Seismic Criteria [9]. Use of these ductility factors on B/B would result in a 10%-50% reduction in design responses computed using an elastic analysis. Based on the above discussion, it can be concluded that there are several areas of major conservatism in the B/B seismic design, and due consideration should be given to these factors when reviewing the B/B seismic design.

VI. Conservatism in Material Strength

The compressive strength of concrete obtained from the cylinder tests exceeds the value used in design. The actual strength for the reinforcement steel and structural steel also exceeds those used in design. Table 130.06-6 compares the values used in the design to those obtained by tests. The actual strength is the mean value obtained from the concrete cylinder test report summaries and a sampling of certified material test reports for reinforcement and structural steel for the B/B project. It shows that the actual strength exceeds the design strength by 12% to 50%, adding proportionality to the design margins.

VII. Response Due to 0.09 g OBE and 0.20 g SSE RG 1.60 Spectrum

To comply with the NRC request, forces, moments, and floor response spectra obtained by applying 0.09 g OBE and 0.20 g SSE RG 1.60 spectra at the foundation level are compared to the corresponding B/B design forces, moments, and floor response spectra. The comparison is provided for the containment and the auxiliary building. The forces, in many instances, increase when the RG 1.60 spectra are applied. However, these increased forces should be judged against the conservatism in the B/B design as discussed above.

A. Containment Forces

Table 130.06-7 presents a comparison between forces and moments for the containment shell and basemat between current B/B values and those obtained by applying the RG 1.60 spectra at the base level. The basemat is designed to resist overturning moments from the containment shell and the containment internal structures. The magnitude of these moments affects the area of the base mat which is uplifted (see Figure 130.06-7) and the design moments in the mat (see Figure 130.06-8). The increased overturning results in the engagement of the reactor cavity as a rotational key producing large meridional membrane forces, whereas for the current B/B design these forces are negligible. Note that in the seismic modeling of the containment below the grade level, the effect of the soil or rock on the sides of the external walls was negelected in computing the responses. Consideration of the side soil/rock effect would tend to reduce the overturning moments and meridional membrane forces.

B. Containment Internal Structures

Reinforced Concrete: A review of the internal concrete structures, including the refueling pool walls, primary shield wall, secondary shield wall, and enclosure walls, was made. The seismic design is controlled by forces generated from horizontal SSE spectra. The lowest horizontal frequency for the internal structures model is 9.8 cps. Figure 130.06-81 shows that for 9.8 cps and higher frequencies, the B/B design spectra envelope the RG 1.60 spectra. The resulting forces for the RG 1.60 spectra are consequently lower than those used in the present B/B design.

Structural Steel: A summary of the structural steel beams showing the percent increase in force for OBE and SSE conditions due to the application of RG 1.60 spectra is presented in Table 130.06-8. The table is based on a representative sample comprised of all beams at elevation 426'0". A total of 108 beams were reviewed, out of an estimated 740 per unit. Note that the increase in forces in 100 of the 108 beams is less than 20%.

Structural steel columns are seismically designed by amplifying the permanent loads on the columns in proportion to the zero period acceleration of the wall response spectra at that elevation. The minimum values for g used for design are 0.5 and 0.9 for OBE and SSE, respectively. The maximum values for the zero period acceleration of the wall spectra at various elevations for the RG 1.60 foundation elevation definition are 0.26 for OBE and 0.42 for SSE. Comparing these g values shows that the forces are consequently larger for the present B/B design than for the RG 1.60 foundation elevation definition.

C. Auxiliary-Fuel Handling Building Complex

Reinforced Concrete: The areas of the basemat found to have increased forces as a result of RG 1.60 spectra are indicated by the cross-hatched areas shown in Figure 130.06-8. The values shown are the percent increase in force over the design force.

A comparison of all the shear wall forces from the B/B design basis with those resulting from implementation of the RG 1.60 spectra was made. A summary of this comparison showing the percent change in seismic force due to RG 1.60 spectra is shown in Table 130.06-9. Note that for the SSE excitation, the increase in forces in 234 of the 272 shear walls is less than 20%.

The remaining concrete structural components, including columns, beams, and slabs, have no increase in seismic forces due to the implementation of RG 1.60 spectra. These components are essentially rigid and are located at elevation 401'0" or below. A comparison of the vertical spectra in Figures 130.06-59 and 130.06-83 shows that the B/B spectra envelope the RG 1.60 spectra.

Structural Steel: A summary of the structural steel beams for the auxiliary-fuel handling building complex showing the percent increase in force due to the application of RG 1.60

spectra is presented in Table 130.06-10. A representative sample comprised of those beams at elevations 451'0" and 426'0" has been reviewed. The 230 beams reviewed are representative of all beams. Note that for the SSE excitation the increase in forces in 224 of the 230 beams is less than 20%.

The criteria for design of the structural steel columns in the auxiliary-fuel handling complex are the same as those for the containment building. The minimum value for g used for design is 0.26 for OBE and 0.68 for SSE. The maximum value for various elevations, based on an RG 1.60 spectra foundation elevation defnintion is 0.23 for OBE and 0.46 for SSE. Comparing these "g" values shows that the forces are consequently larger for the present B/B design than for RG 1.60.

D. <u>Floor Response Spectra</u>

Figures 130.06-57 through 130.06-104 provide a comparison of the present design floor response spectra with those obtained by using 0.09 g OBE and 0.20 g SSE RG 1.60 spectra at the foundation elevation. The comparison is provided for both horizontal and vertical response for the containment and auxiliary building. Table 130.06-11 lists the locations and elevations for the spectra comparison.

VIII. Summary

In the present Byron/Braidwood design, a wide band RG 1.60 spectrum is specified at the grade elevation. One-dimensional deconvolution analysis is used to compute the foundation elevation spectra. The structural response and floor response spectra are computed using the deconvolved foundation level spectra. In the question, the NRC staff states that the deconvolution procedure is not appropriate for the Byron/Braidwood sites and that analysis should be based on an RG 1.60 spectra applied at the foundation elevation.

In this response, the background to the present design is presented to highlight the bases of the present criteria. The conservatism associated with the design "g" levels, with the design response spectrum when the effect of earthquake wave passage is considered, with the use of elastic analysis and low damping values, and the use of minimum yield/ultimate strength for design are quantified to show that any reduction in response due to the use of the deconvolution analysis is more than compensated for by the margins in design introduced by the conservative definition of other seismic design parameters. To comply with the NRC request, the structural responses and floor response spectra obtained by applying the RG 1.60 spectra at the foundation levels are also presented.

Based on a composite evaluation of the above information, it is concluded that the present design of Byron/Braidwood is conservative.

VIII. References

1. Schnabel, P. B., Lysmer, J., and Seed, H. B., "SHAKE - A Computer Program for Earthquake Response Analysis of Horizontally-Layered Sites," Earthquake Engineering Research Center, Report No. EERC 72-12, University of California, Berkeley, 1972.

2. Submittal to the NRC dated December 9, 1976, entitled "Byron and Braidwood Stations Units 1&2 - Additional Information on Seismic Design Analysis," NRC Dockets 50-454/455 and 50-456/457.

3. Murphy, J. R. and O'Brien, L. J., "Analysis of a Worldwide Strong Motion Data Sample to Develop an Improved Correlation between Peak Acceleration, Seismic Intensity, and Other Physical Parameters," NUREG-0402, report prepared for the NRC by Computer Services Corporation, January 1978.

4. Newmark, N. M., "A Rationale for Development of Design Spectra for Diablo Canyon Reactor Facility," report to the USNRC, September 1976.

5. Bartu, A. S.,"Discussion on Seismic Design Spectra for Nuclear Power Plants, Journal of the Power Division, ASCE, December 1974.

6. Penzien, J. and Watabe, M., Characteristics of 3-Dimensional Earthquake Ground Motions, <u>Earthquake Engineering and Structural Dynamics</u>, Vol. 3, 1975.

7. Hall, W. J., Mohraz, B., and Newmark, N. M., "Statistical Studies of Vertical and Horizontal Earthquake Spectra," Report NUREG-0003, prepared for USNRC January 1976.

8. Newmark, N. M. and Hall, W. J., "Development of Criteria for Seismic Review of Selected Nuclear Power Plant, Report NUREG/CR-0098, prepared for NRC May 1978.

9. Newmark, N. M. and Rosenblueth, E., "Fundamentals of Earthquake Engineering," Prentice-Hall, Inc., 1971.

10. NRC Summary of Meeting held February 4, 1977 to discuss the Diablo Canyon Seismic Design Re-evaluation.

Table 130.06-1
Acceleration-Intensity Relationship

Intensity	Trifunac & Brady	CSC
VI	0.065 g	0.05 g
V	0.0325 g	0.029 g
IV	0.0165 g	0.0165 g

Table 130.06-2
Comparison of Current B/B Containment
Forces with 0.12 g RG 1.60 SSE

ITEM	FORCE OR MOMENT (SSE) B/B DESIGN	NRC RG 1.60
Total overturning moment at base of shell	4,540,000^{1-k}	3,156,000^{1-k}
Total shear at base of shell	26,500^{k}	18,420^{k}

Table 130.06-3
Locations for Spectra Comparison -
B/B Design vs. 0.06 g OBE and 0.12 g SSE

BUILDING	ELEVATION Byron;Braidwood	EARTHQUAKE	DIRECTION	FIGURE NO.
Auxiliary & Containment	330;374	OBE	Horizontal EW;NS	130.06-9
Auxilary & Containment	330;374	OBE	Vertical	130.06-10
Auxiliary (wall)	346;364 383;401	OBE	Vertical	130.06-11
Auxiliary (slab)	346;364 383;401	OBE	Vertical	130.06-12
Auxiliary	401	OBE	Horizontal EW	130.06-13
Auxiliary	401	OBE	Horizontal NS	130.06-14
Auxiliary;Turbine; Heater Bay	426	OBE	Horizontal NS	130.06-15
Auxiliary;Turbine; Heater Bay	426	OBE	Horizontal EW	130.06-16
Auxiliary (wall)	426;439 451	OBE	Vertical	130.06-17
Auxiliary (slab)	426;451 439	OBE	Vertical	130.06-18

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BUILDING	ELEVATION Byron;Braidwood	EARTHQUAKE	DIRECTION	FIGURE NO.
Auxiliary;Turbine; Heater Bay	451	OBE	Horizontal NS	130.06-19
Auxiliary;Turbine Heater Bay	451	OBE	HOrizontal EW	130.06-20
Auxiliary	477	OBE	Horizontal NS	130.06-21
Auxiliary	477	OBE	Horizontal EW	130.06-22
Auxiliary (slab)	467;477	OBE	Vertical	130.06-23
Auxiliary (wall)	467;477 473;485	OBE	Vertical	130.06-24
Containment	424;436	OBE	Vertical	130.06-25
Containment	424;436	OBE	Horizontal NS	130.06-26
Containment	496	OBE	Horizontal NS;EW	130.06-27
Containment	496	OBE	Vertical	130.06-28
Containment Inner Structure	426	OBE	Horizontal NS	130.06-29
Containment Inner Structure	426	OBE	Horizontal EW	130.06-30
Containment Inner Structure (wall)	412;426	OBE	Vertical	130.06-31
Containment Inner Structure (slab)	390;401 412;426	OBE	Vertical	130.06-32

BUILDING	ELEVATION Byron;Braidwood	EARTHQUAKE	DIRECTION	FIGURE NO.
Auxiliary & Containment	330;374	SSE	Horizontal	130.06-33
Auxiliary & Containment	330;374	SSE	Vertical	130.06-34
Auxiliary (wall)	346;383 364;401	SSE	Vertical	130.06-35
Auxiliary (slab)	346;383 364;401	SSE	Vertical	130.06-36
Auxiliary	401	SSE	Horizontal NS	130.06-37
Auxiliary	401	SSE	Horizontal EW	130.06-38
Auxiliary;Turbine; Heater Bay	426	SSE	Horizontal NS	130.06-39
Auxiliary;Turbine; Heater Bay	426	SSE	Horizontal EW	130.06-40
Auxiliary (wall)	426;439 451	SSE	Vertical	130.06-41
Auxiliary (slab)	426;439 451	SSE	Vertical	130.06-42
Auxiliary;Turbine Heater Bay	451	SSE	Horizontal NS	130.06-43
Auxiliary;Turbine Heater Bay	451	SSE	Horizontal EW	130.06-44

BUILDING	ELEVATION Byron;Braidwood	EARTHQUAKE	DIRECTION	FIGURE NO.
Auxiliary (wall)	467;477 473;485	SSE	Vertical	130.06-45
Auxilairy (slab)	467;477	SSE	Vertical	130.06-46
Auxiliary	477	SSE	Horizontal NS	130.06-47
Auxiliary	477	SSE	Horizontal EW	130.06-48
Containment	424;436	SSE	Horizontal NS;EW	130.06-49
Containment (wall)	424;436	SSE	Vertical	130.06-50
Containment	496	SSE	Horizontal NS;EW	130.06-51
Containment (wall)	496	SSE	Vertical	130.06-52
Containment Inner Structure	426	SSE	Horizontal NS	130.06-53
Containment Inner Structure	426	SSE	Horizontal EW	130.06-54
Containment Inner Structure (wall)	412;426	SSE	Vertical	130.06-55
Containment Inner Structure (slab)	390;412 401;426	SSE	Vertical	130.06-56

Table 130.06-4

Earthquake Wave Transit Time and Peak Ground Acceleration

Structure	τ (sec)	Peak Ground Acceleration (g)	Reduction Factor
Small Structures	0.00	0.75	1.00
Containments	0.04	0.60	0.80
Aux. Building	0.052	0.55	0.73
Turbine Building	0.067	0.50	0.67

Table 130.06-5

Comparison of RG 1.61 and NUREG-0098 Damping Values

Structure or Component	RG 1.61 Damping for SSE	NUREG-0098 Damping At or Just Below Yield
Piping	2-3	2 to 3
Welded Steel	4	5 to 7
Prestressed Concrete		
(a) Without complete loss in prestress	5	5 to 7
(b) With no prestress left	7	7 to 10
Reinforced Concrete	7	7 to 10
Bolted Steel Structures	7	10 to 15

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Table 130.06-6
Material Strength

MATERIAL	DESIGN STRENGTH (PSI)	ACTUAL MEAN STRENGTH (PSI)
Concrete (f'_c)	5,500 3,500	6,935 5,265
Reinforcement (fy)	60,000	67,000
Structural Steel (fy)	36,000 50,000	43,200 56,000

Table 130.06-7
Comparison of B/B Containment Design Forces
to Those from RG 1.60 Spectra

DESCRIPTION	B/B (SSE)	RG 1.60 (0.2 g)
Total overturning moment at base of shell	$4{,}540{,}000^{1-k}$	$5{,}260{,}000^{1-k}$
Total shear at base of shell	$26{,}500^{k}$	$30{,}700^{k}$
Net tensile membrane force in shell	27 k/1	72 k/1
Bending moment in basemat	$6{,}650^{1-k/1}$	$9{,}513^{1-k/1}$
Net membrane tensile force in reactor cavity wall	NA	1335 k/1

Table 130.06-8

Containment Building Structural Beams Comparison of Forces Between B/B Design Basis Force and RG 1.60

% INCREASE IN FORCES DUE TO RG 1.60	NUMBER OF BEAMS	
	OBE	SSE
<0	84	88
0 - 10	12	8
10 - 20	4	8
20 - 30	–	4
30 - 40	8	–
>40	–	–
TOTAL	108	108

NOTES

1. All 108 beams reviewed for el. 426'0".
2. Percent increase does not necessarily reflect a state of stress in the beam.

Table 130.06-9

Auxiliary Building-Fuel Handling Building Complex Shear Walls - Comparison Between B/B Design Basis Seismic Forces and RG 1.60

% INCREASE IN FORCES DUE TO RG 1.60	NUMBER OF SPRINGS OBE	SSE
<0	122	153
0 - 10	25	51
10 - 20	19	30
20 - 30	8	7
30 - 40	50	8
40 - 50	33	6
>50	15	17
TOTAL	272	272

NOTE

Percent increase does not necessarily reflect a state of stress in the wall.

Table 130.06-10

Auxiliary-Fuel Handling Building Complex Structural Steel Beams - Comparison of Forces Between B/B Design Basis Forces and RG 1.60

% INCREASE IN FORCES DUE TO RG 1.60		NUMBER OF BEAMS OBE	SSE
<0		148	132
0 - 10		61	85
10 - 20		16	7
20 - 30		5	6
>30		—	—
	TOTAL	230	230

NOTE

1. Beams located at el. 426'0" and 451'0" in auxiliary building.

2. Percent increase does not necessarily reflect a state of stress in the beam.

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Table 130.06-11
Locations for Spectra Comparison -
B/B Design vs. 0.09 g OBE and 0.20 g SSE

BUILDING	ELEVATION Byron;Braidwood	EARTHQUAKE	DIRECTION	FIGURE NO.
Auxiliary & Containment	330;374	OBE	Horizontal NS,EW	130.06-57
Auxiliary & Containment	330;374	OBE	Vertical	130.06-58
Auxiliary (wall)	346-364 383;401	OBE	Vertical	130.06-59
Auxiliary (slab)	346;364 383;401	OBE	Vertical	130.06-60
Auxiliary	401	OBE	HOrizontal NS	130.06-61
Auxiliary	401	OBE	Horizontal EW	130.06-62
Auxiliary;Turbine Heater Bay	426	OBE	Horizontal NS	130.06-63
Auxiliary;Turbine Heater Bay	426	OBE	Horizontal EW	130.06-64
Auxiliary (wall)	426;451 439	OBE	Vertical	130.06-65
Auxiliary (slab)	426;451 439	OBE	Vertical	130.06-66

BUILDING	ELEVATION Byron;Braidwood	EARTHQUAKE	DIRECTION	FIGURE NO.
Auxiliary; Turbine Heater	451	OBE	Horizontal NS	130.06-67
Auxiliary;Turbine Heater Bay	451	OBE	Horizontal EW	130.06-68
Auxilary (wall)	467;477 473;485	OBE	Vertical	130.06-69
Auxiliary (slab)	467;477	OBE	Vertical	130.06-70
Auxiliary	477	OBE	Horizontal NS	130.06-71
Auxiliary	477	OBE	Horizontal EW	130.06-72
Containment	424;436	OBE	Horizontal NS	130.06-73
Containment (wall)	424;436	OBE	Vertical	130.06-74
Containment	496	OBE	Horizontal NS;EW	130.06-75
Containment	496	OBE	Vertical	130.06-76
Containment Inner Structure	426	OBE	Horizontal NS	130.06-77
Containment Inner Structure	426	OBE	Horizontal EW	130.06-78
Containment Inner Structure (wall)	412;426	OBE	Vertical	130.06-79
Containment Inner Structure (slab)	390;412 401;426	OBE	Vertical	130.06-80

BUILDING	ELEVATION Byron;Braidwood	EARTHQUAKE	DIRECTION	FIGURE NO.
Auxiliary & Containment	330;374	SSE	Horizontal NS;EW	130.06-81
Auxiliary & Containment	330;374	SSE	Vertical	130.06-82
Auxiliary (wall)	346;383 364;401	SSE	Vertical	130.06-83
Auxiliary (slab)	346;383 364;401	SSE	Vertical	130.06-84
Auxiliary	401	SSE	Horizontal NS	130.06-85
Auxiliary	401	SSE	Horizontal EW	130.06-86
Auxiliary;Turbine; Heater Bay	426	SSE	Horizontal NS	130.06-87
Auxiliary;Turbine Heater Bay	426	SSE	Horizontal EW	130.06-88
Auxiliary (wall)	426;439 451	SSE	Vertical	130.06-89
Auxiliary (slab)	426;451 439	SSE	Vertical	130.06-90
Auxiliary;Turbine Heater Bay	451	SSE	Horizontal NS	130.06-91
Auxiliary;Turbine Heater Bay	451	SSE	Horizontal EW	130.06-92
Auxiliary (wall)	467;477 473;485	SSE	Vertical	130.06-93

BUILDING	ELEVATION Byron;Braidwood	EARTHQUAKE	DIRECTION	FIGURE NO.
Auxiliary (lab)	457;477	SSE	Vertical	130.06-94
Auxiliary	477	SSE	Horizontal NS	130.06-95
Auxiliary	477	SSE	Horizontal EW	130.06-96
Containment	424;436	SSE	Horizontal NS;EW	130.06-97
Containment (wall)	424;436	SSE	Vertical	130.06-98
Containment	496	SSE	Horizontal NS;EW	130.06-99
Containment (wall)	496	SSE	Vertical	130.06-100
Containment Inner Structure	426	SSE	Horizontal NS	130.06-101
Containment Inner Structure	426	SSE	Horizontal EW	130.06-102
Containment Inner Structure (wall)	412;426	SSE	Vertical	130.06-103
Containment Inner Structure (slab)	390;412 401;426	SSE	Vertical	130.06-104

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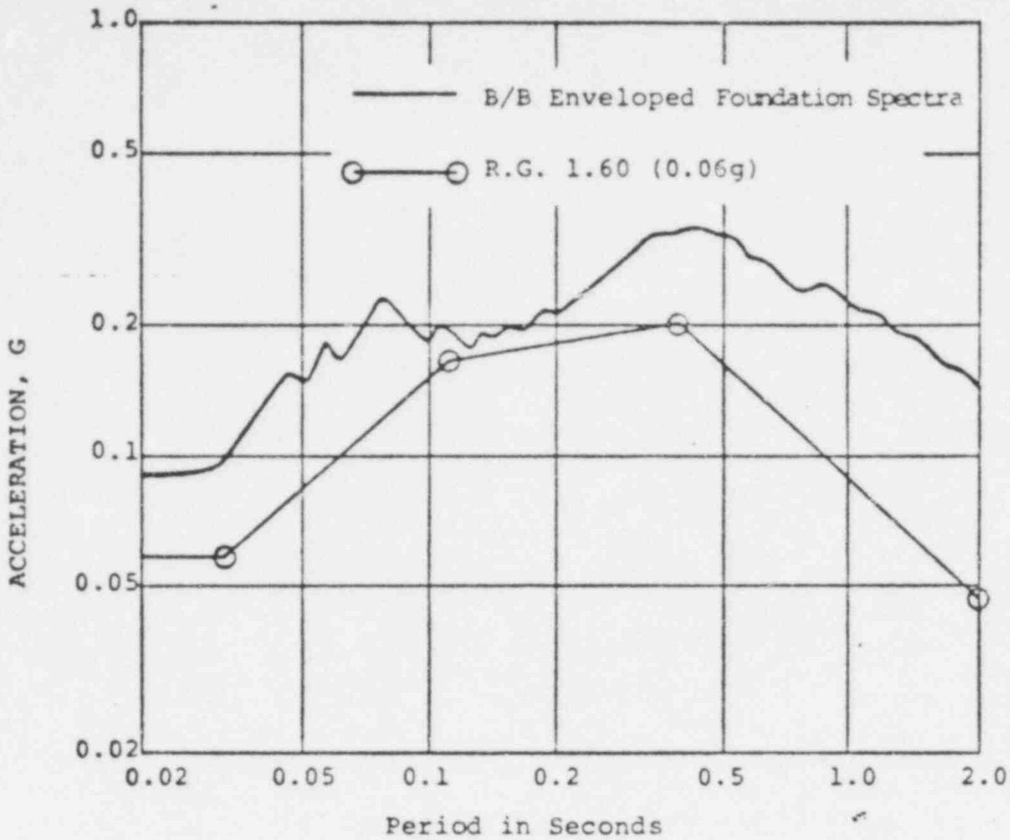
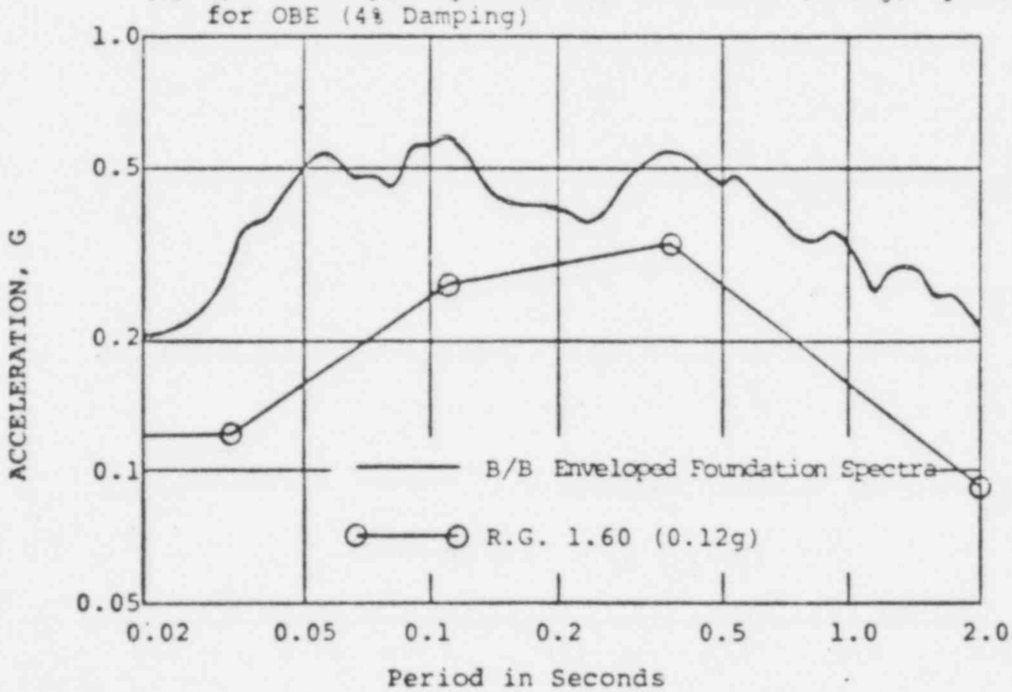


(a) B/B Enveloped Spectra and R.G. 1.60 (0.06g) Spectra for OBE (4% Damping)



(b) B/B Enveloped Spectra and R.G. 1.60 (0.12g) Spectra for SSE (7% Damping)

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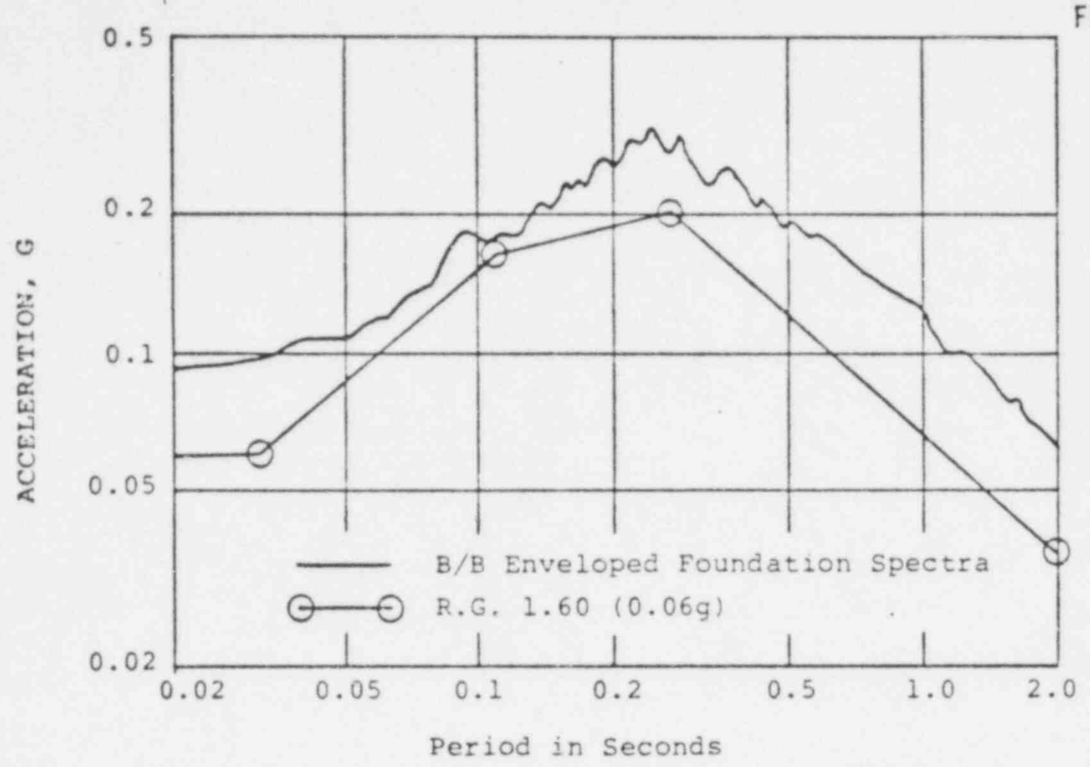
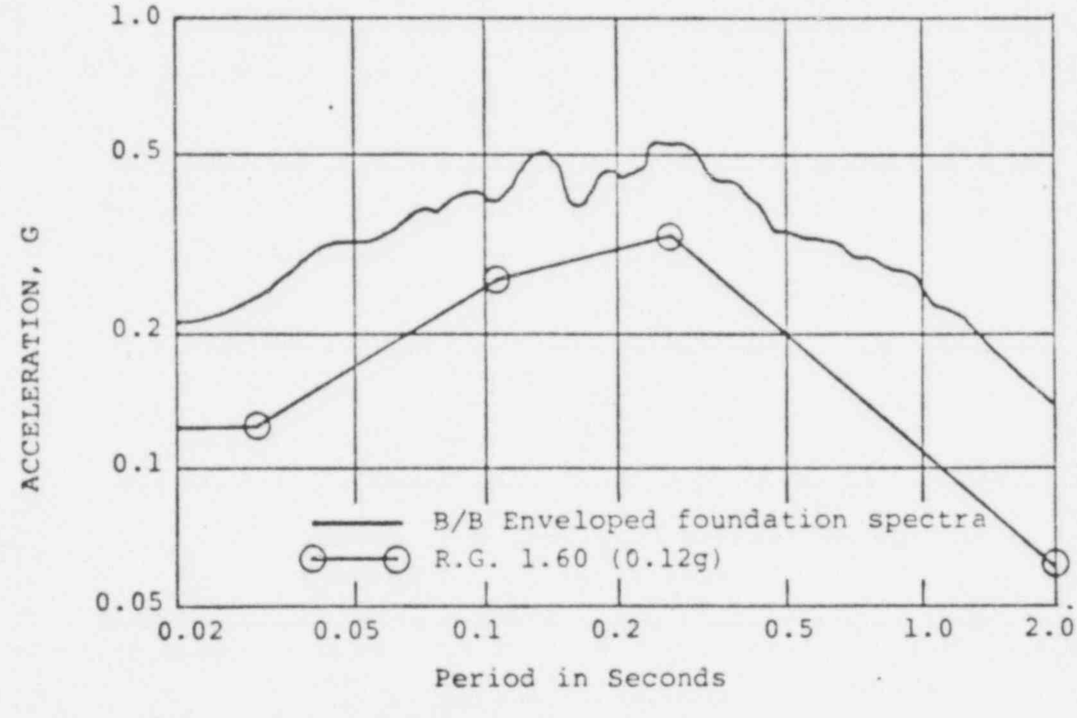
FIGURE Q130.6-1

COMPARISON OF HORIZONTAL SPECTRA



(a) B/B Enveloped spectra and R.G. 1.60 (0.06g) spectra for OBE (4% Damping)



(b) B/B Enveloped spectra and R.G. 1.60 (0.12g) spectra for SSE (7% Damping)

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FIGURE Q130.6-2

COMPARISON OF VERTICAL SPECTRA

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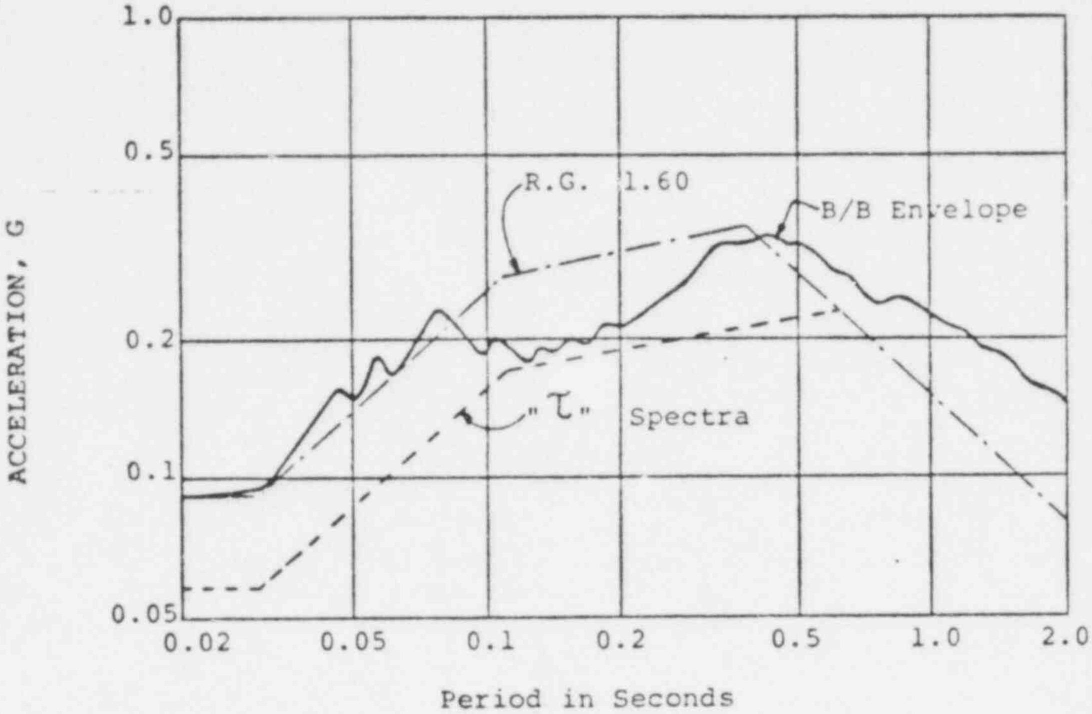
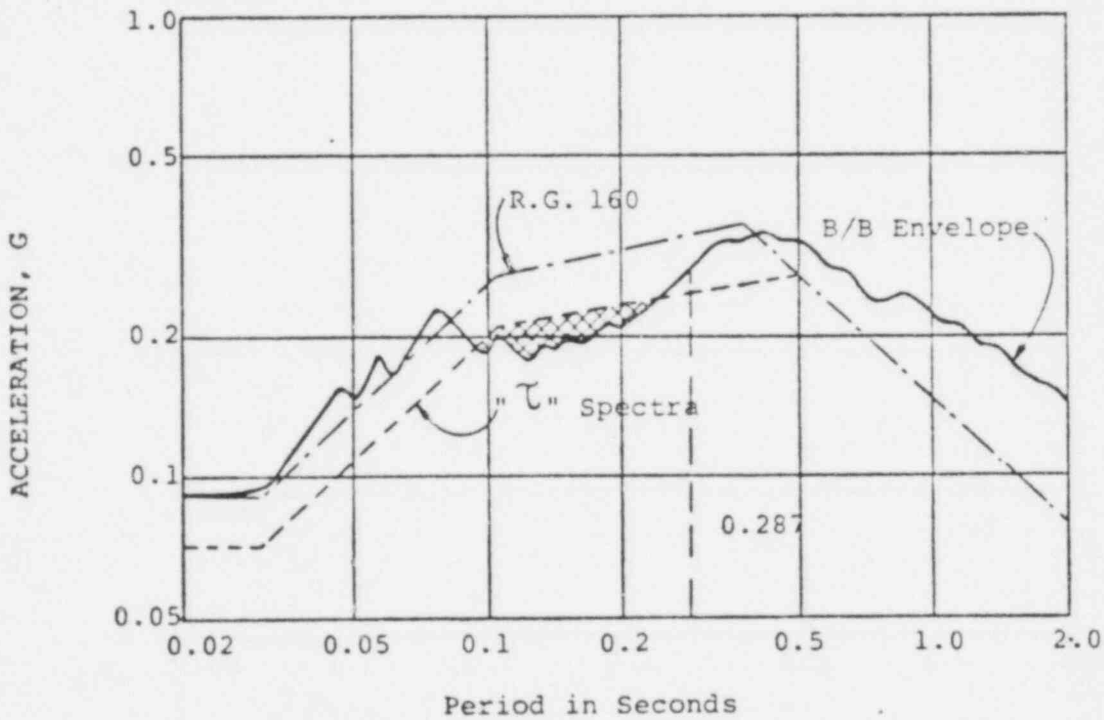


(a) OBE (4%) Spectra for AUX-TUR complex (τ = 0.067 sec.)



(b) OBE (4%) Spectra for Containment (τ = 0.04 sec.)

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FIGURE Q130.6-3

HORIZONTAL OBE (4%) SPECTRA COMPARISON

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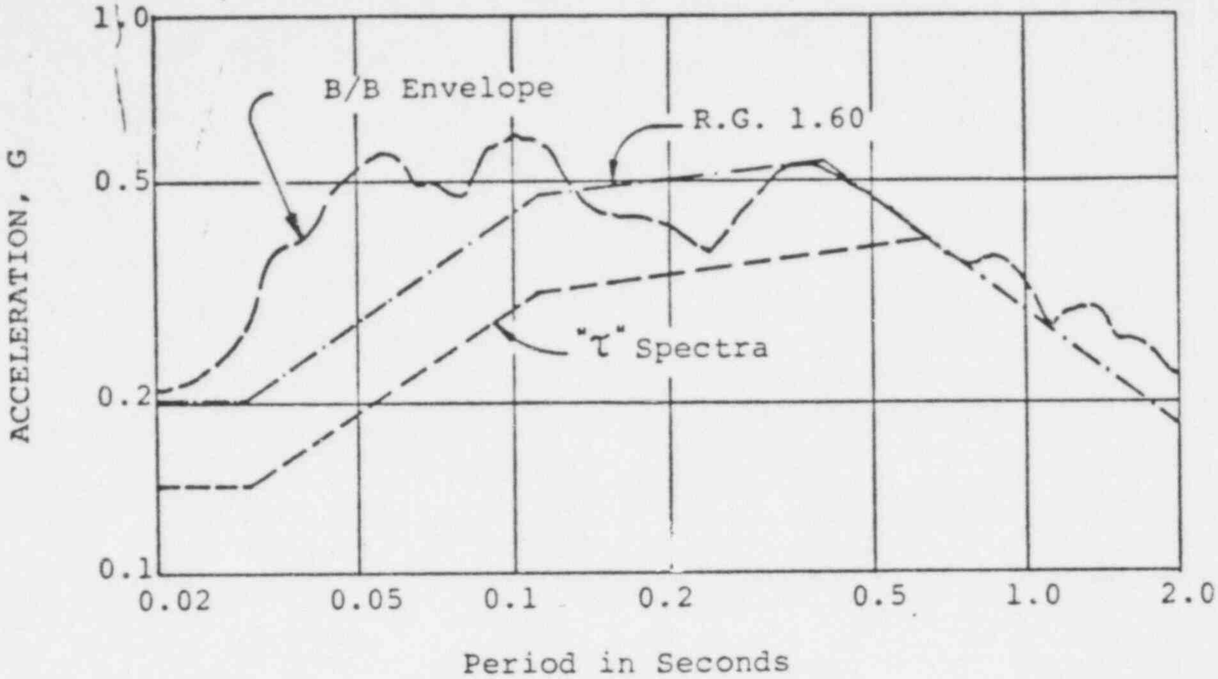
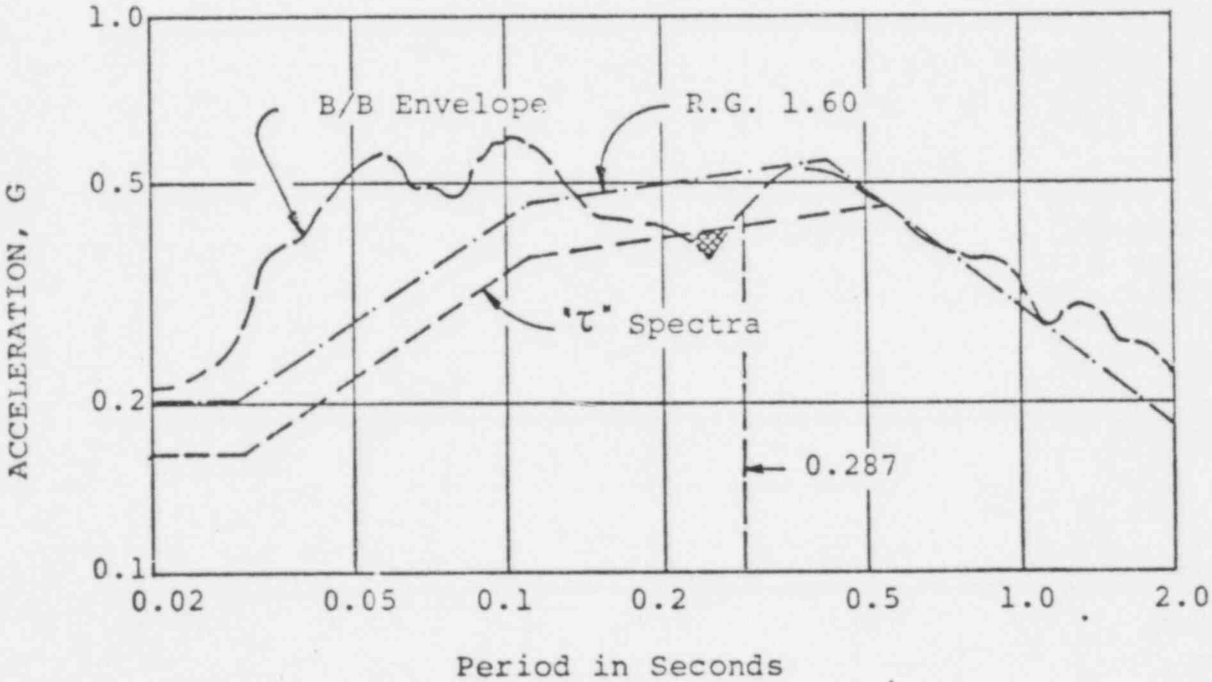


(a) SSE (7%) spectra for AUX-TUR complex (τ = 0.067 sec.)



(b) SSE (7%) spectra for containment (τ = 0.04 sec.)

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FIGURE Q130.6-4

HORIZONTAL SSE (7%) SPECTRA COMPARISON

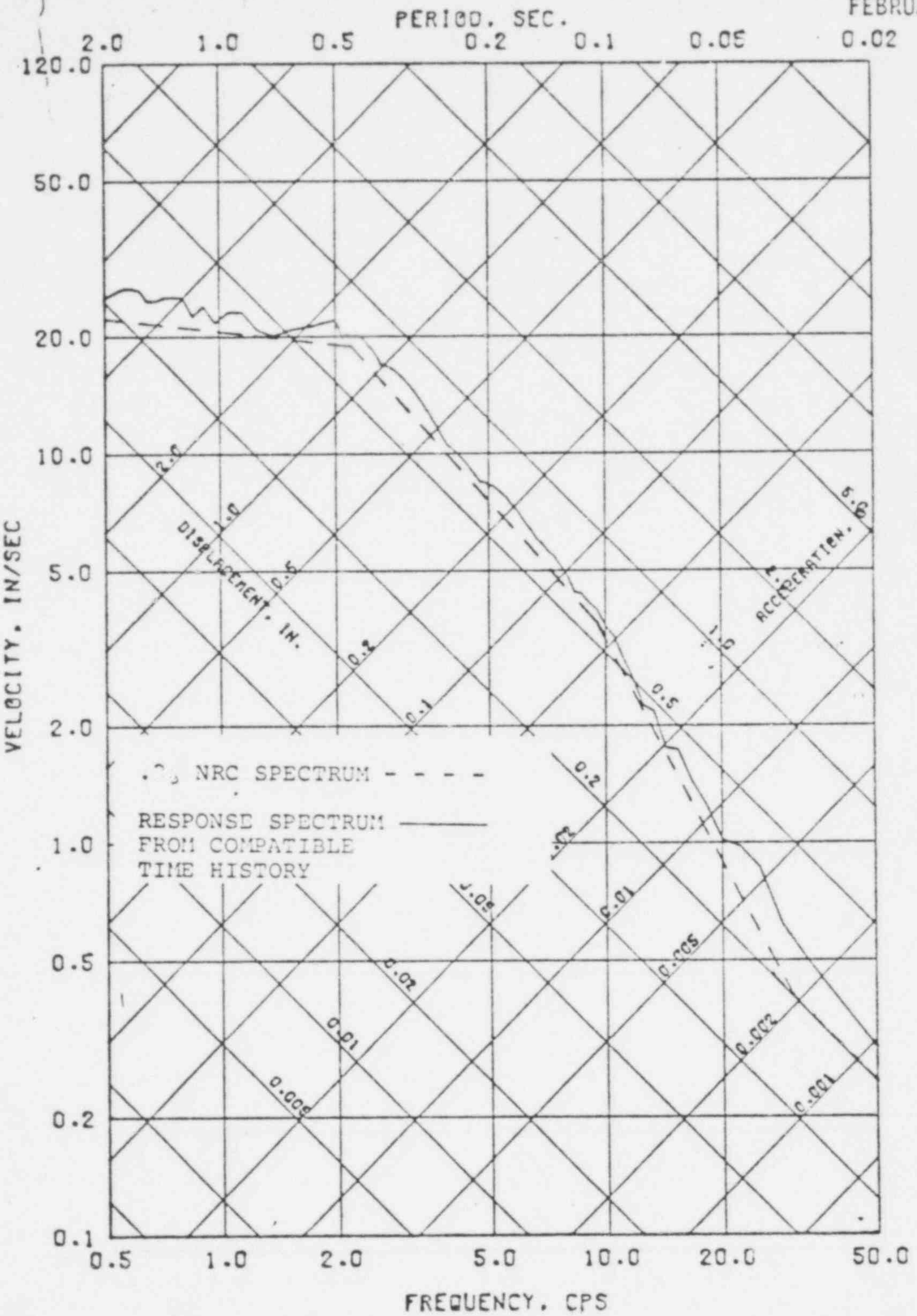

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FIGURE Q130.6-5

HORIZONTAL RESPONSE SPECTRA
(4% DAMPING)

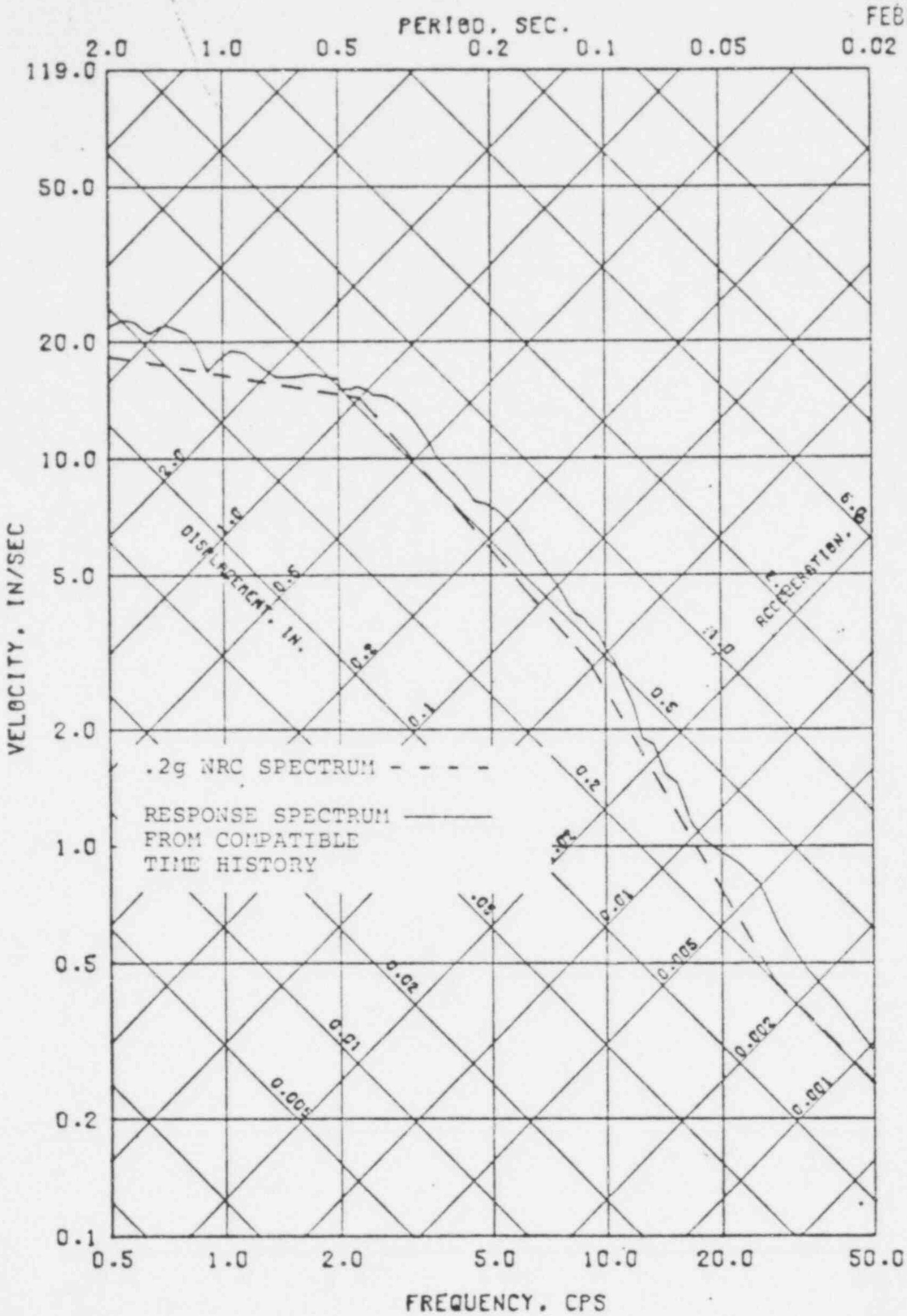

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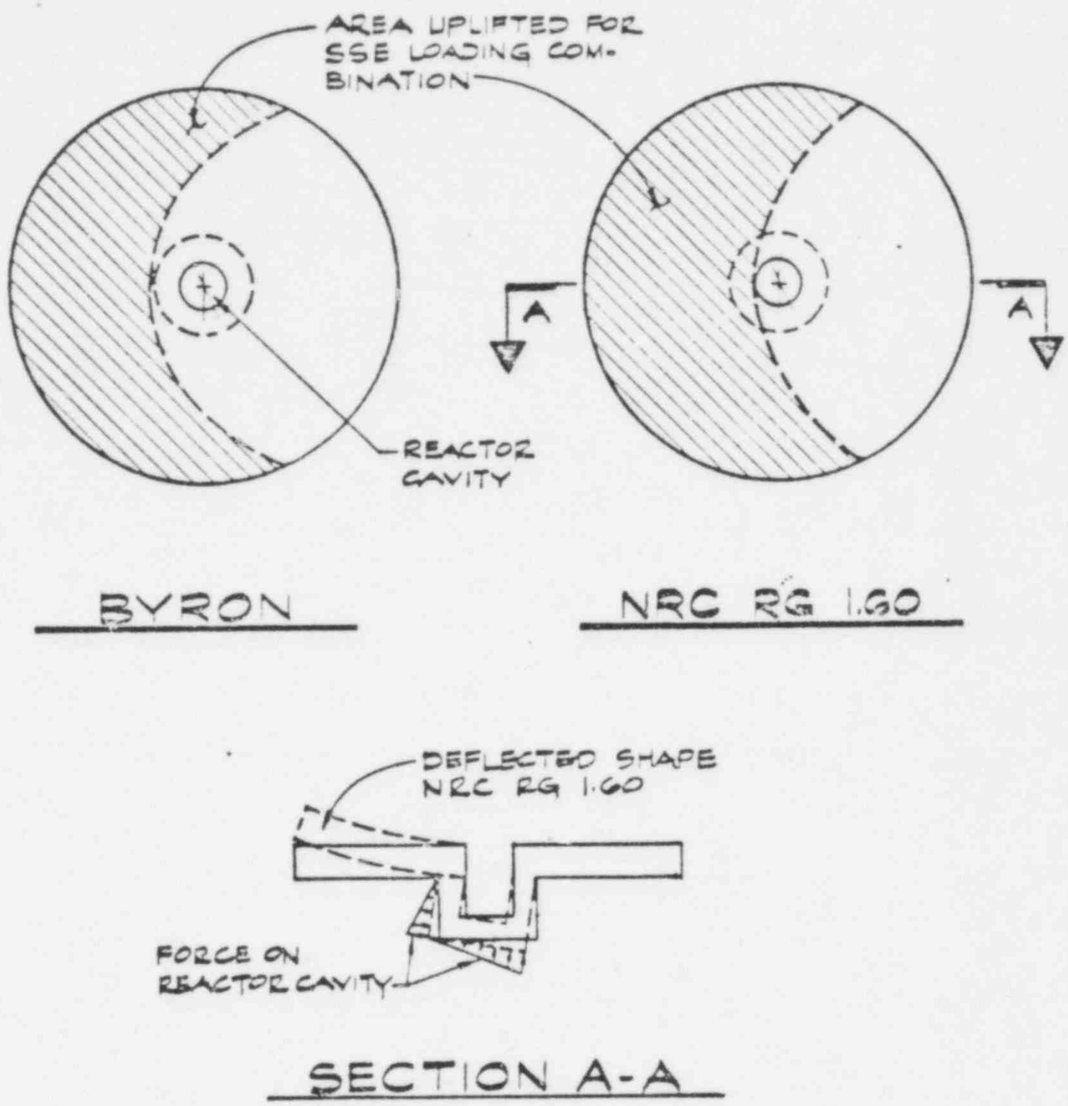
FIGURE Q130.6-6

HORIZONTAL RESPONSE SPECTRA
(7% DAMPING)



NOTE: THE UPLIFT CALCULATIONS DO NOT ACCOUNT FOR THE SIDE SOIL/ROCK RESISTANCE WHICH WOULD BE MOBILIZED

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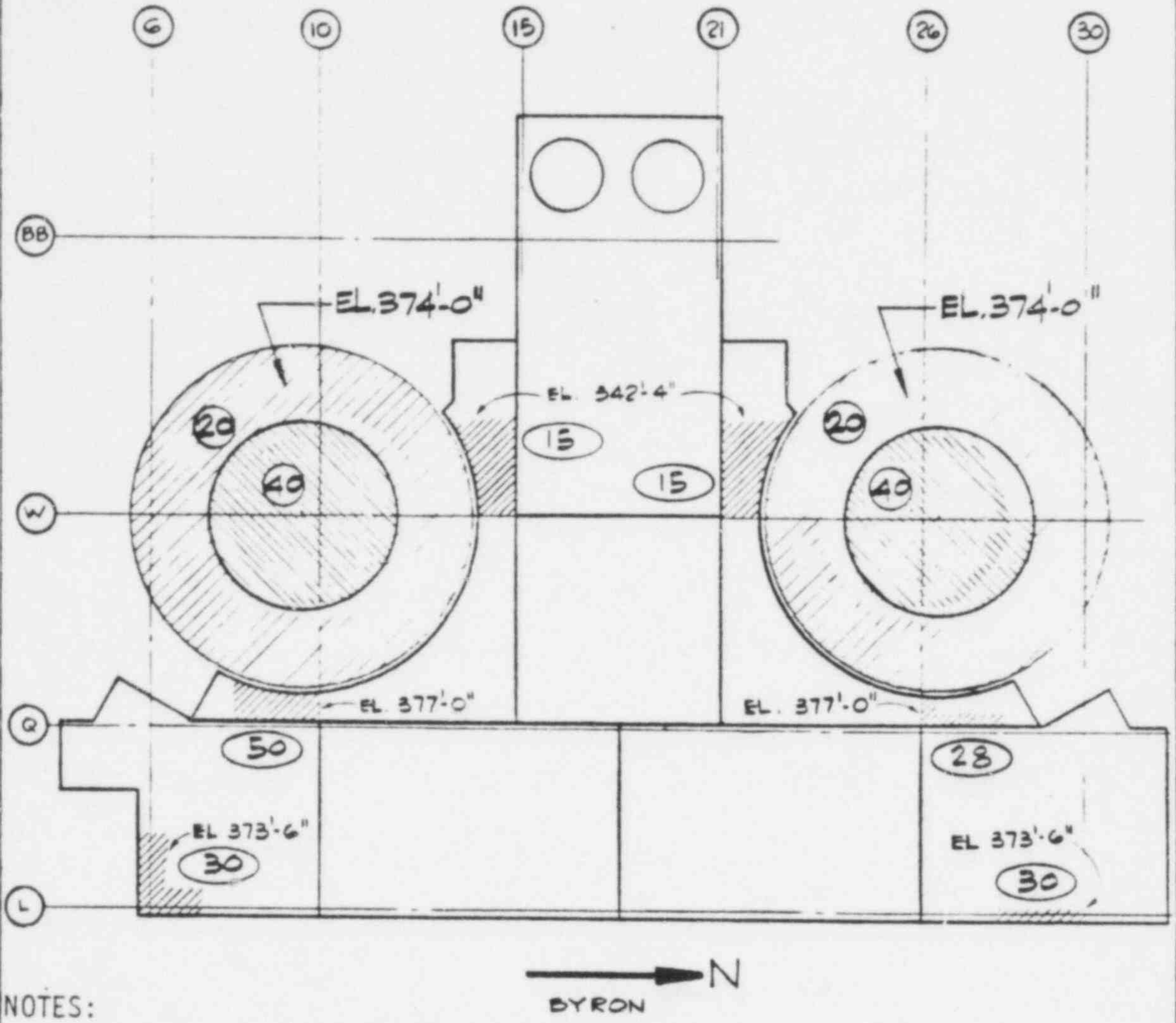
FIGURE Q130.6-7

CONTAINMENT BASEMAT UPLIFT COMPARISON



NOTES:

1. THE CHANGES IN THE FORCES ARE PRIMARILY DUE TO INCREASED UPLIFT OF THE MAT.
2. THE UPLIFT CALCULATIONS DO NOT ACCOUNT FOR THE SIDE SOIL/ROCK RESISTANCE WHICH WOULD BE MOBILIZED.

LEGEND:

(oval) INDICATES AVERAGE % INCREASE IN SEISMIC FORCES IN BASE MAT.

(hatching) INDICATES AFFECTED AREAS

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FIGURE Q130.6-8

CONTAINMENT - AUXILIARY - FUEL HANDLING BUILDING COMPLEX AT MAT ELEVATION

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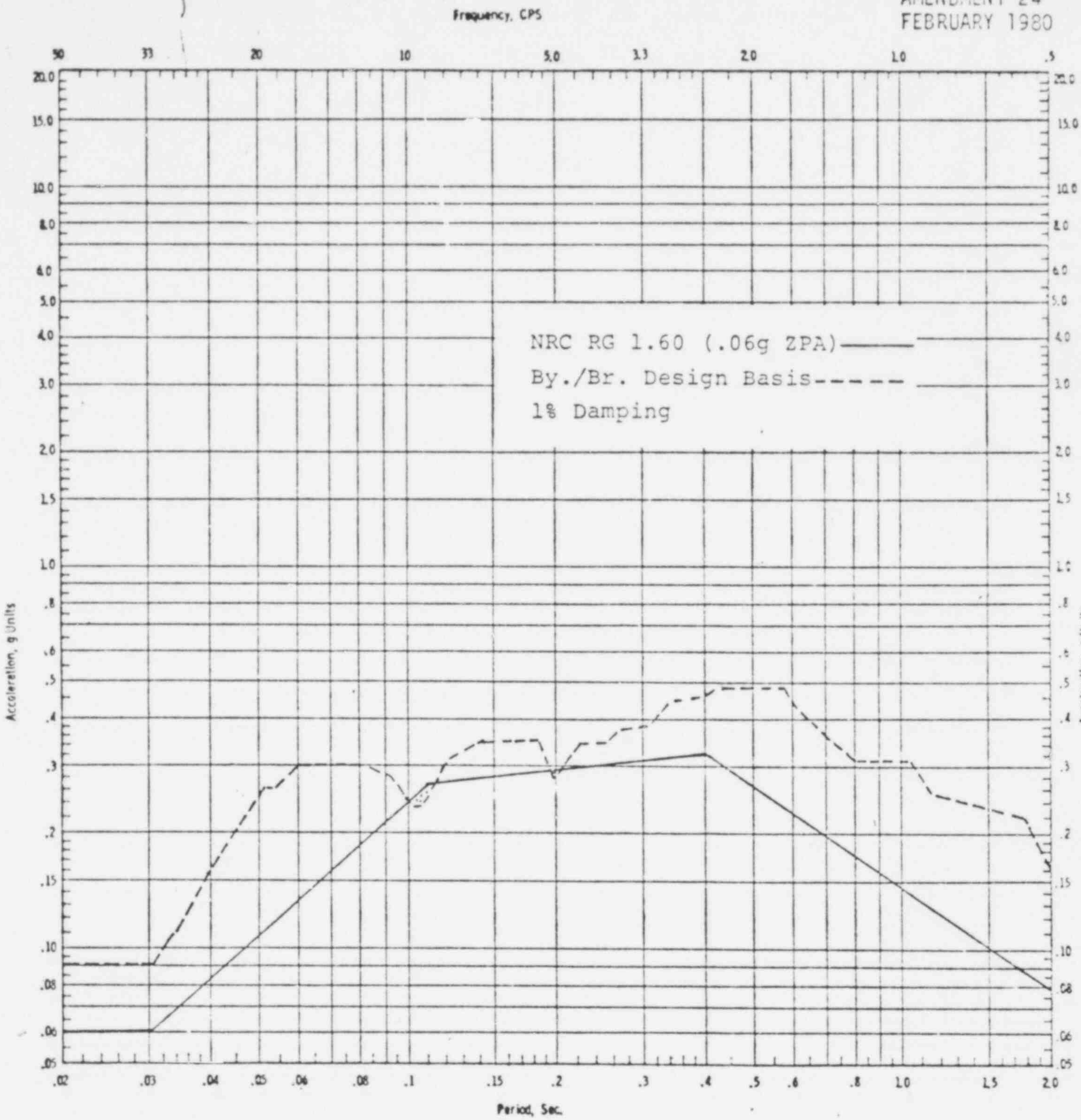

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FIGURE Q130.6-9
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS AND EW
LOCATION: AUXILIARY AND CONTAINMENT BLDG.
ELEVATION: 330'-0"; 374'-0"

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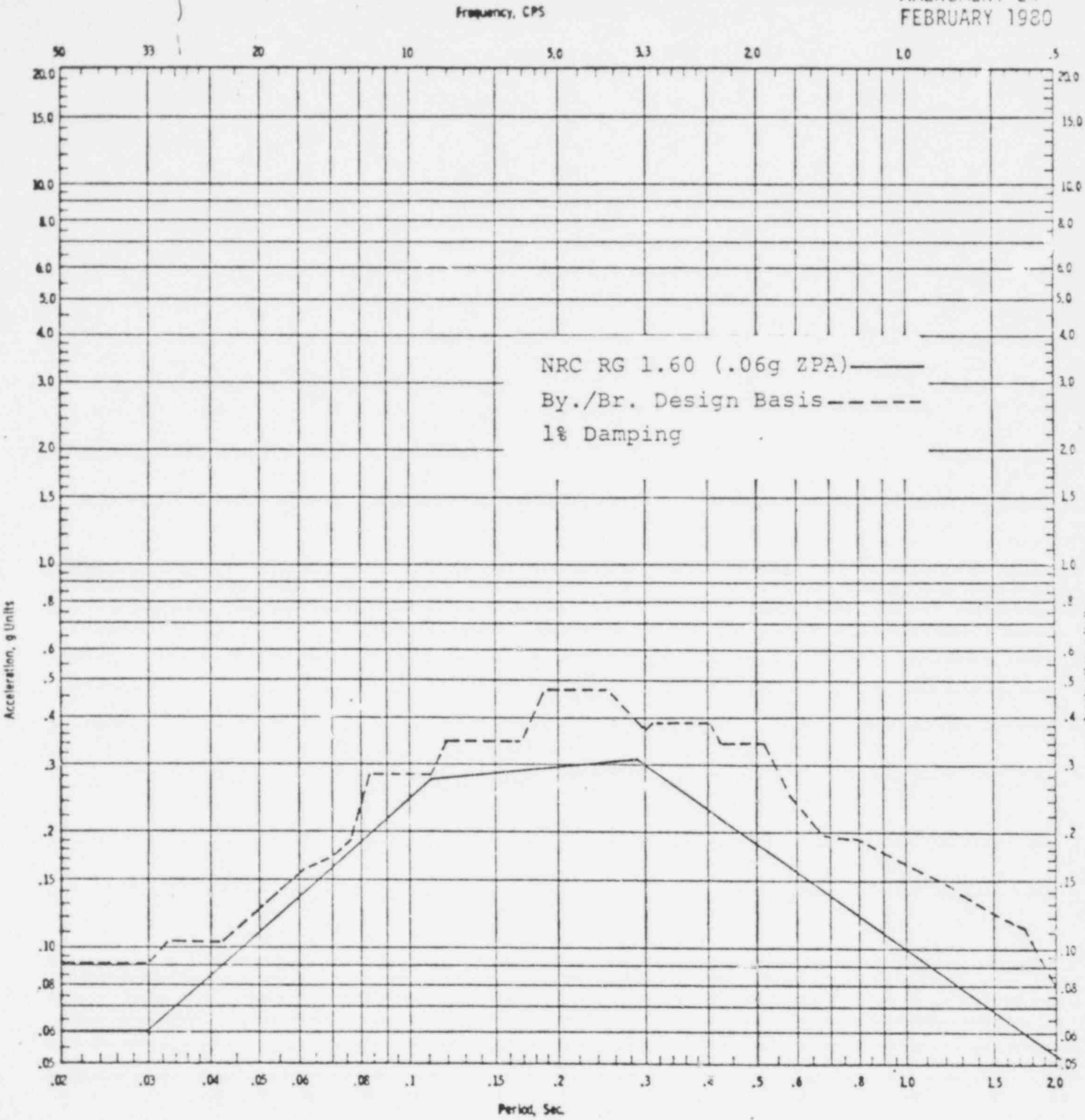

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FIGURE Q130.6-10
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL AND SLAB
LOCATION: AUXILIARY AND CONTAINMENT BLDG.
ELEVATION: 330'-0"; 374'-0"

1842 195

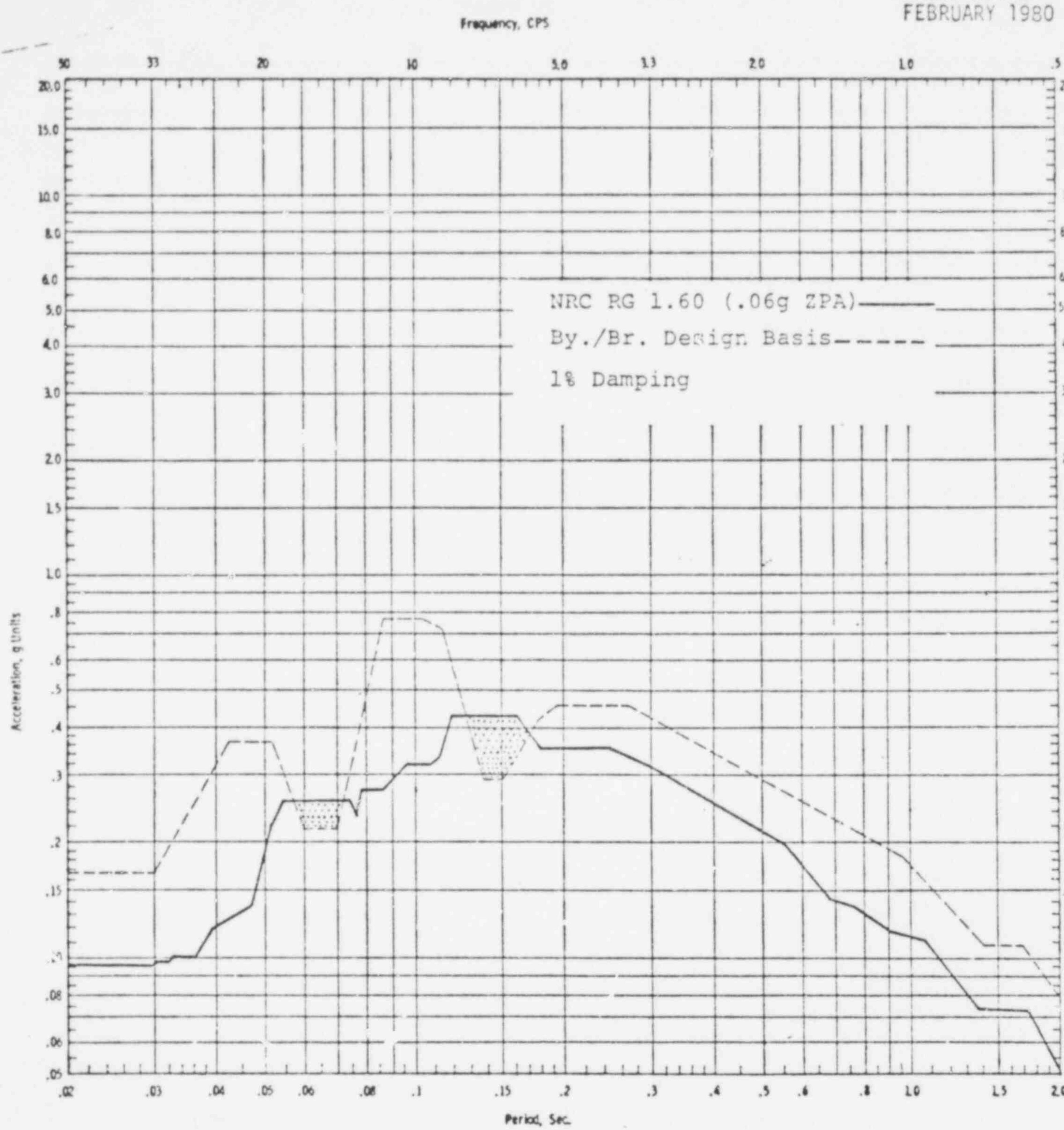

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FIGURE Q130.6-11
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 346'-0"; 364'-0"; 383'-0"; 401'-0"

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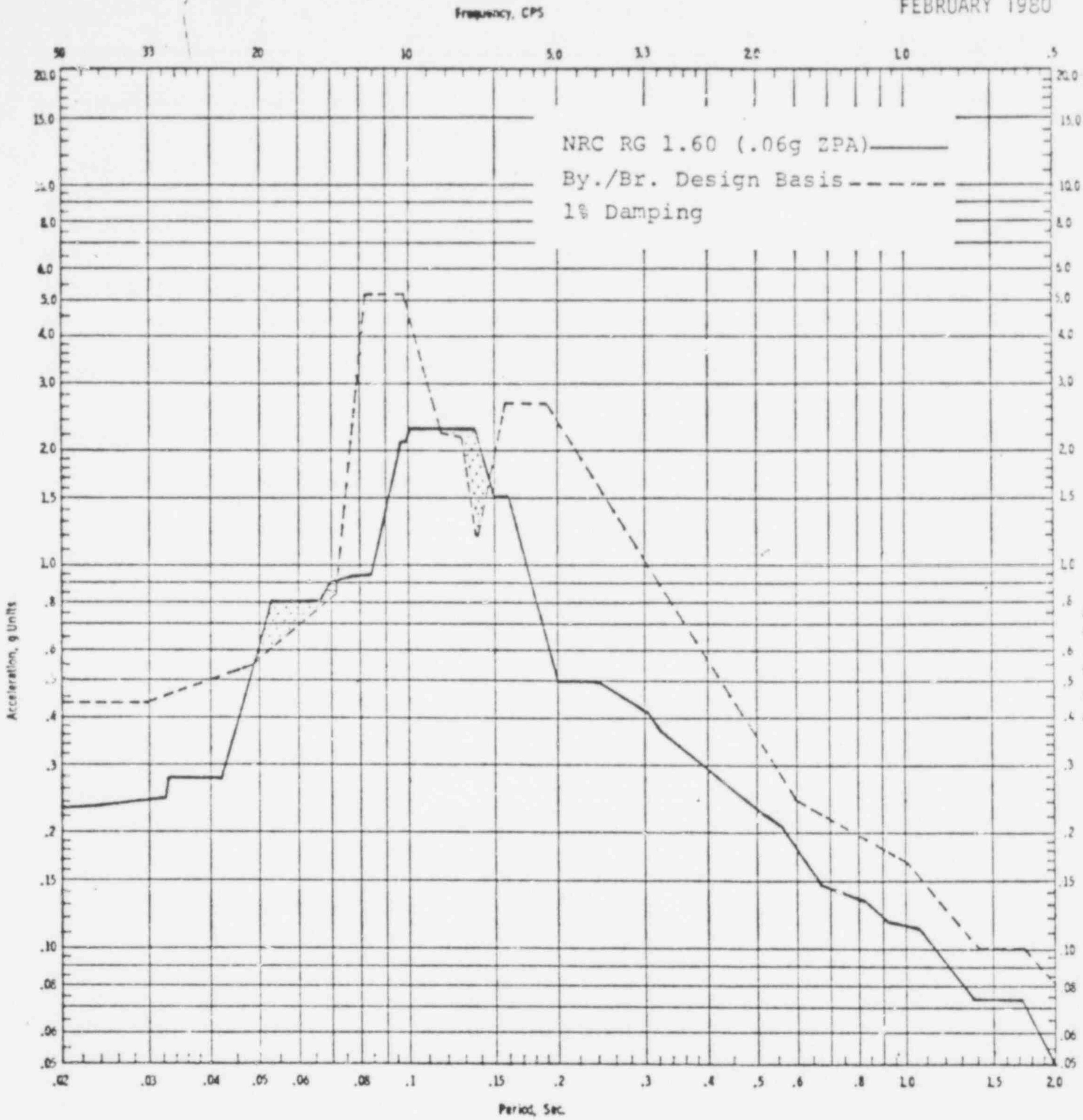

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FIGURE Q130.6-12
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 346'-0"; 364'-0"; 383'-0"; 401'-0"

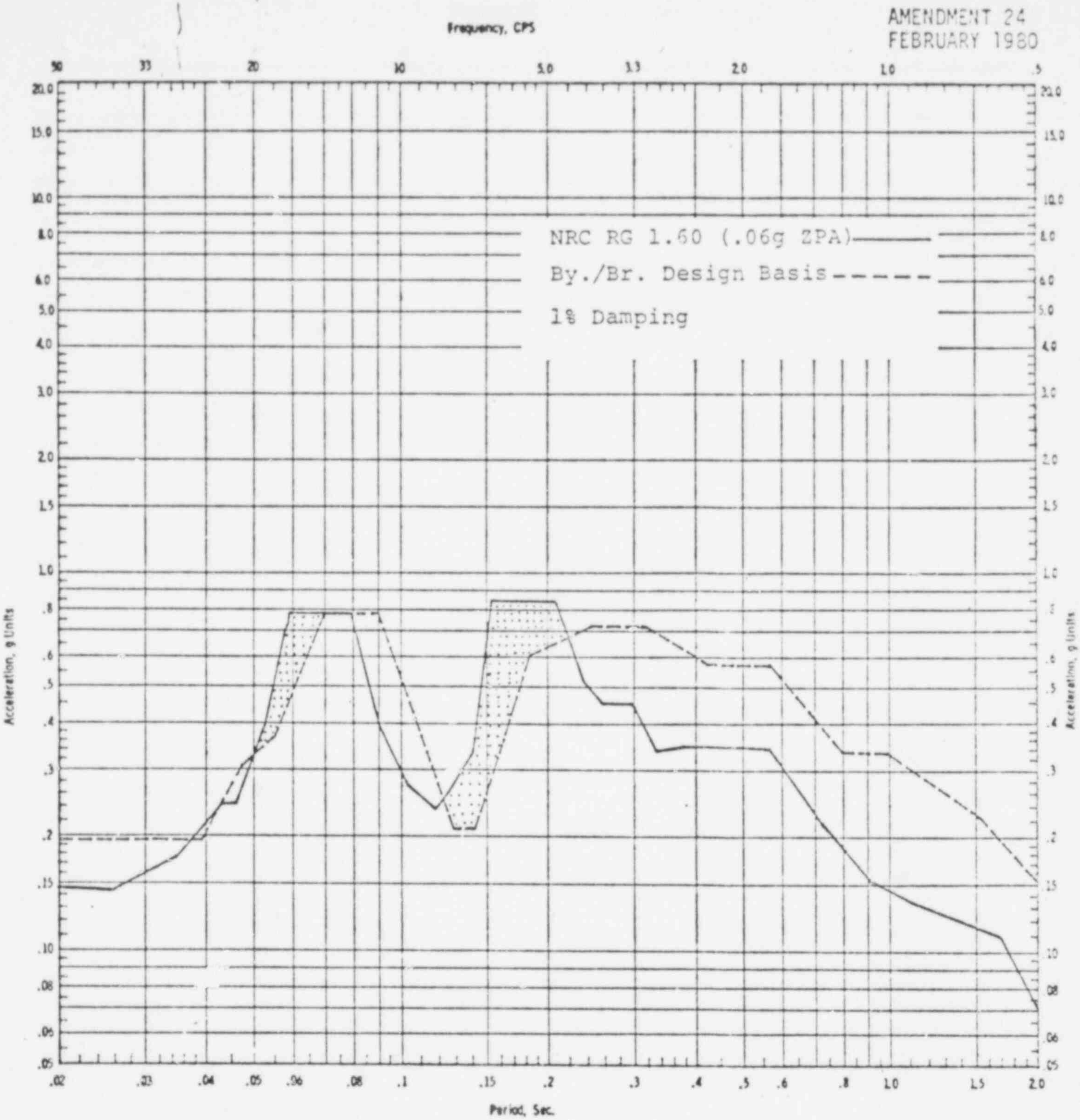

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FIGURE Q130.6-13

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING
ELEVATION: 401'-0"

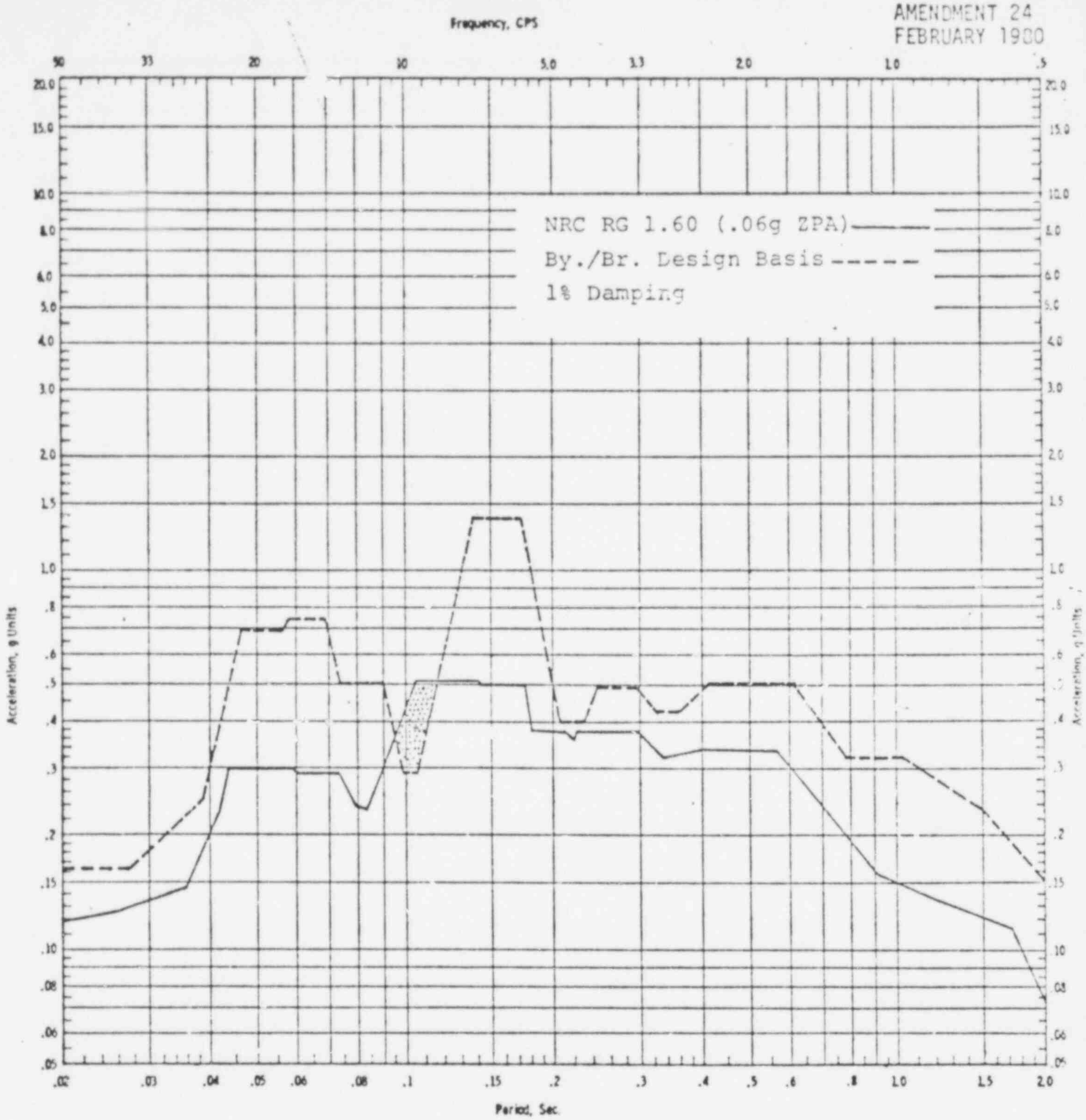

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FIGURE Q130.6-14

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING
ELEVATION: 401'-0"

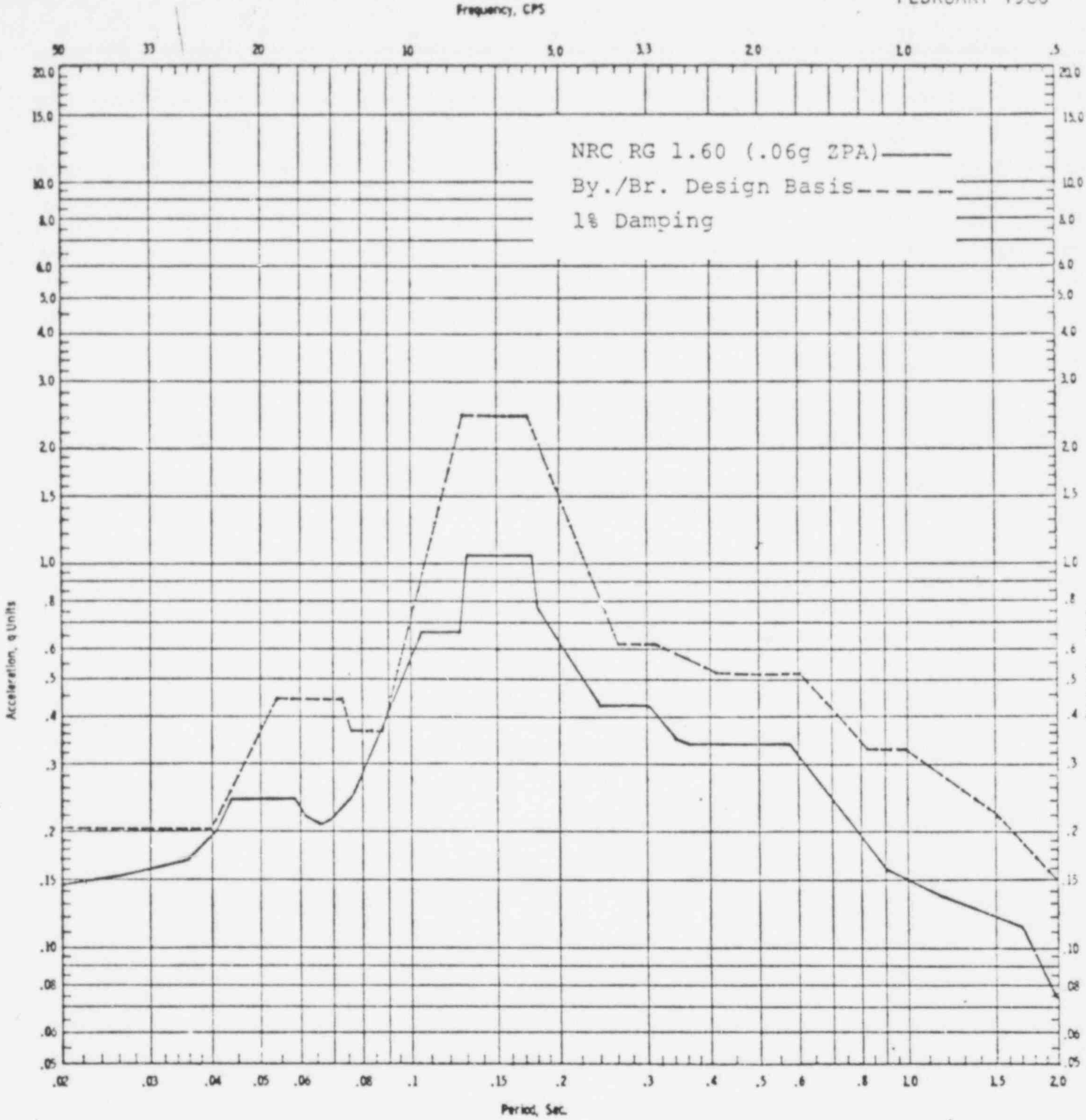

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FIGURE Q130.6-15
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 426'-0"

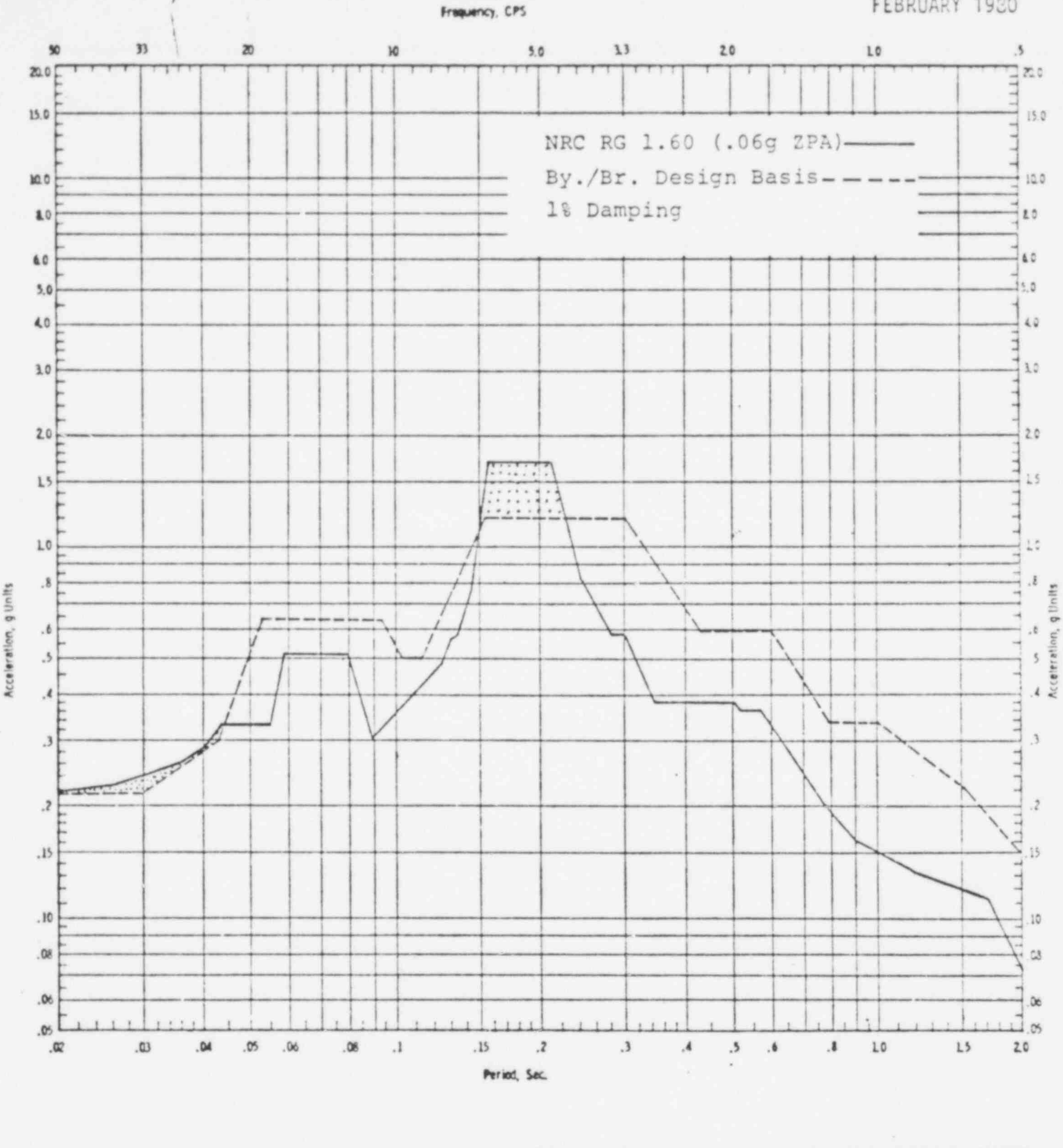

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FIGURE Q130.6-16
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 426'-0"

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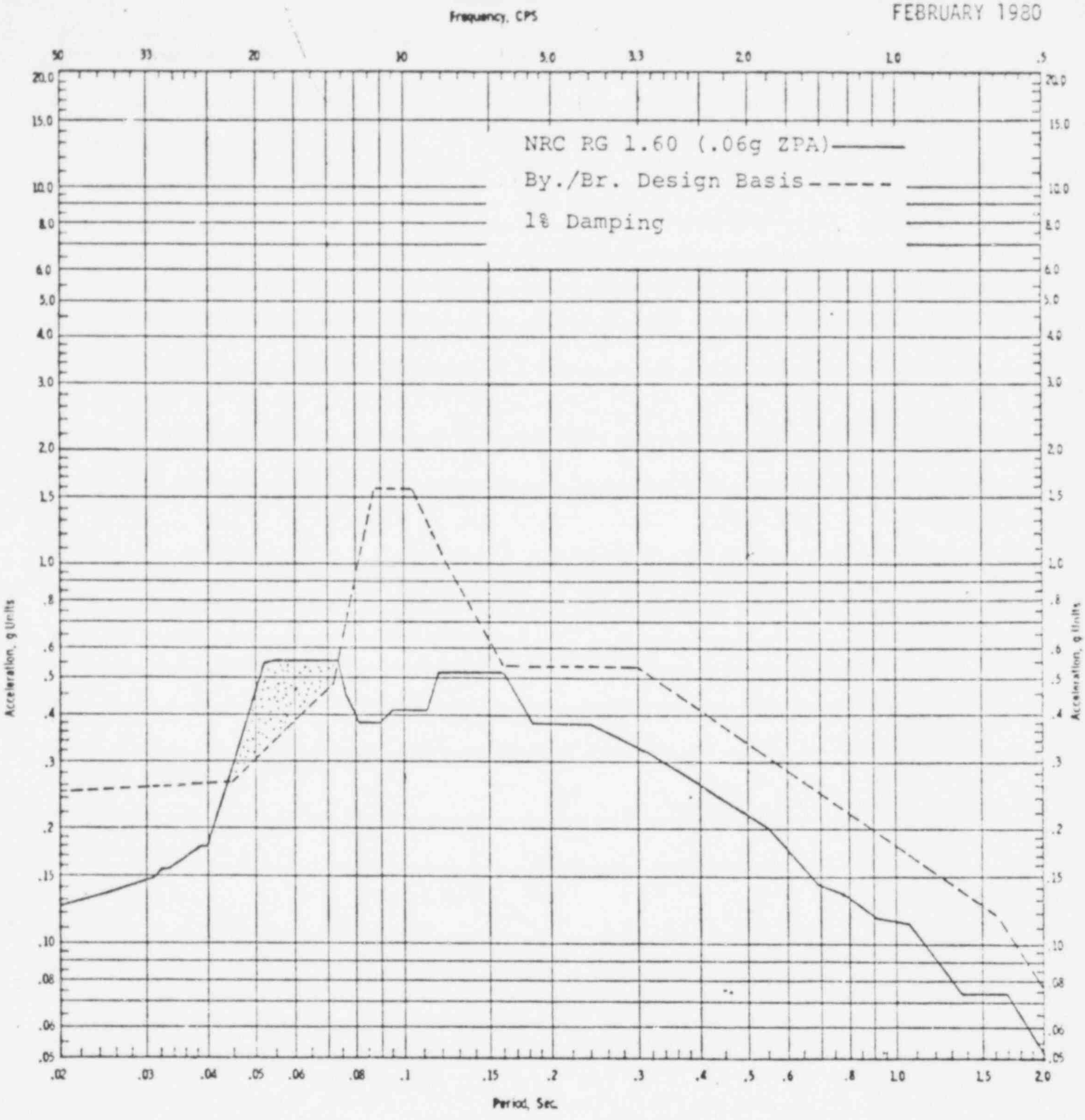

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FIGURE Q130.6-17

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 426'-0"; 439'-0"; 451'-0"

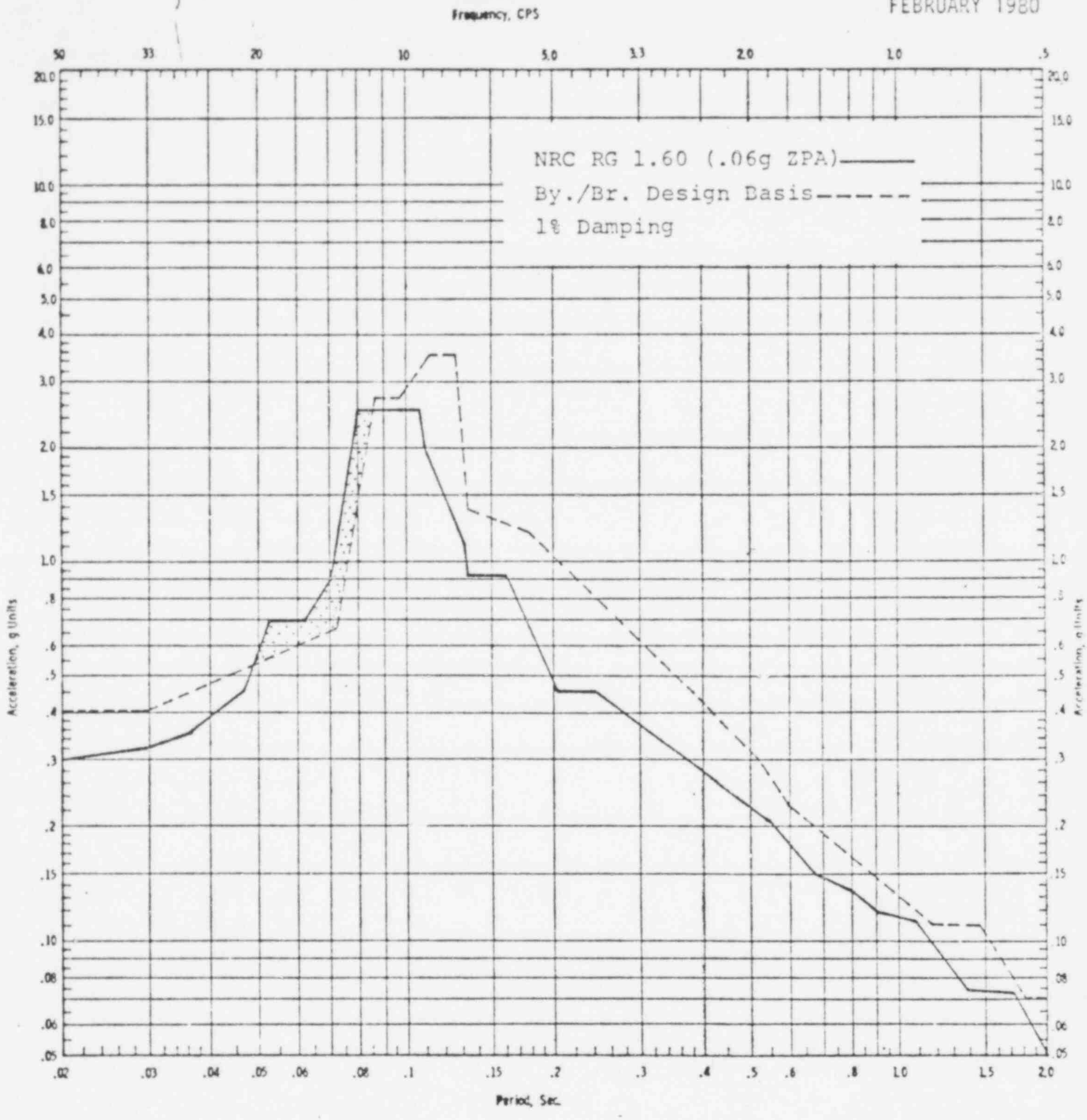

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FIGURE Q130.6-18

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 426'-0"; 439'-0"; 451'-0"

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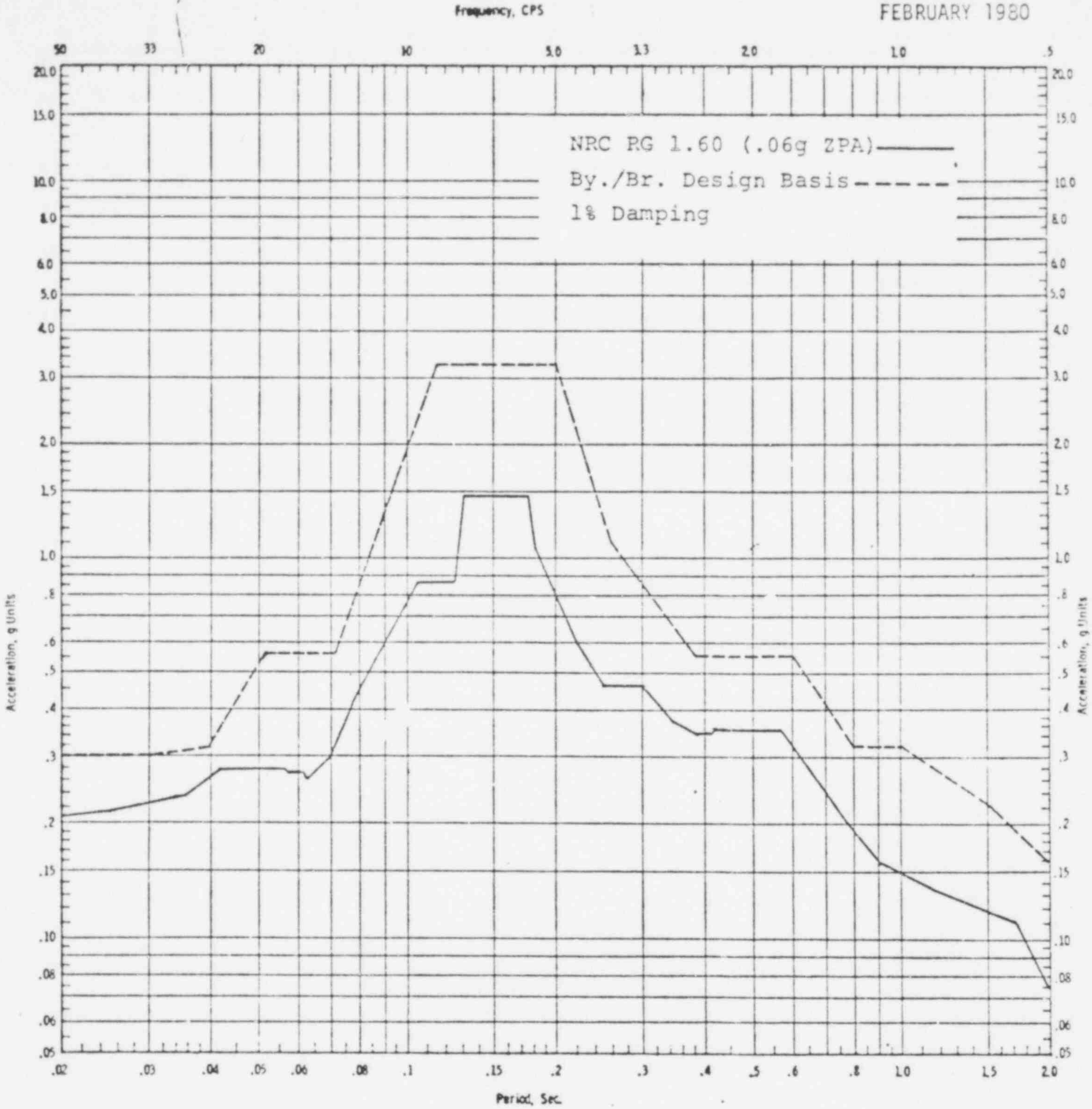

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FIGURE Q130.6-19
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 451'-0"

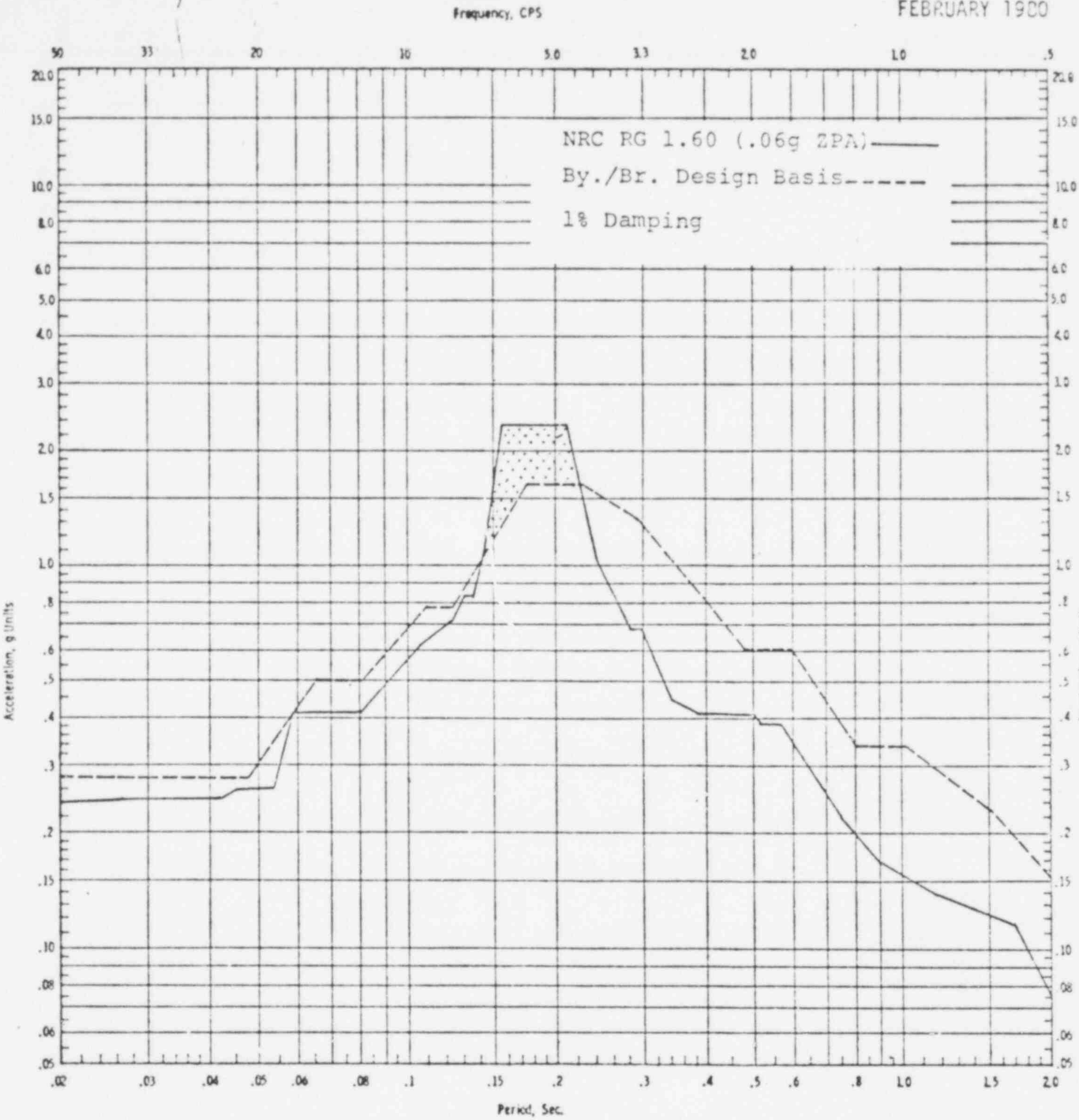

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FIGURE Q130.6-20
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 451'-0"

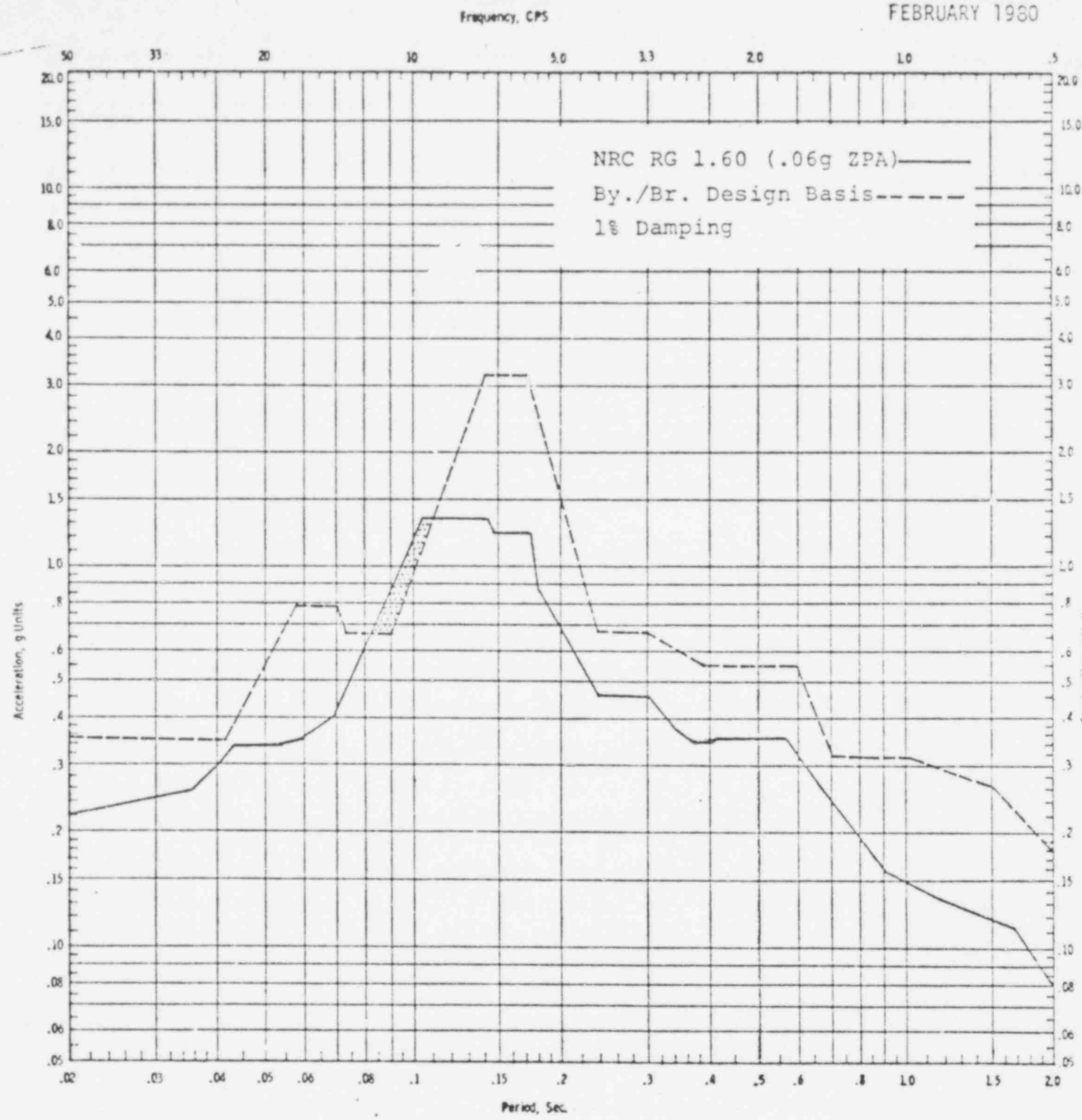

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FIGURE Q130.6-21

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING
ELEVATION: 477'-0"

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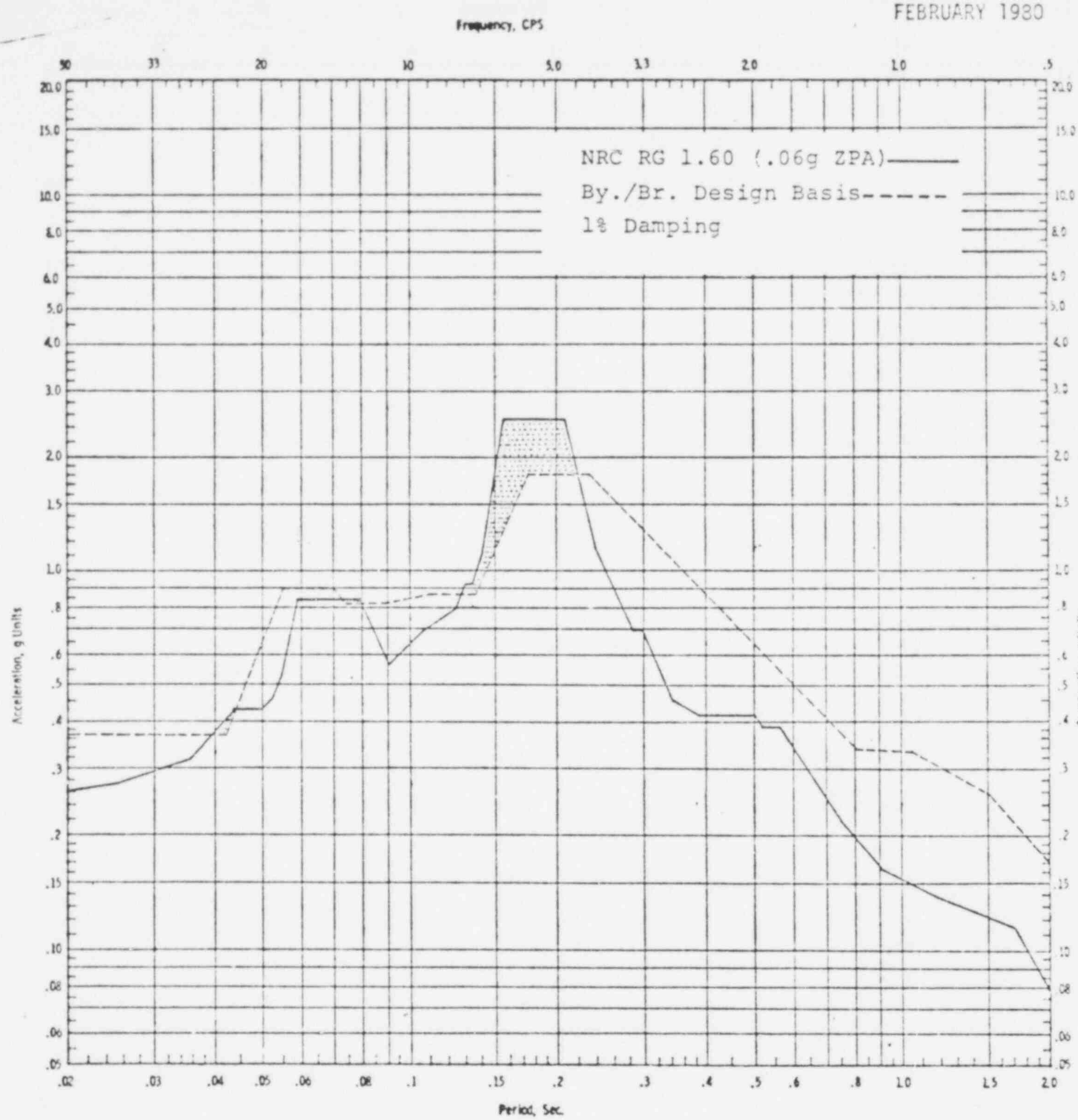

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FIGURE Q130.6-22

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING
ELEVATION: 477'-0"

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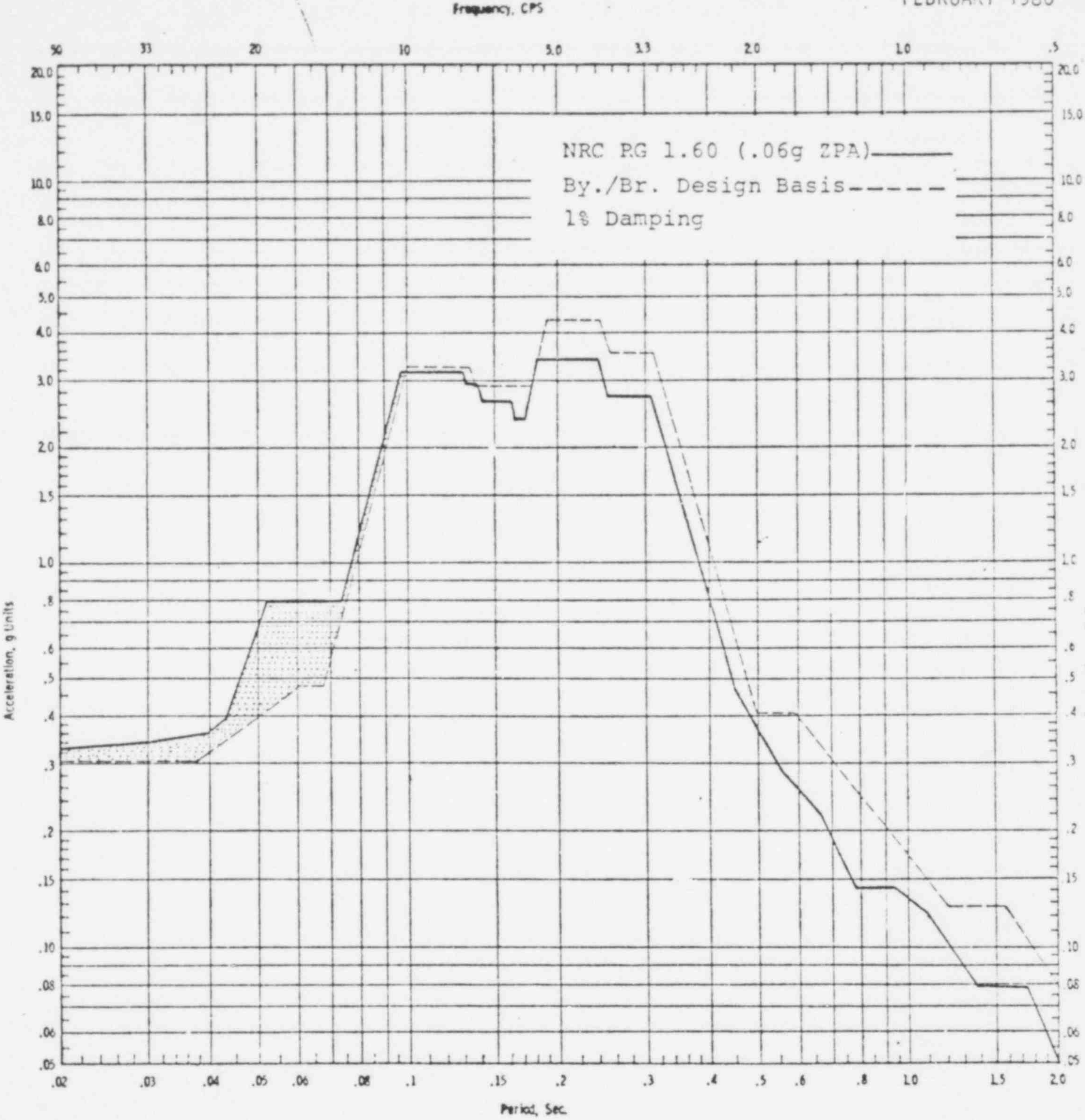

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FIGURE Q130.6-23

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 467'-0"; 477'-0"

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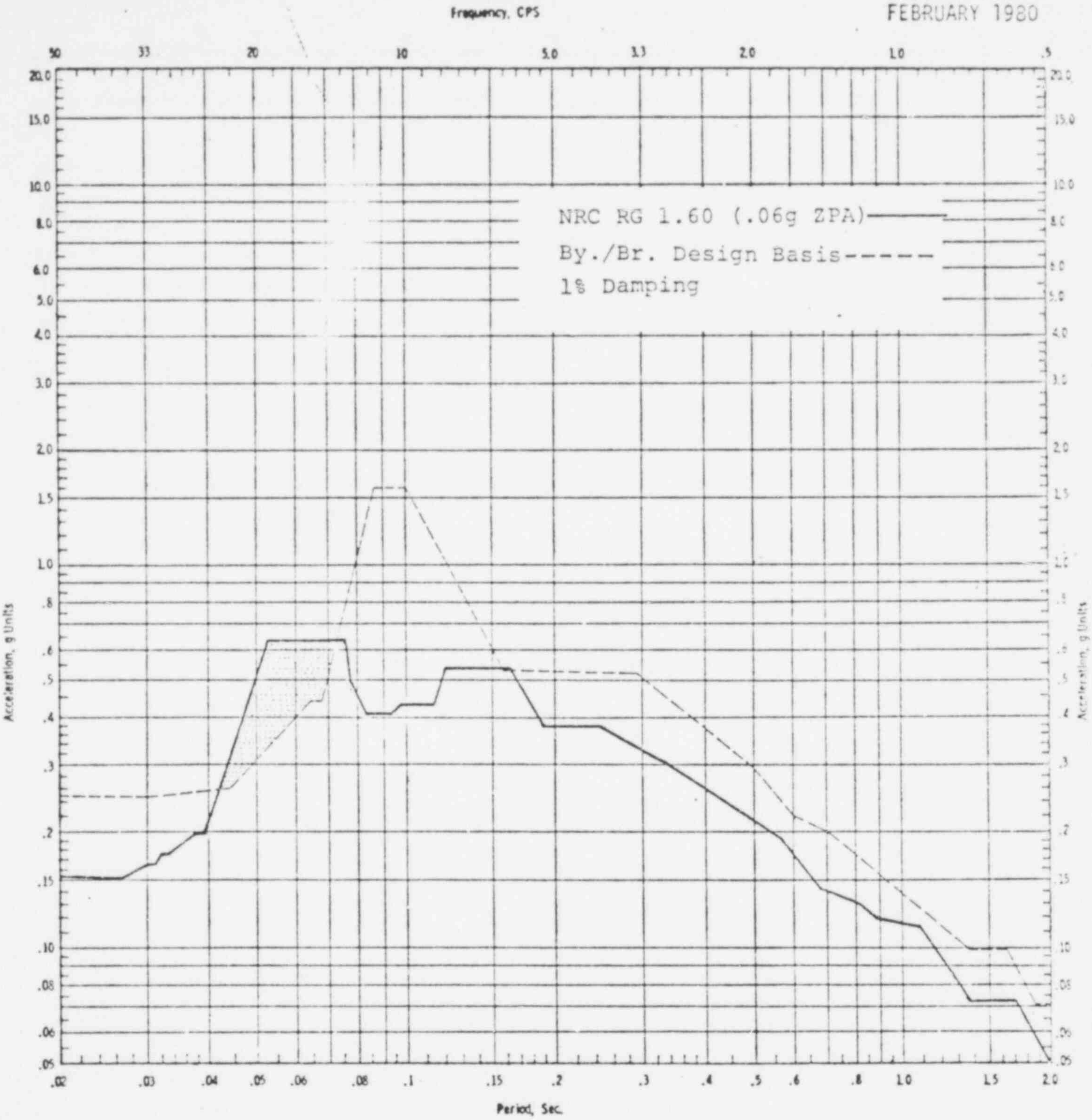

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FIGURE Q130.6-24
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 467'-0"; 477'-0"; 473'-0"; 485'-0"

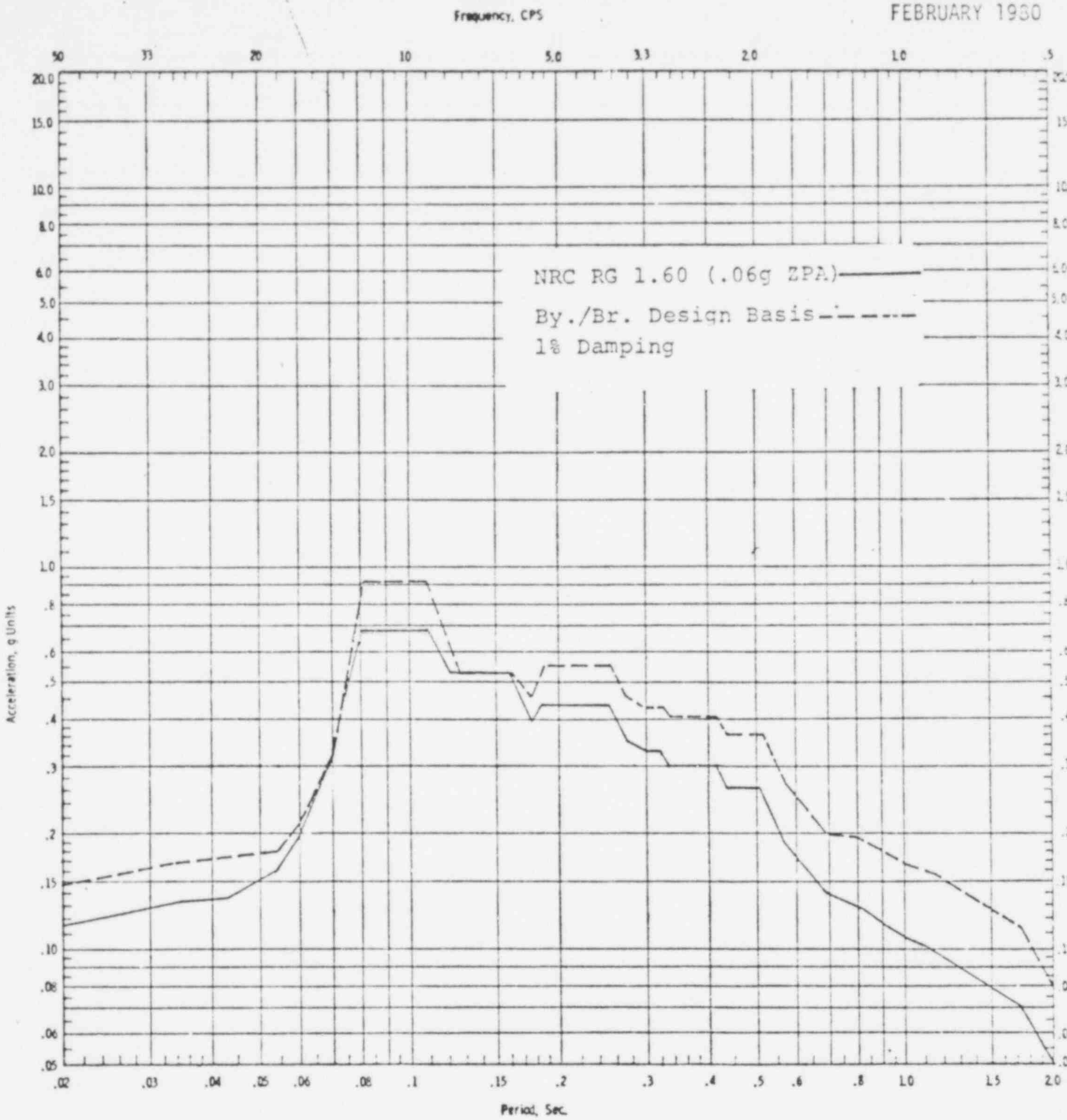

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FIGURE Q130.6-25

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: CONTAINMENT BUILDING WALL
ELEVATION: 424'-0"; 436'-0"

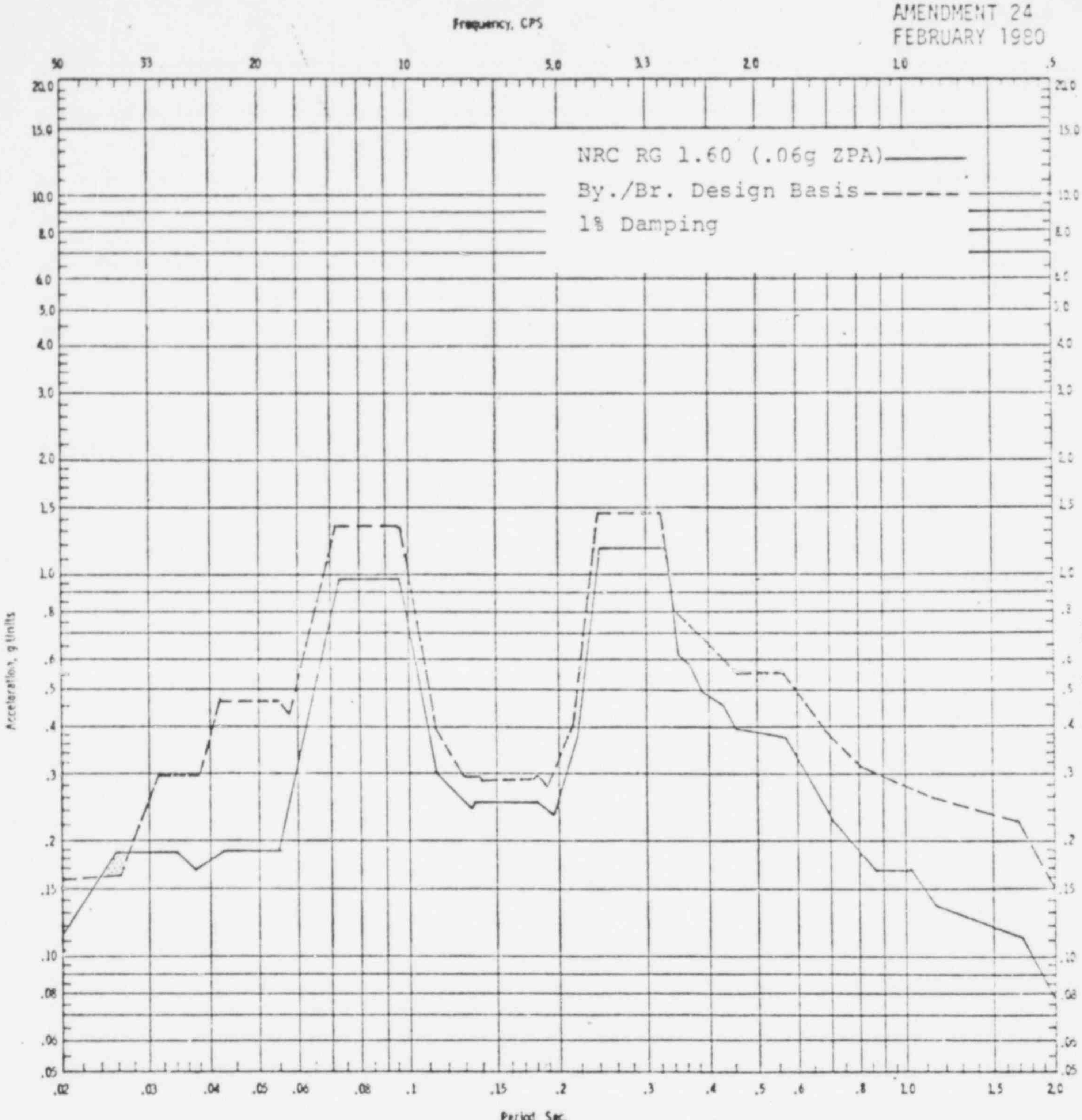

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FIGURE Q130.6-26

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: CONTAINMENT BUILDING
ELEVATION: 424'-0"; 436'-0"

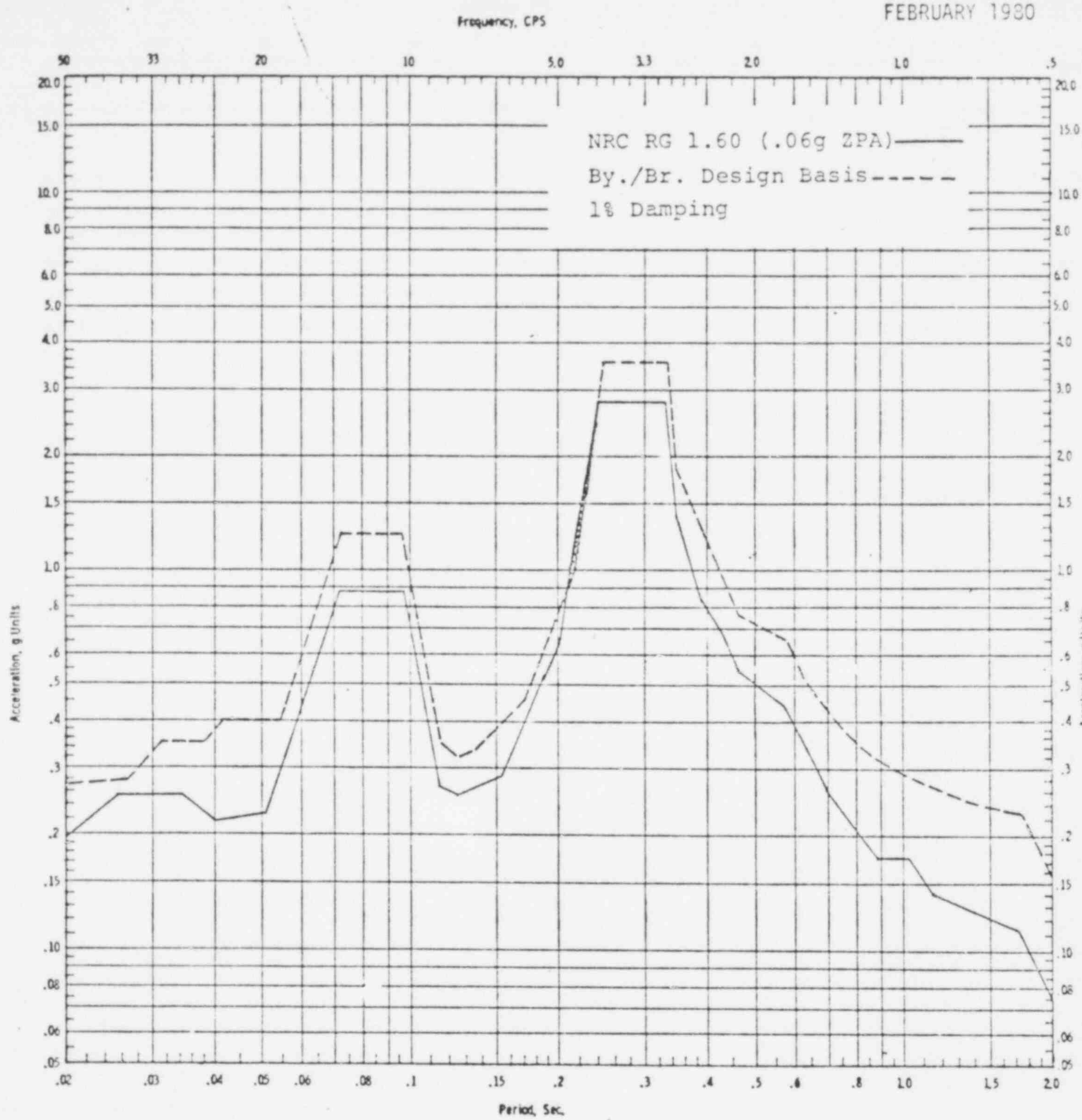

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FIGURE Q130.6-27

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS AND EW
LOCATION: CONTAINMENT BUILDING
ELEVATION: 496'-0"

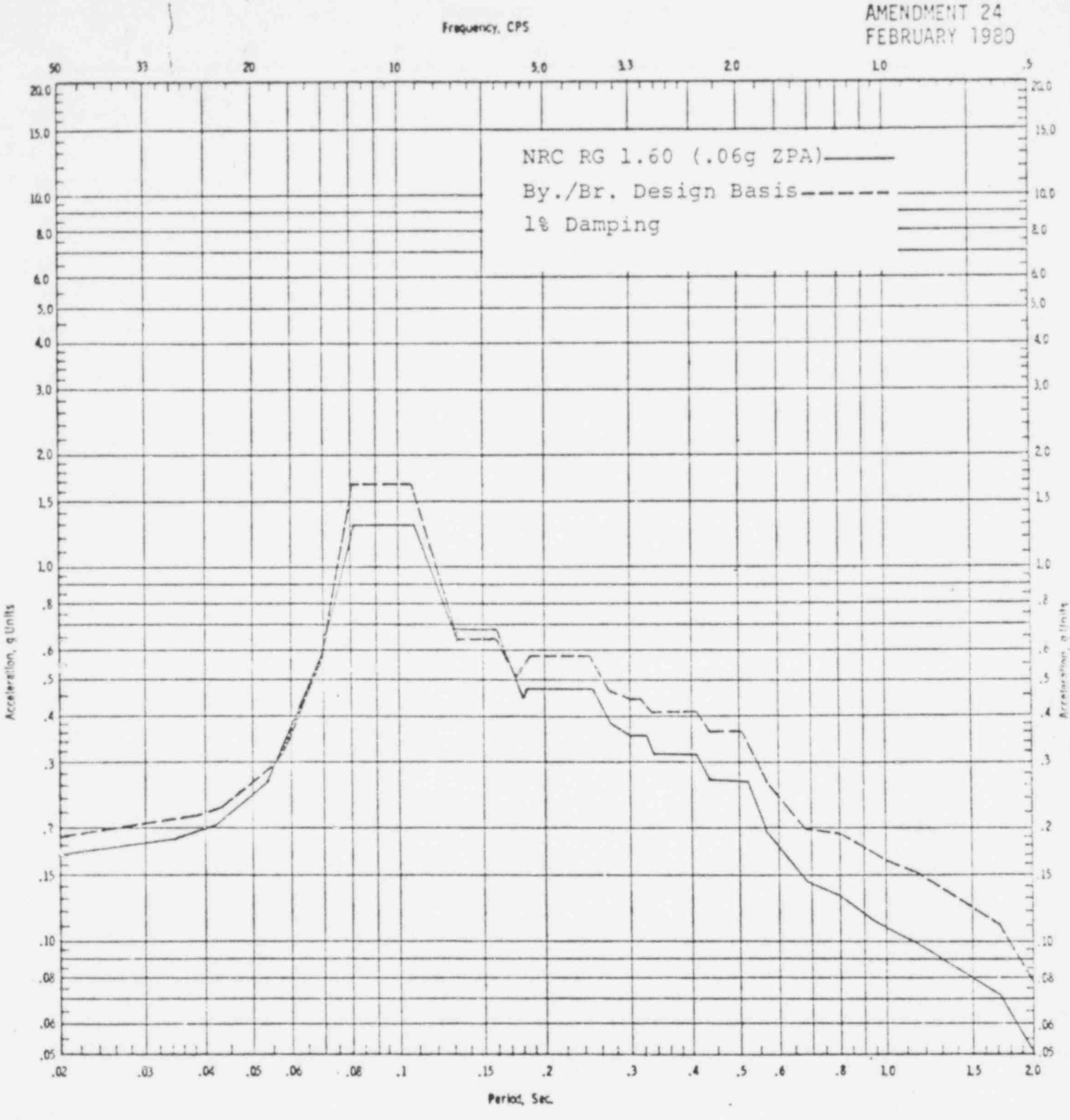

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FIGURE Q130.6-28

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: CONTAINMENT BUILDING
ELEVATION: 496'-0"

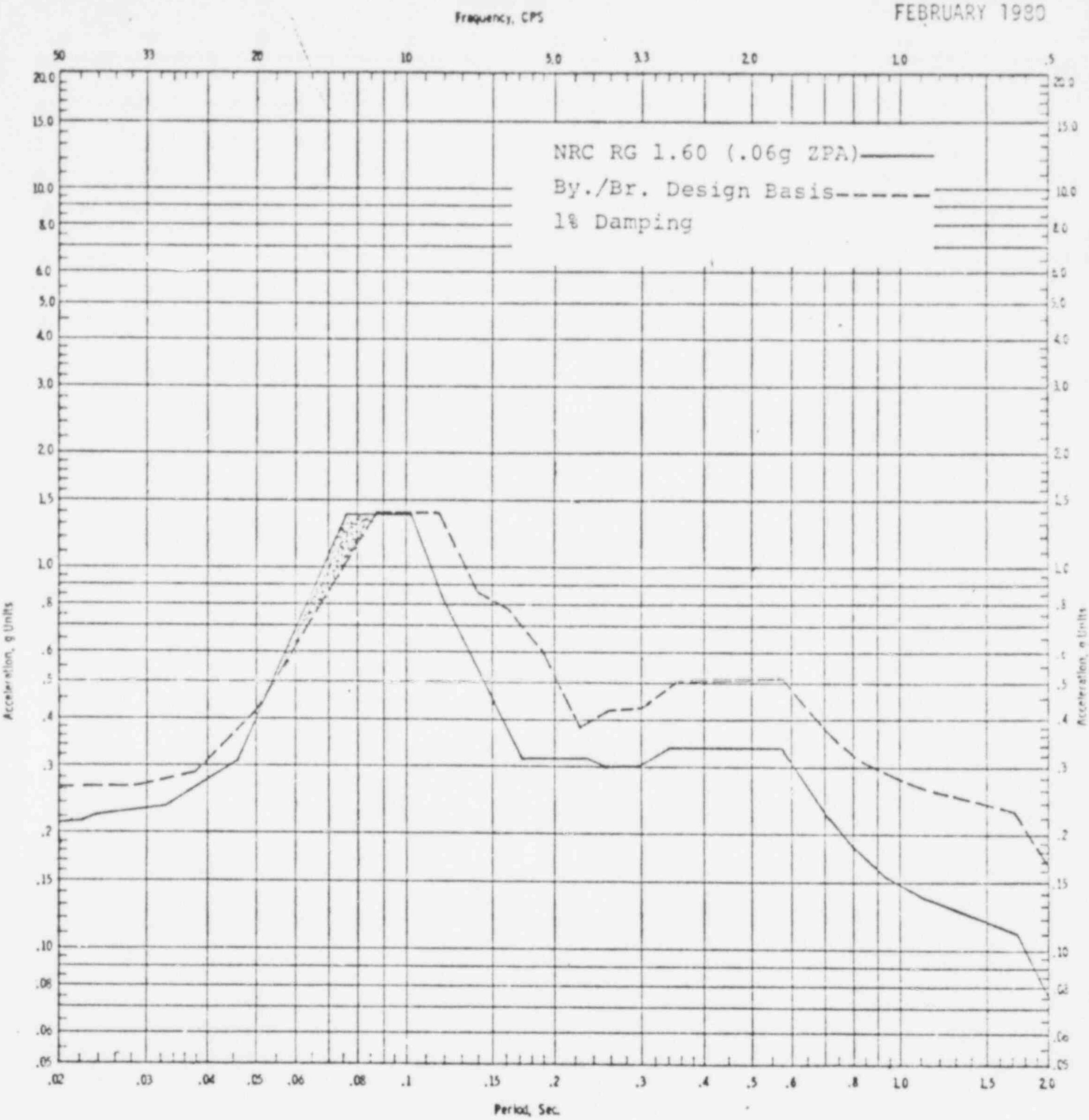

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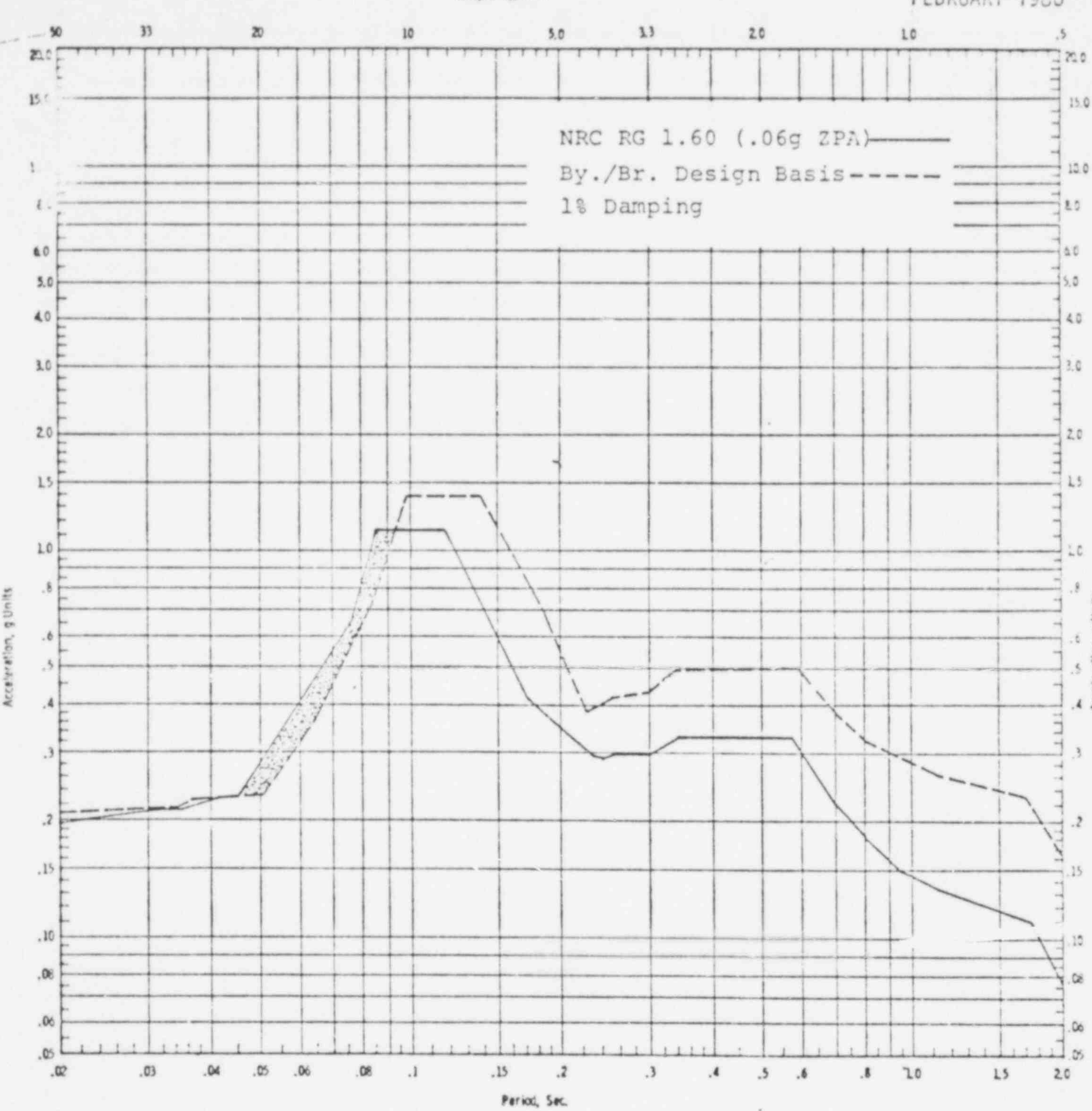
FIGURE Q130.6-29

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: CONTAINMENT INNER STRUCTURE
ELEVATION: 426'-0"



1842 215

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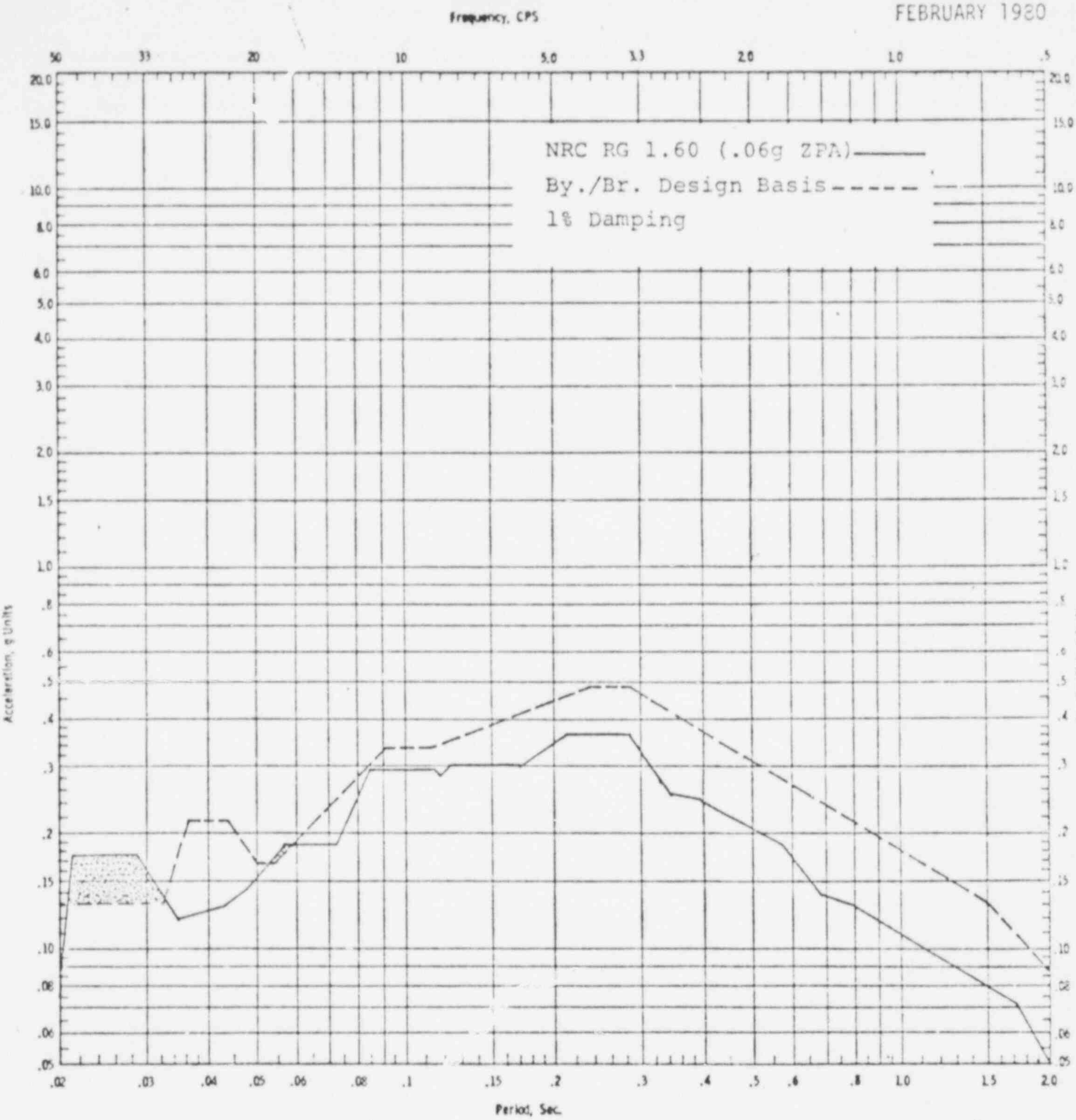
FIGURE Q130.6-30

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, EW
LOCATION: CONTAINMENT INNER STRUCTURE
ELEVATION: 426'-0"



1842 216

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FIGURE Q130.6-31
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: CONTAINMENT INNER STRUCTURE WALL
ELEVATION: 412'-0"; 426'-0"

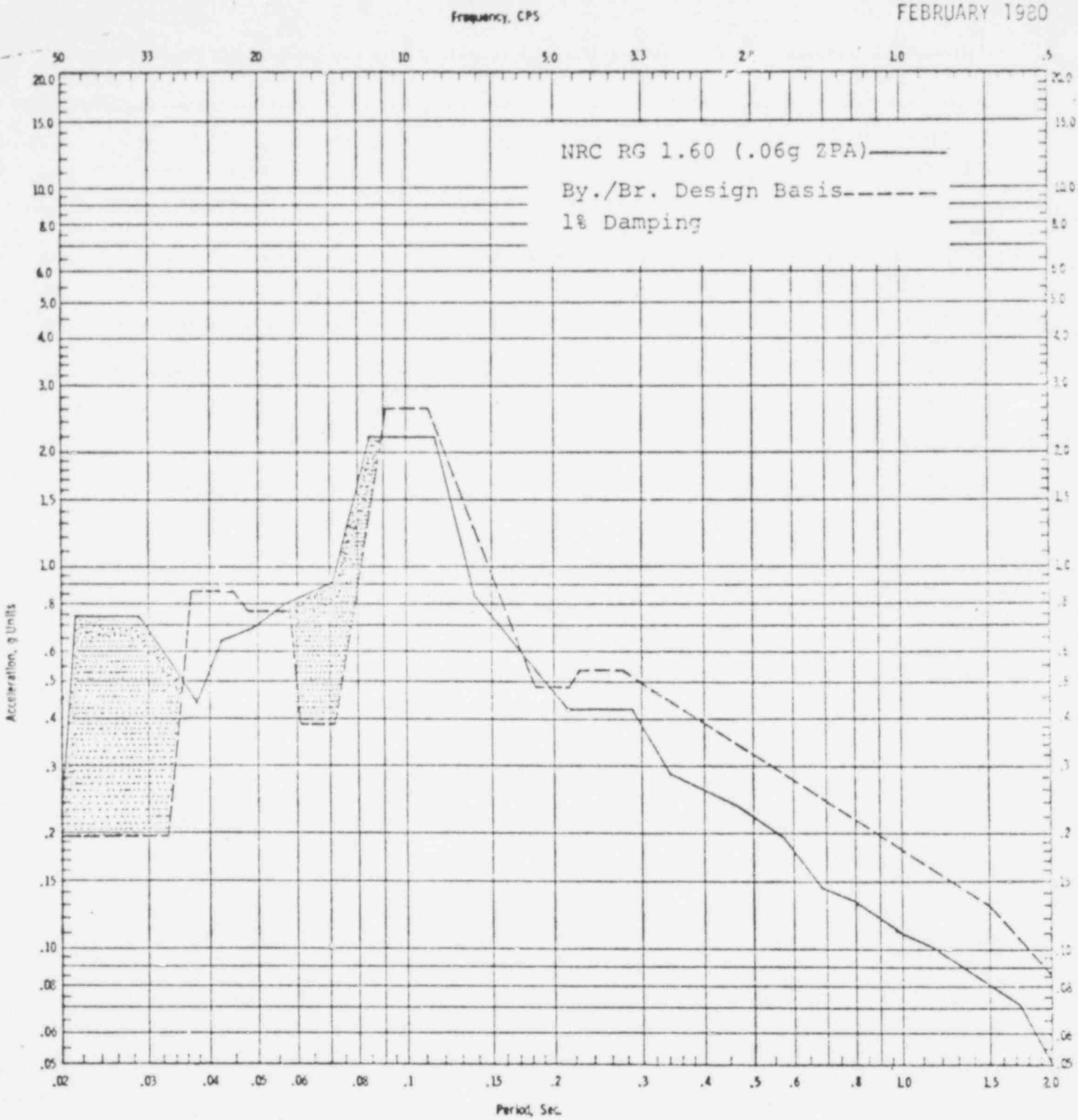

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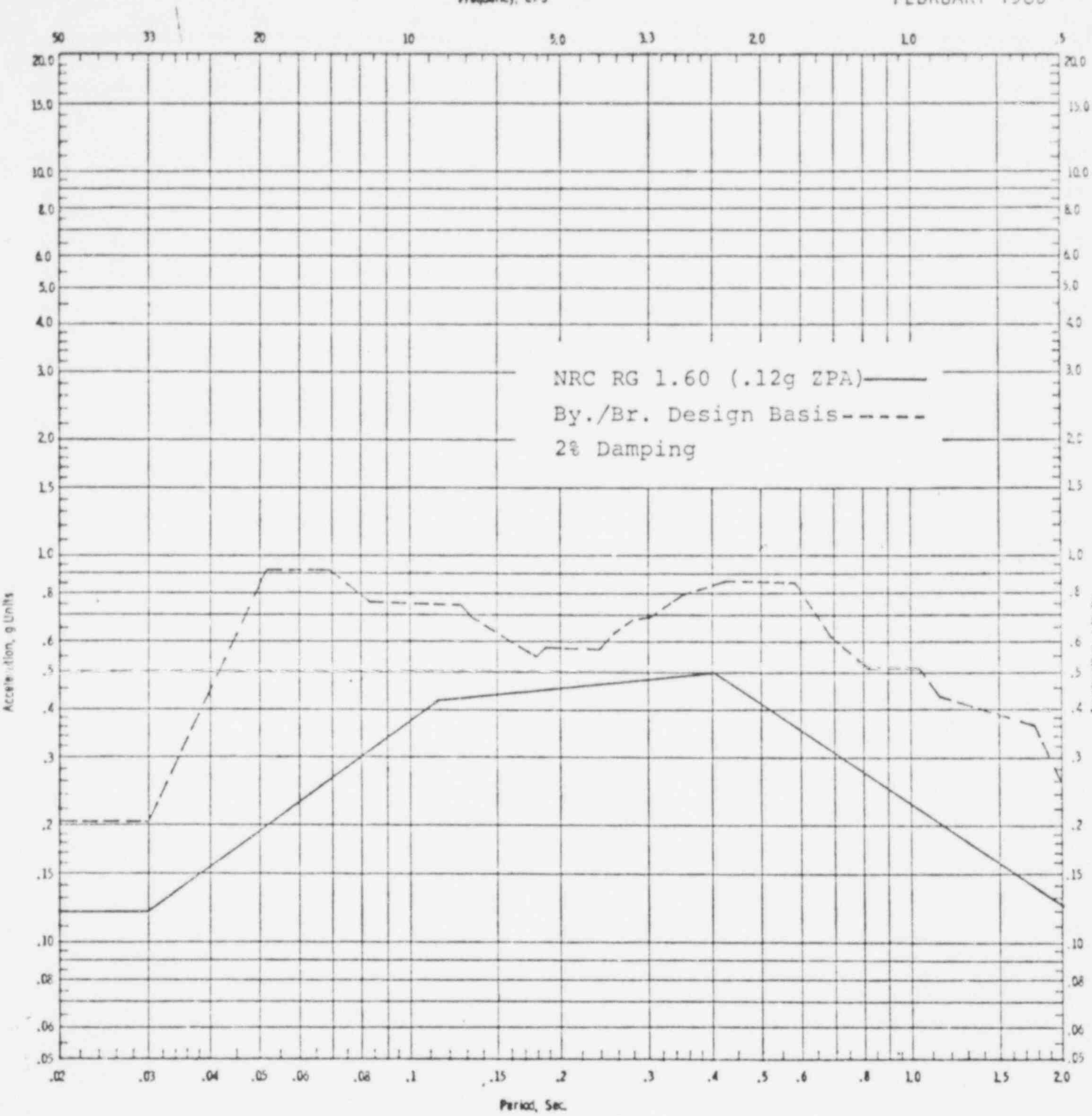
FIGURE Q130.6-32
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, SLAB
LOCATION: CONT. INNER STRUCTURE SLAB
ELEVATION: 390'-0"; 401'-0"; 412'-0"; 426'-0"



1842 218

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FIGURE Q130.6-33
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS AND EW
LOCATION: AUXILIARY AND CONTAINMENT BLDGS.
ELEVATION: 330'-0"; 374'-0"

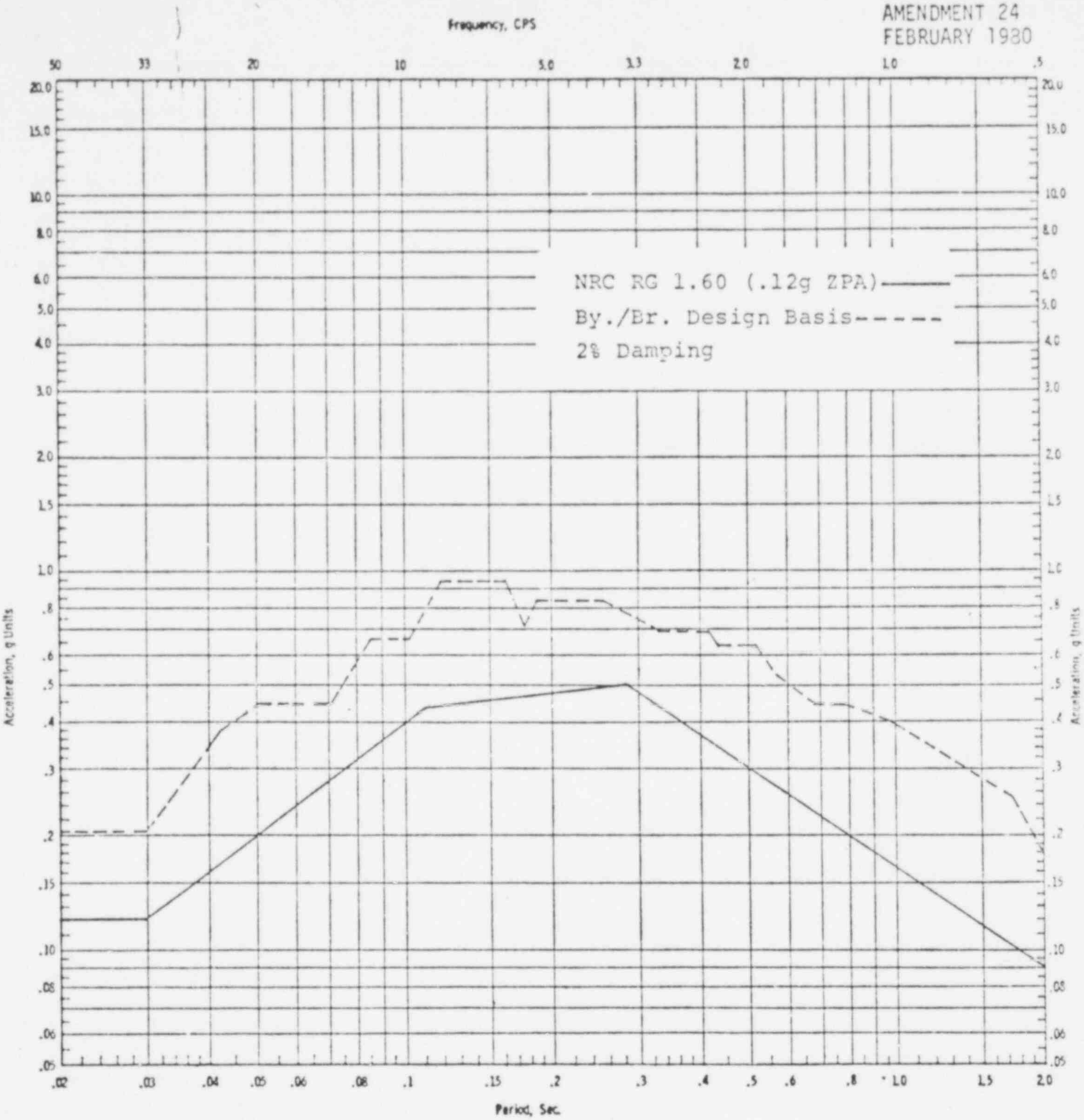

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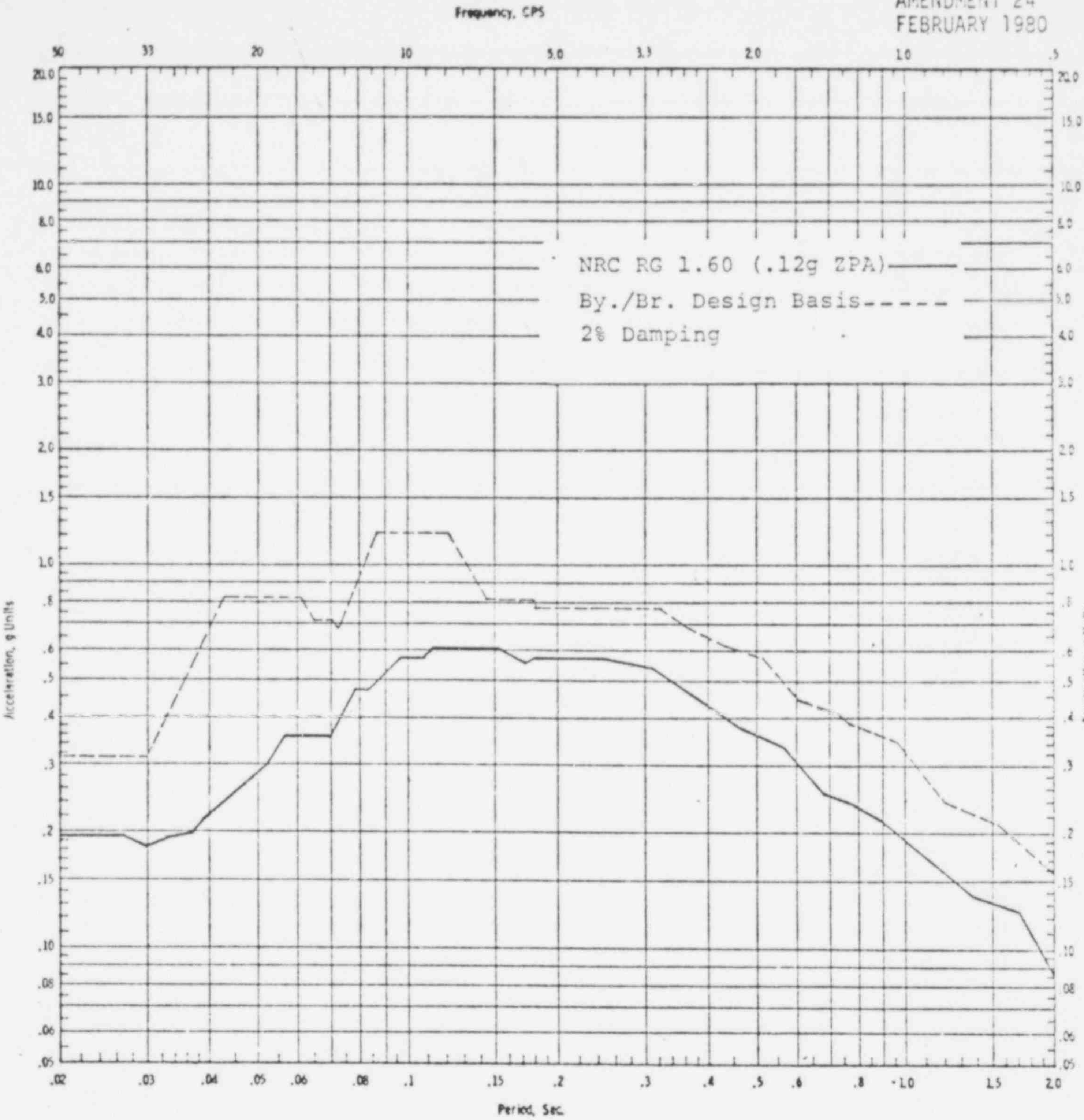
FIGURE Q130.6-34
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL AND SLAB
LOCATION: AUXILIARY AND CONTAINMENT BUILDINGS
ELEVATION: 330'-0"; 374'-0"



1842 220

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FIGURE Q130.6-35
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 346'-0"; 364'-0"; 383'-0"; 401'-0"

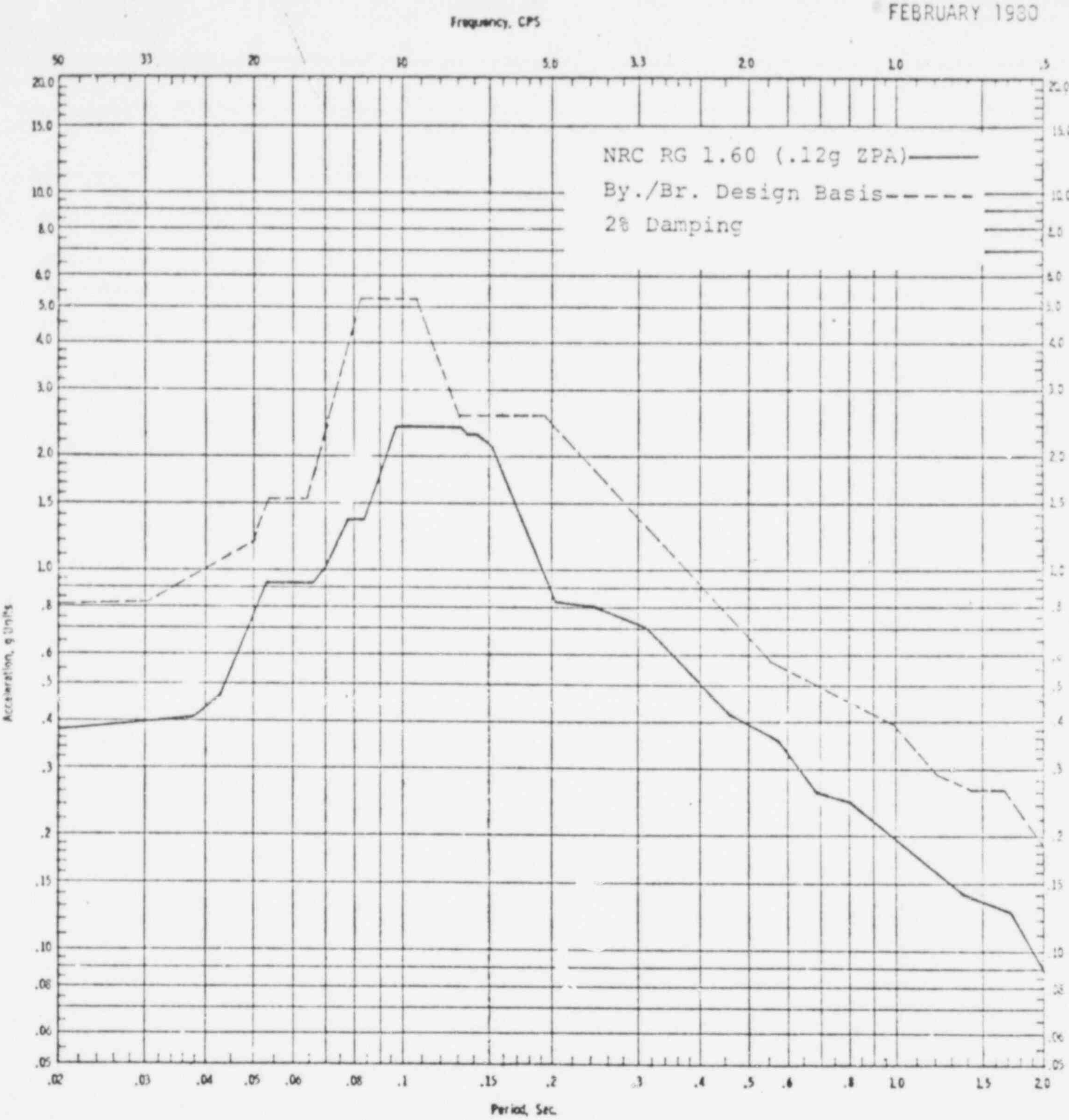

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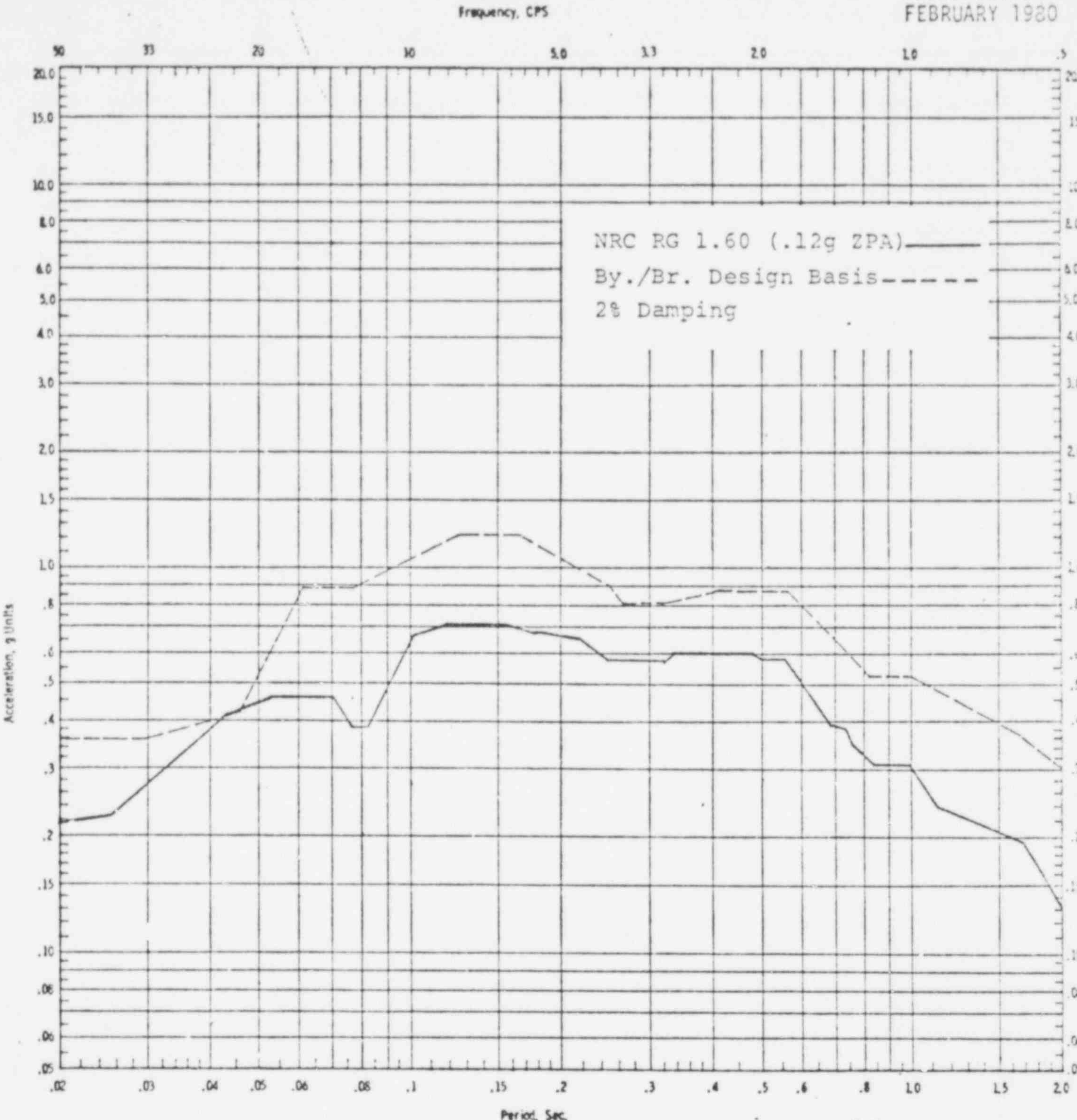
FIGURE Q130.6-36
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 346'-0"; 364'-0"; 383'-0"; 401'-0"



1842 222

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FIGURE Q130.6-37

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING
ELEVATION: 401'-0"

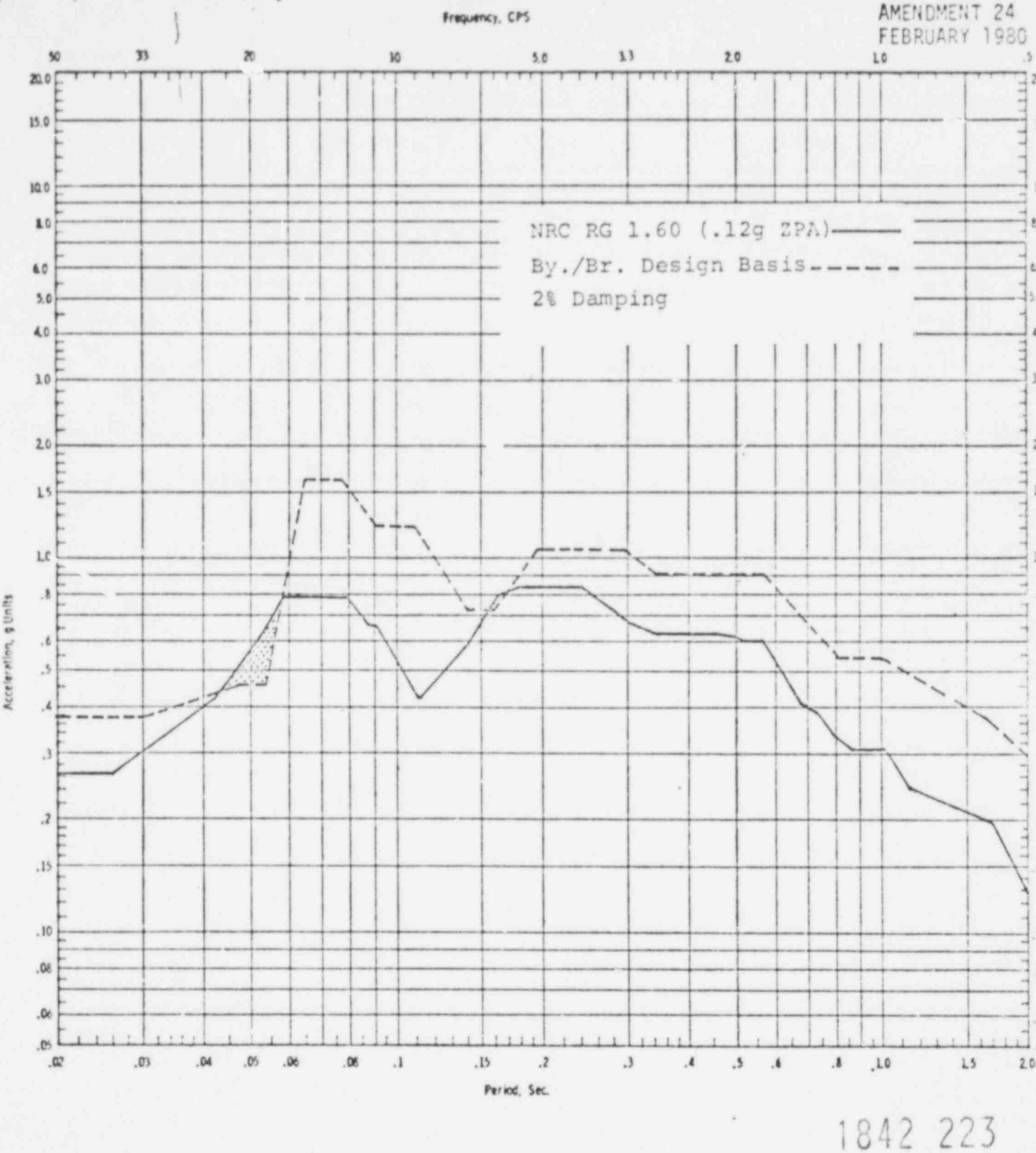

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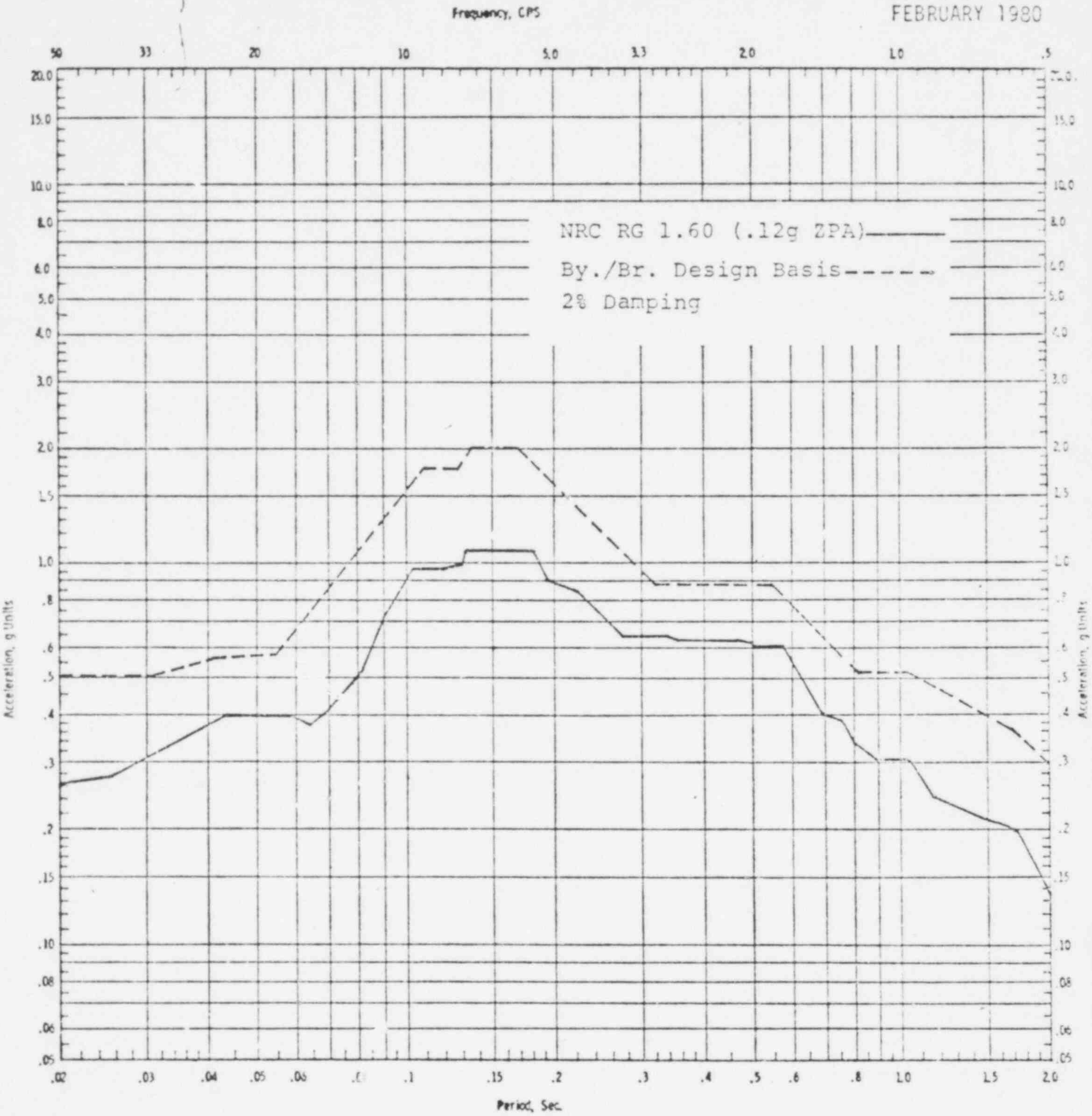
FIGURE Q130.6-38

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING
ELEVATION: 401'-0"



1842 224

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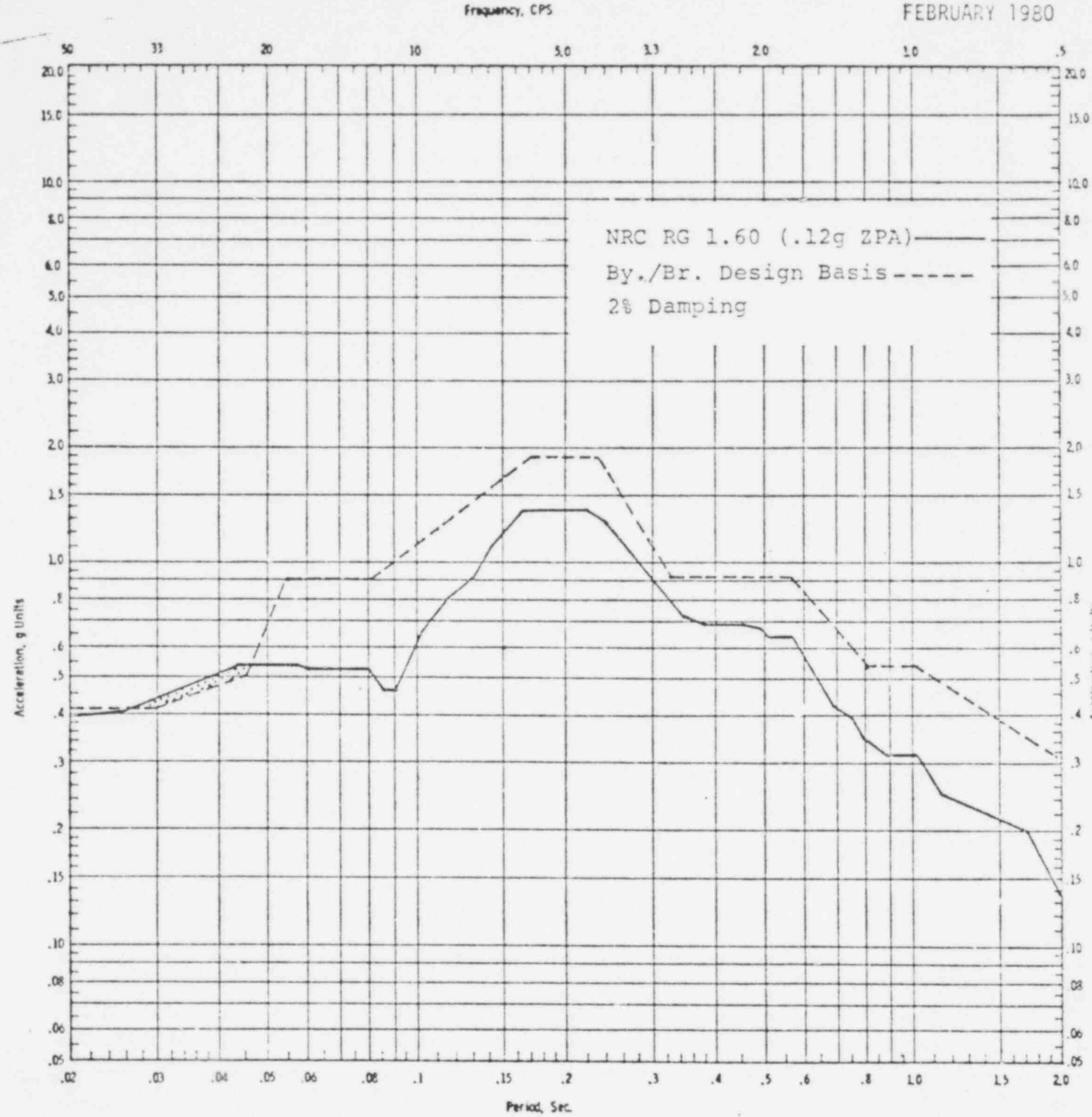
FIGURE Q130.6-39
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 426'-0"



1842 225

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FIGURE Q130.6-40
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 426'-0"

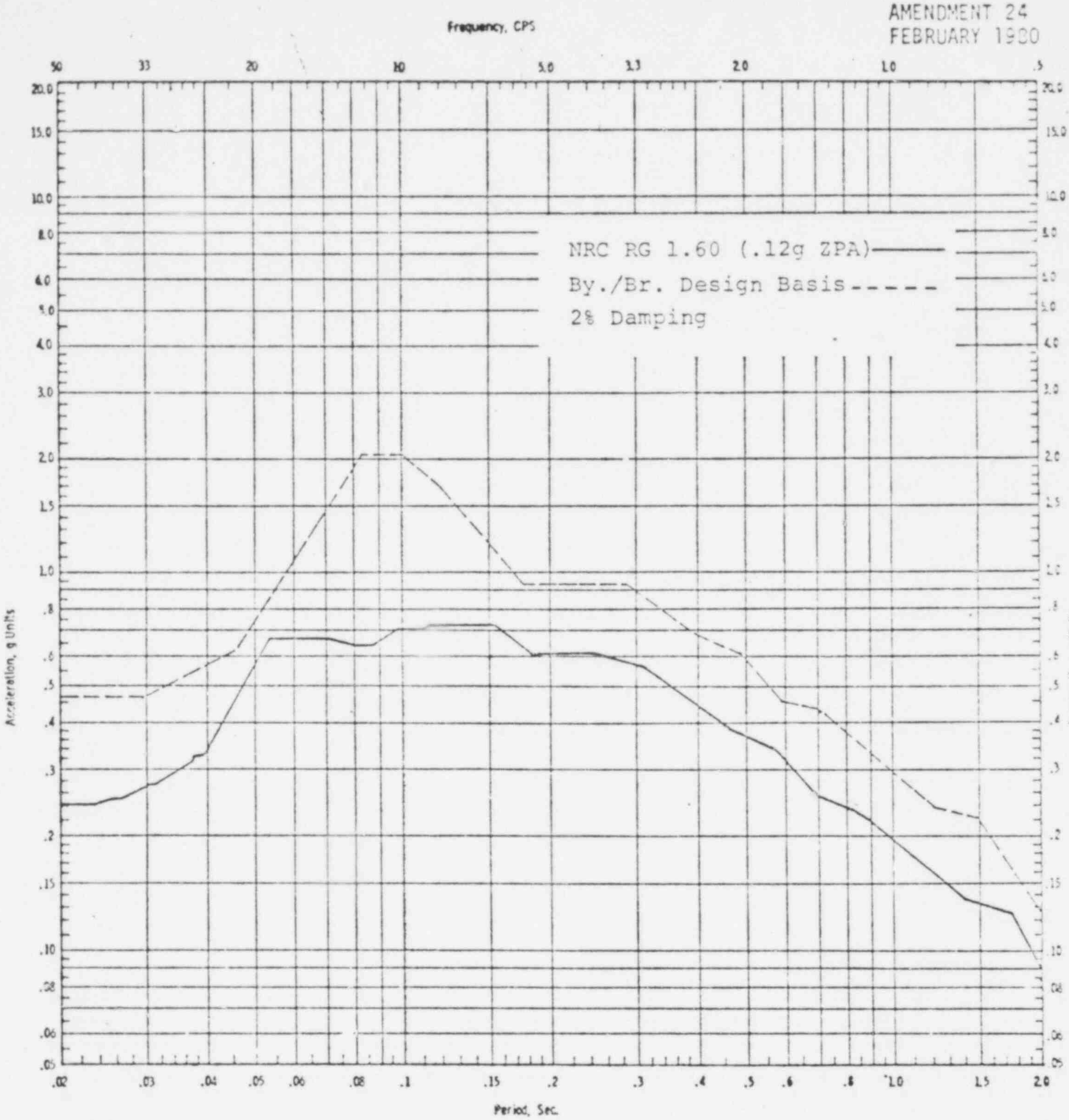

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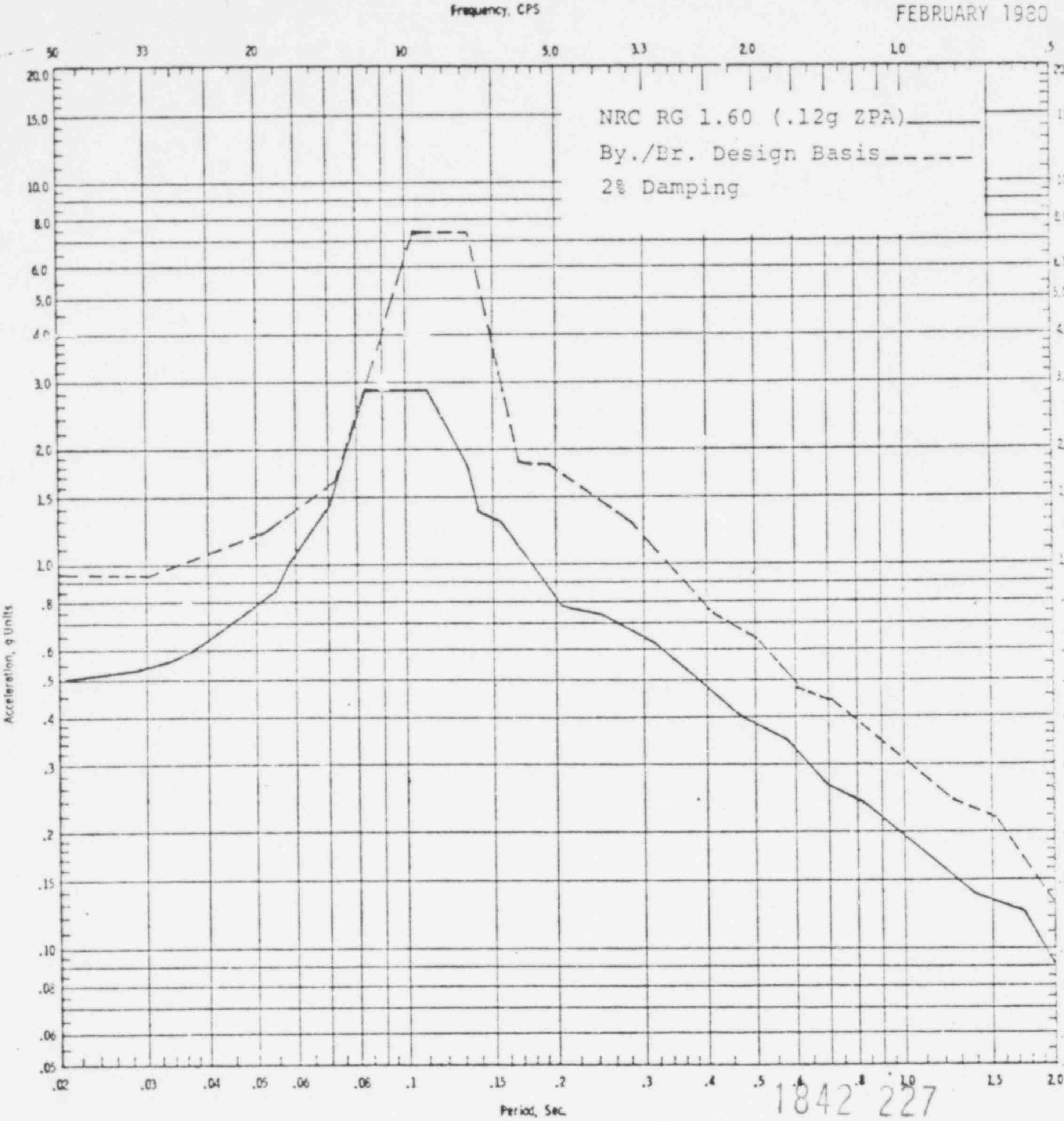
FIGURE Q130.6-41

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 426'-0"; 439'-0"; 451'-0"



1842 227

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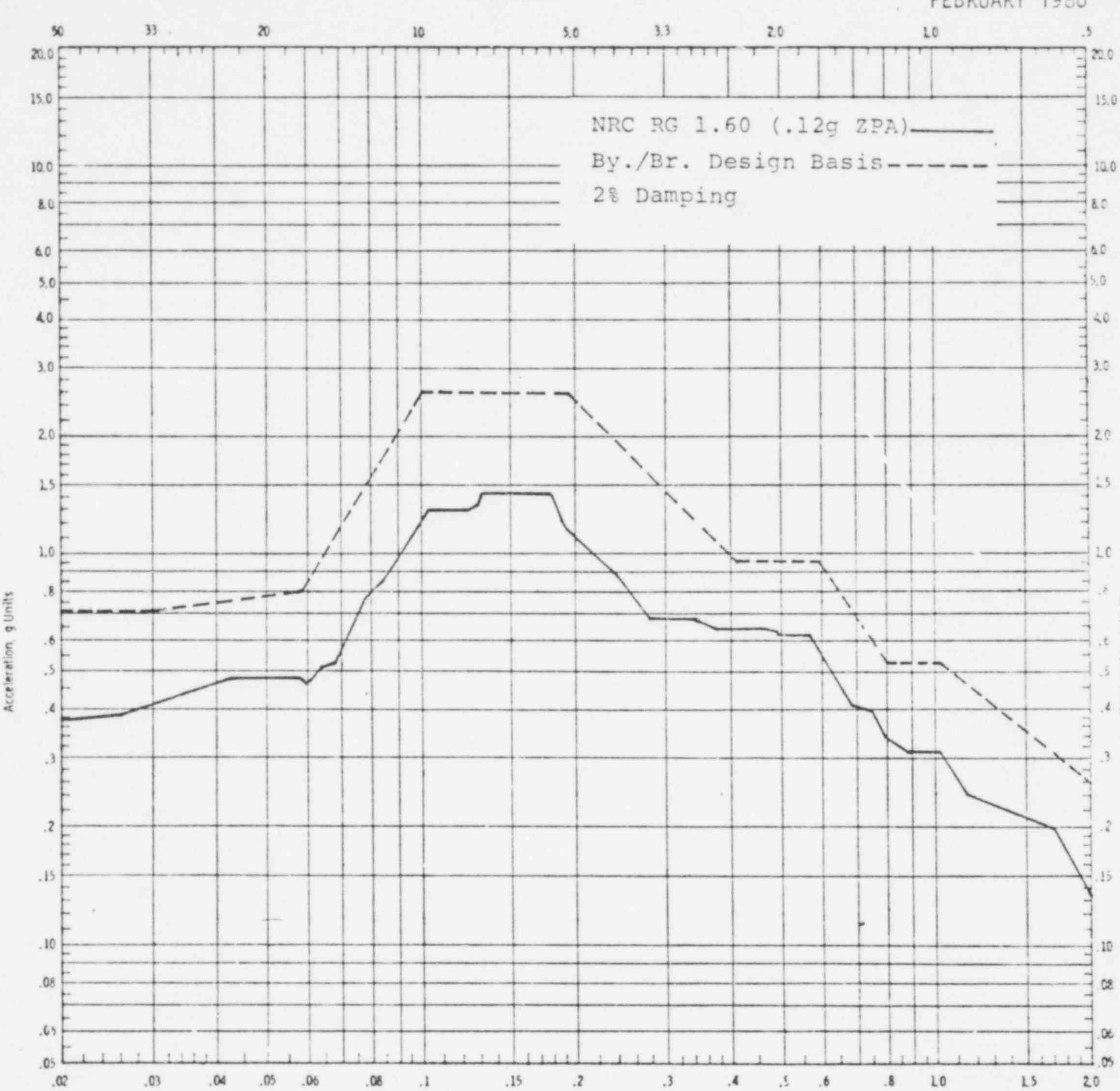
FIGURE Q130.6-42

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 426'-0"; 439'-0"; 451'-0"



1842 228

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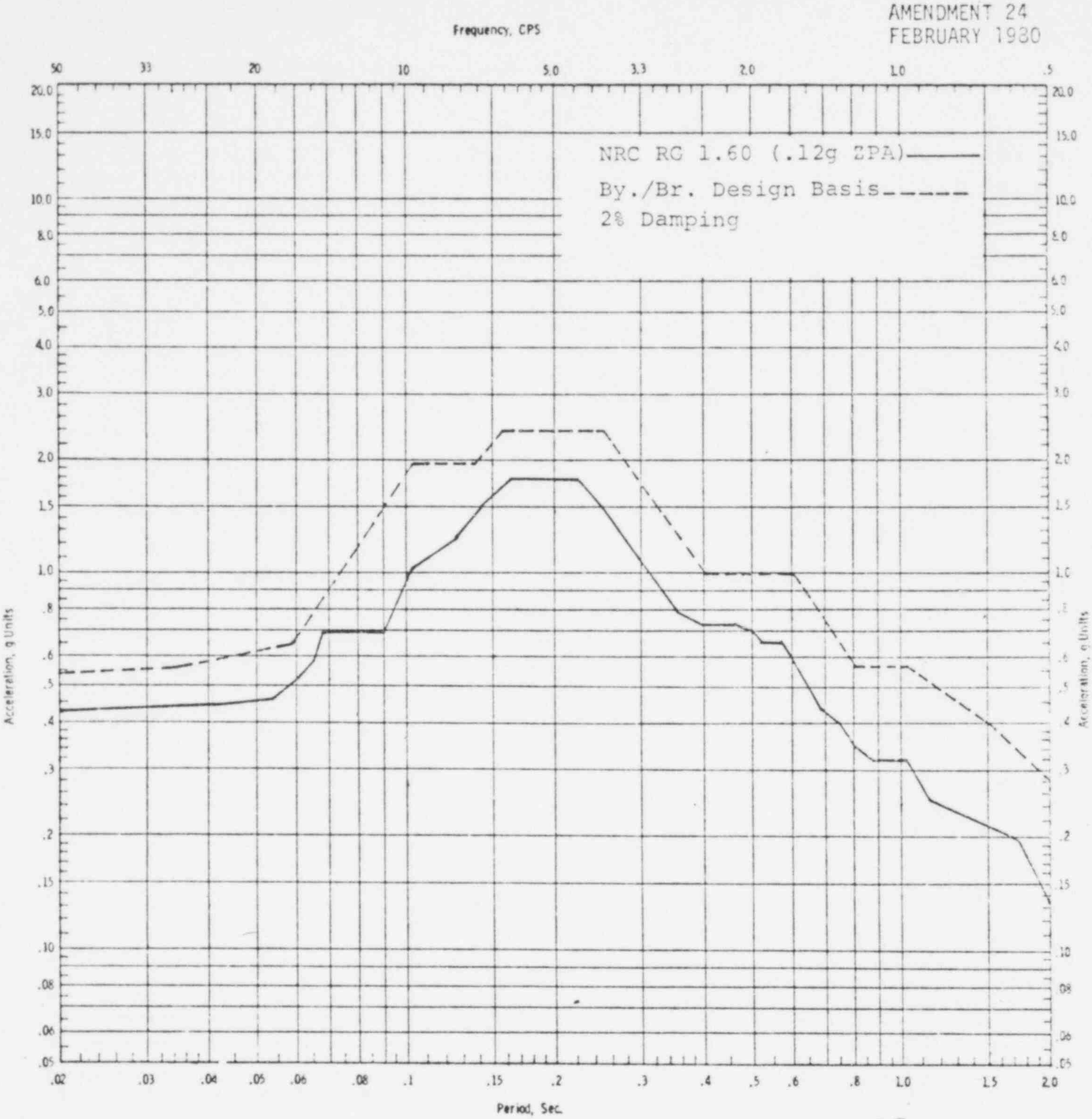
FIGURE Q130.6-43
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 451'-0"



1842 229

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FIGURE Q130.6-44
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 451'-0"

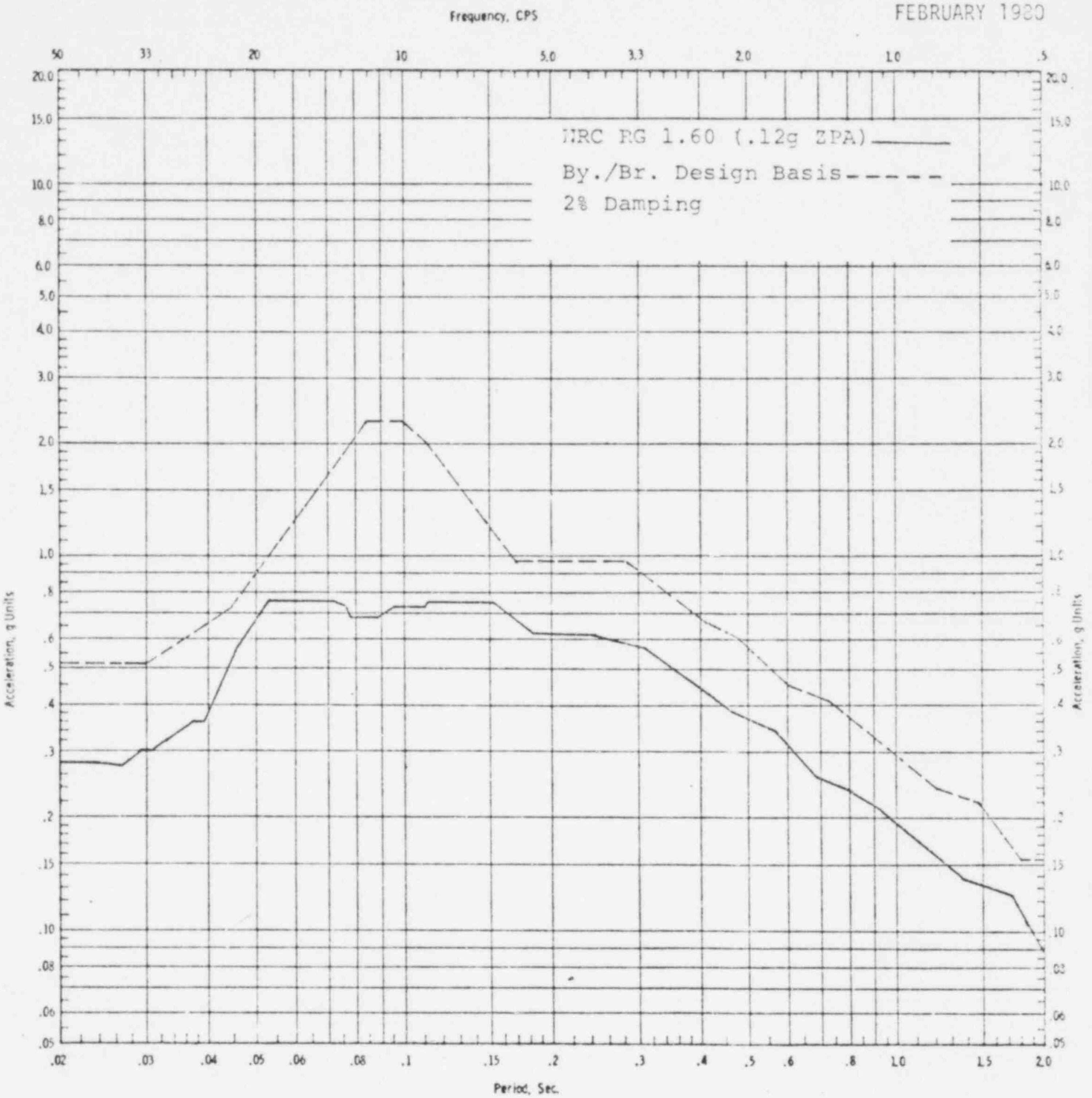

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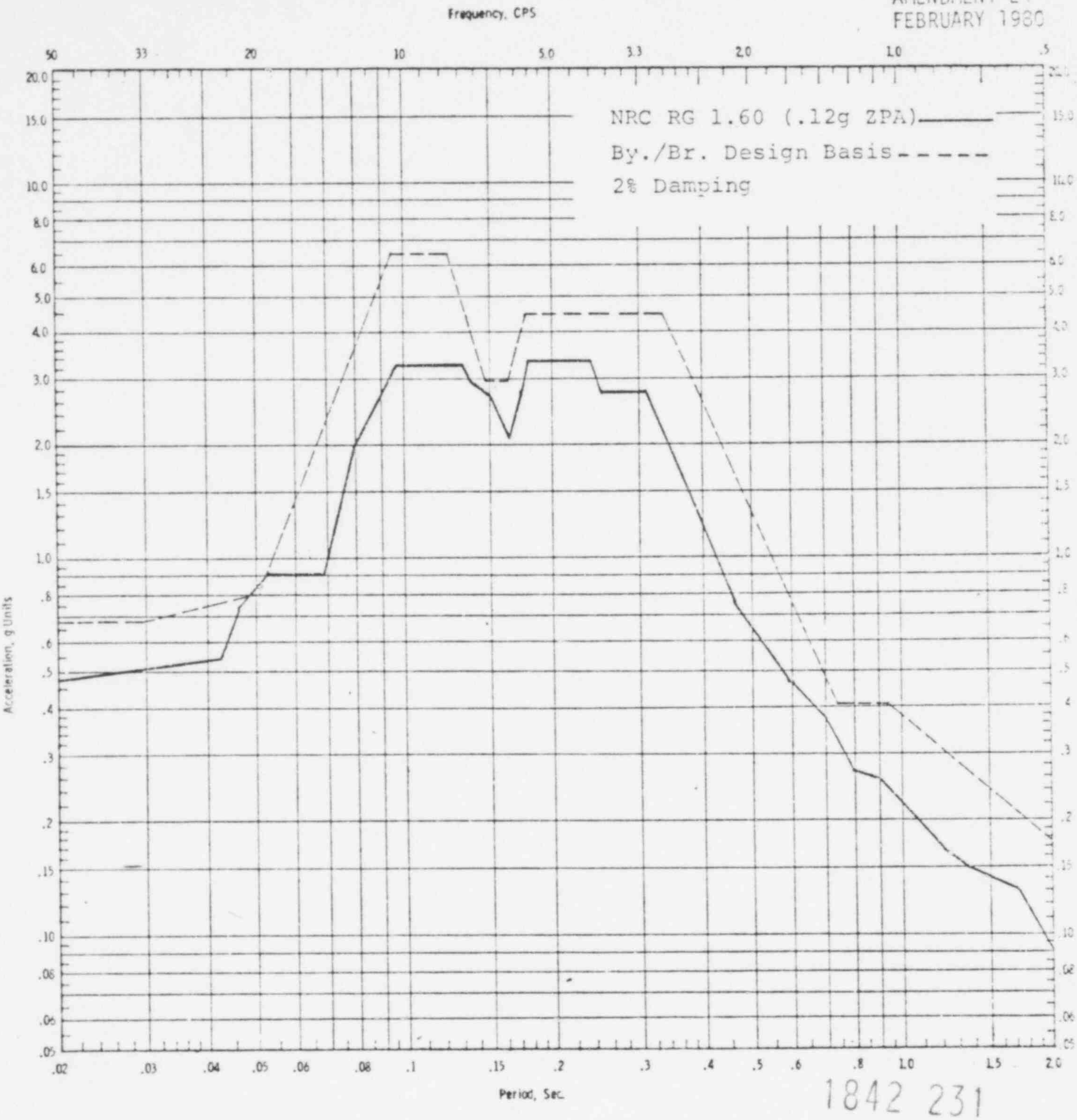
FIGURE Q130.6-45
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 467'-0"; 473'-0"; 477'-0"; 485'-0"



1842 231

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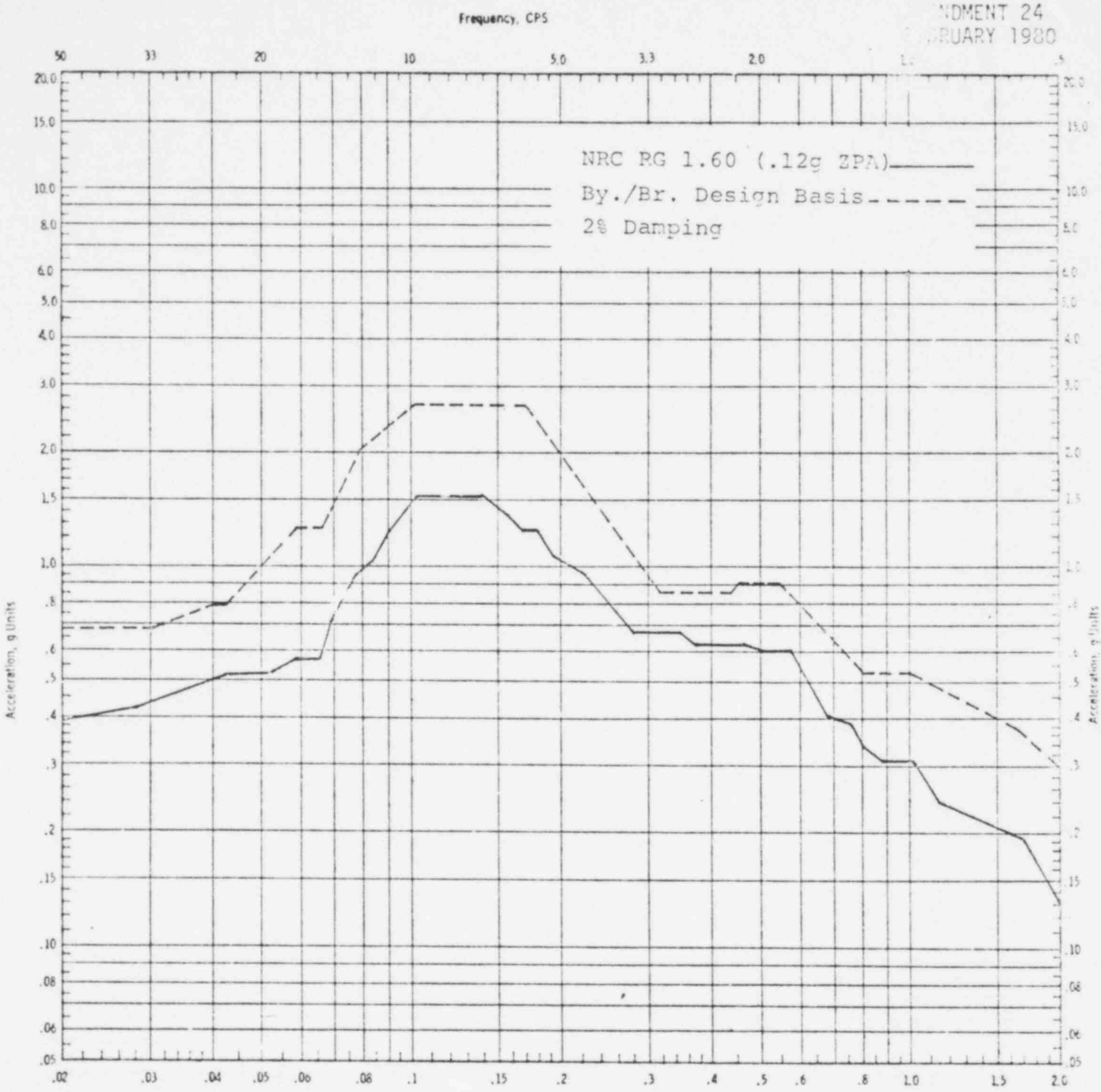
FIGURE Q130.6-46

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 467'-0"; 477'-0"



1842 232

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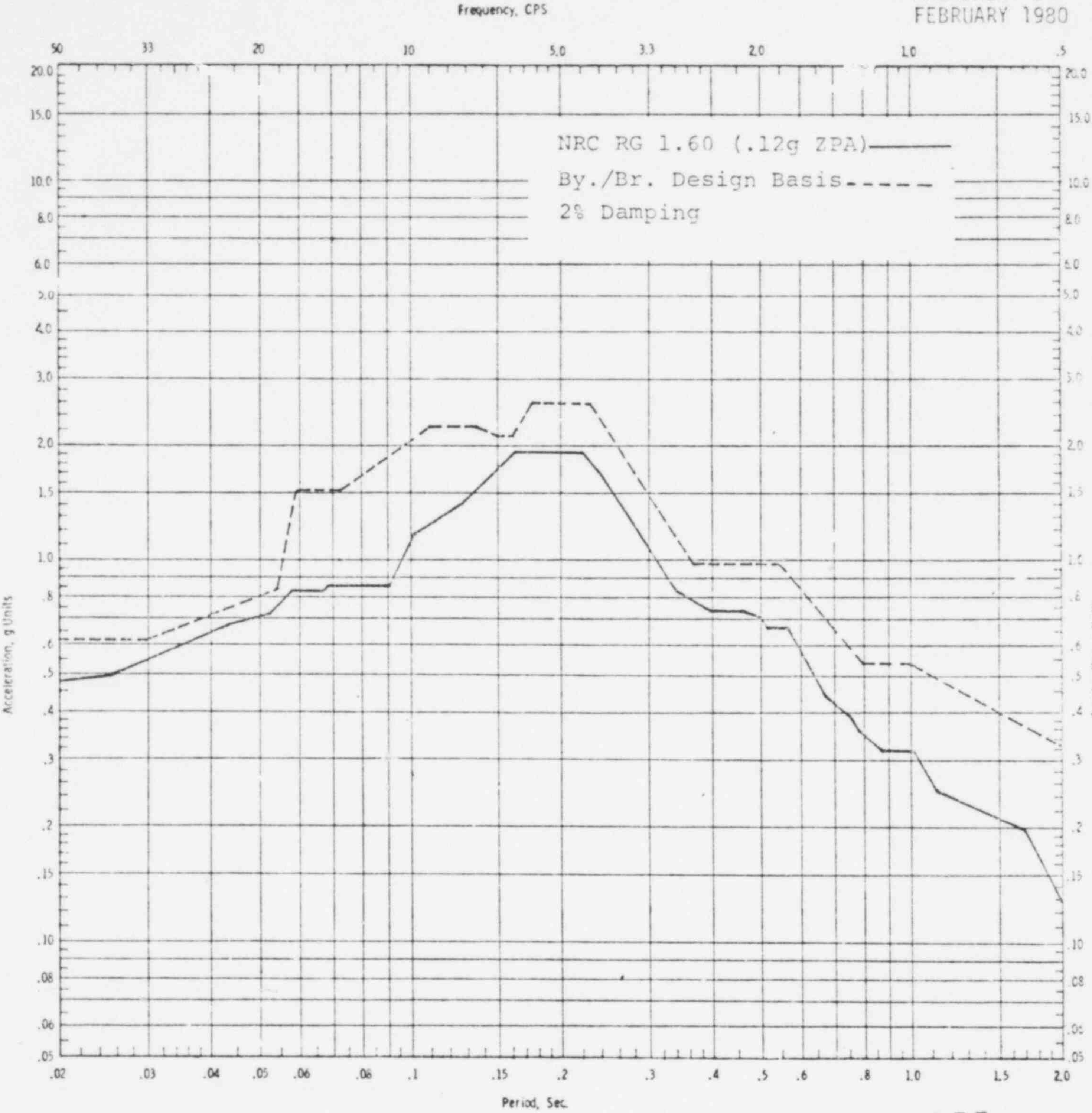
FIGURE Q130.6-47

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING
ELEVATION: 477'-0"



1842 233

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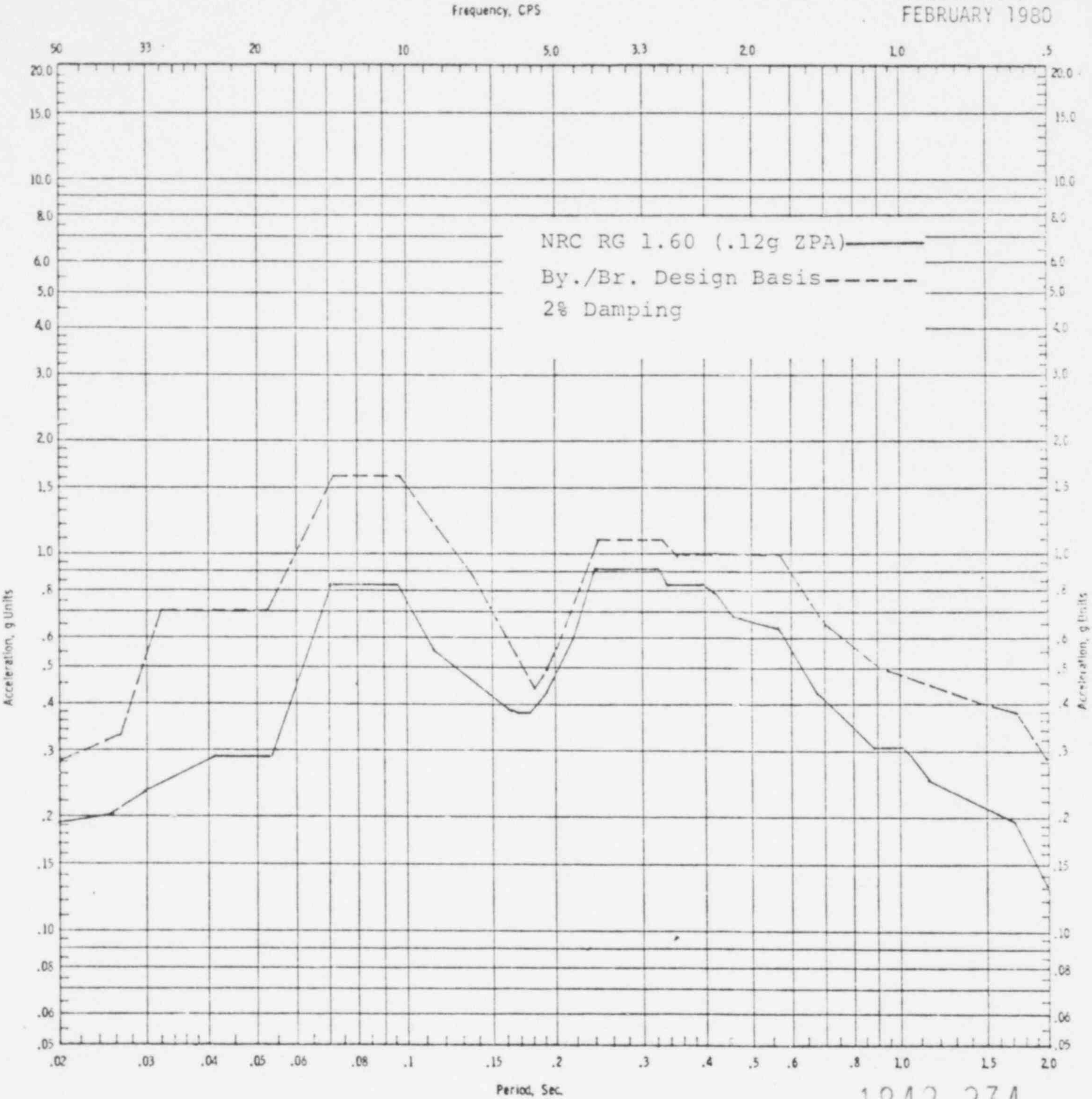
FIGURE Q130.6-48

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING
ELEVATION: 477'-0"



1842 234

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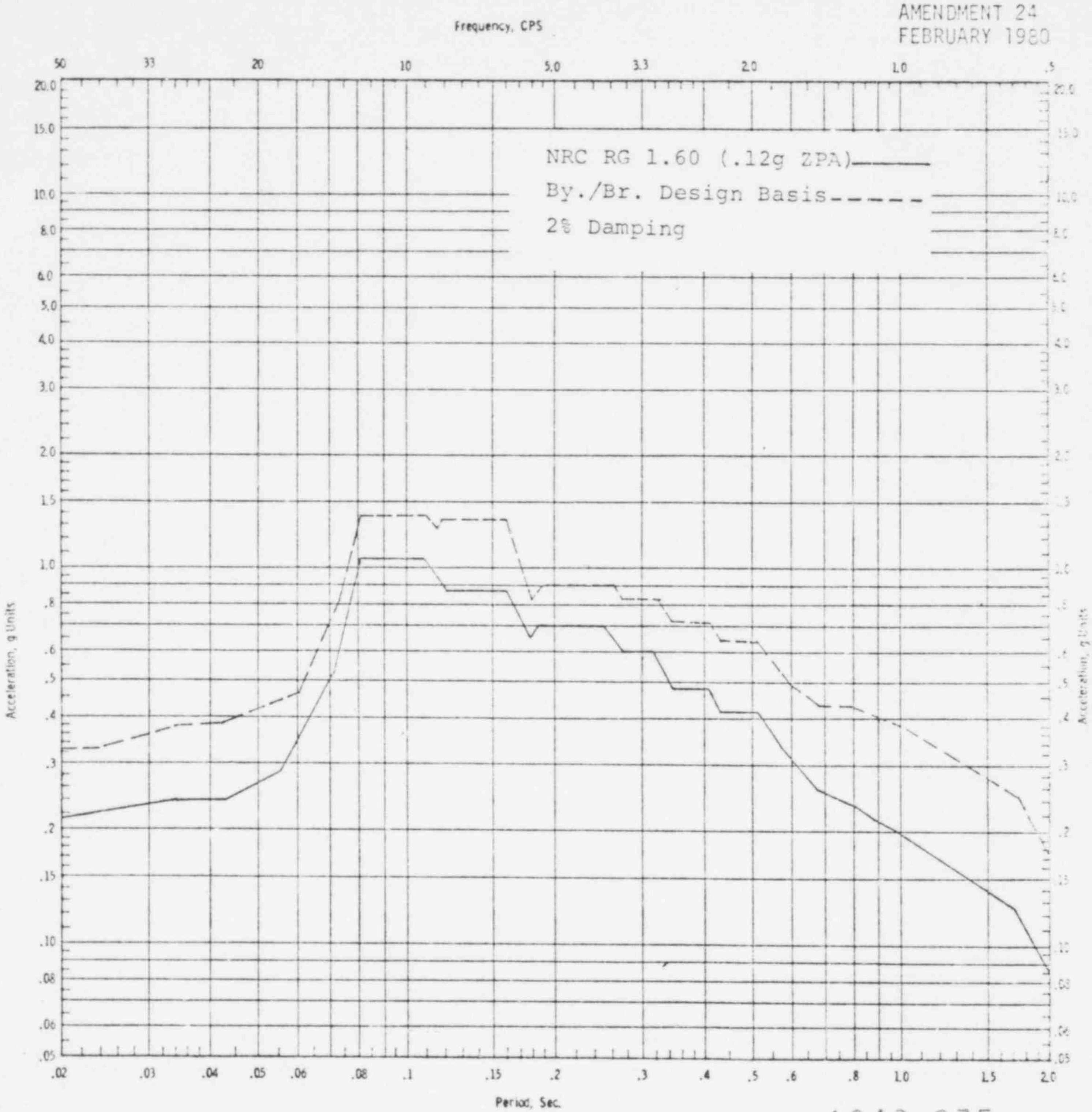
FIGURE Q130.6-49

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS AND EW
LOCATION: CONTAINMENT BUILDING
ELEVATION: 424'-0"; 436'-0"



1842 235

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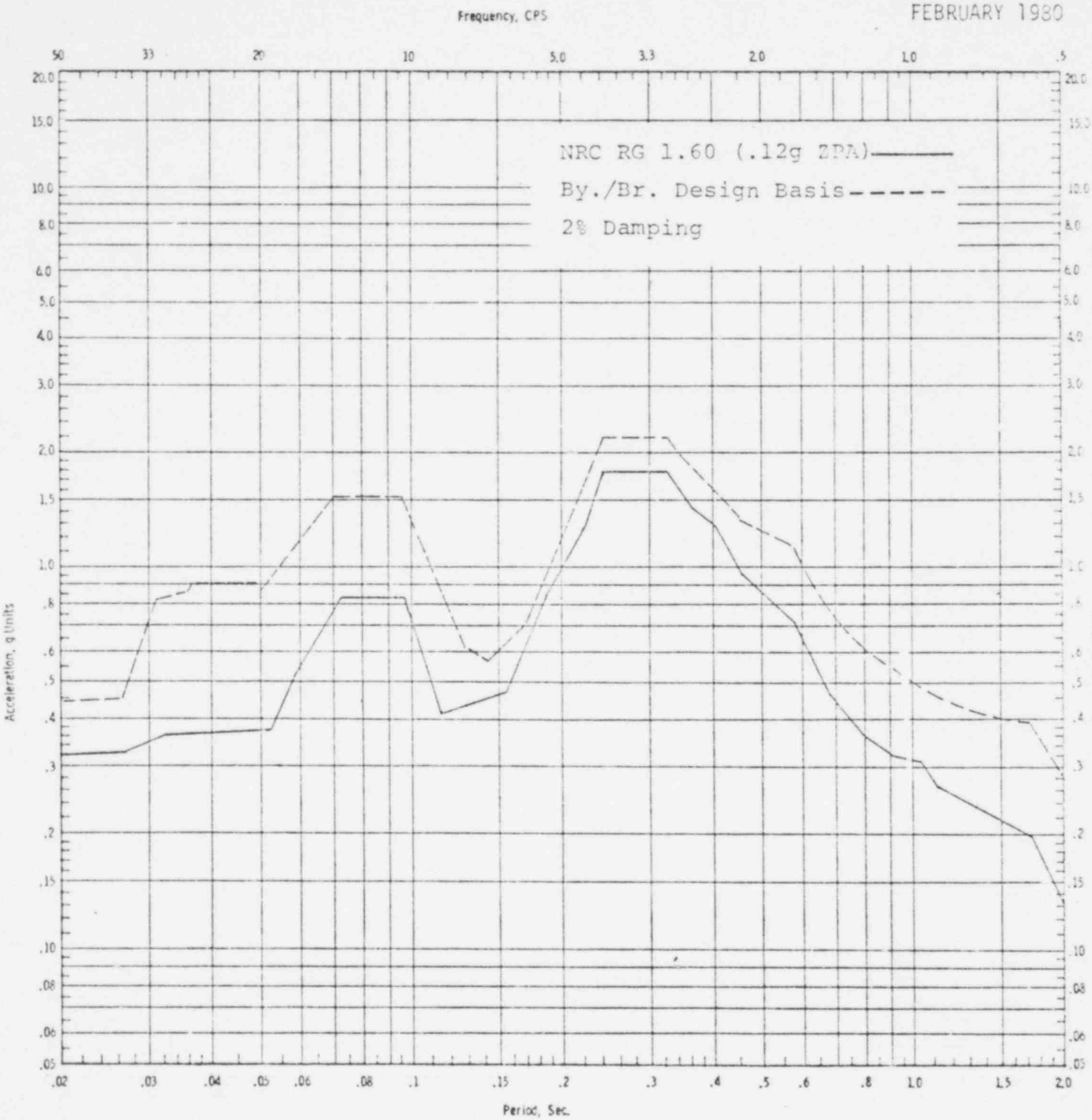
FIGURE Q130.6-50

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: CONTAINMENT BUILDING WALL
ELEVATION: 424'-0"; 436'-0"



1842 236

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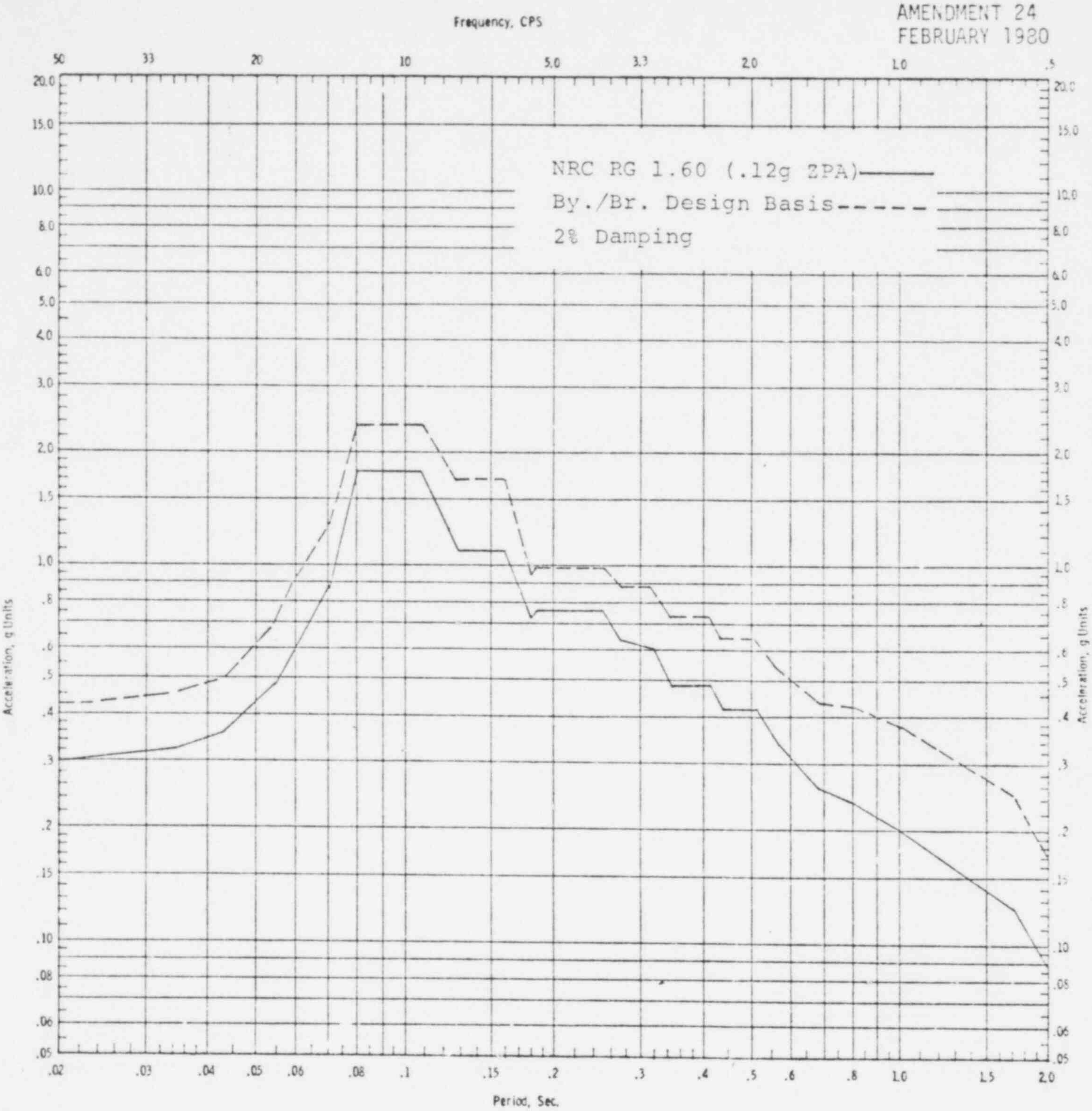
FIGURE Q130.6-51

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS AND EW
LOCATION: CONTAINMENT BUILDING
ELEVATION: 496'-0"



1842 237

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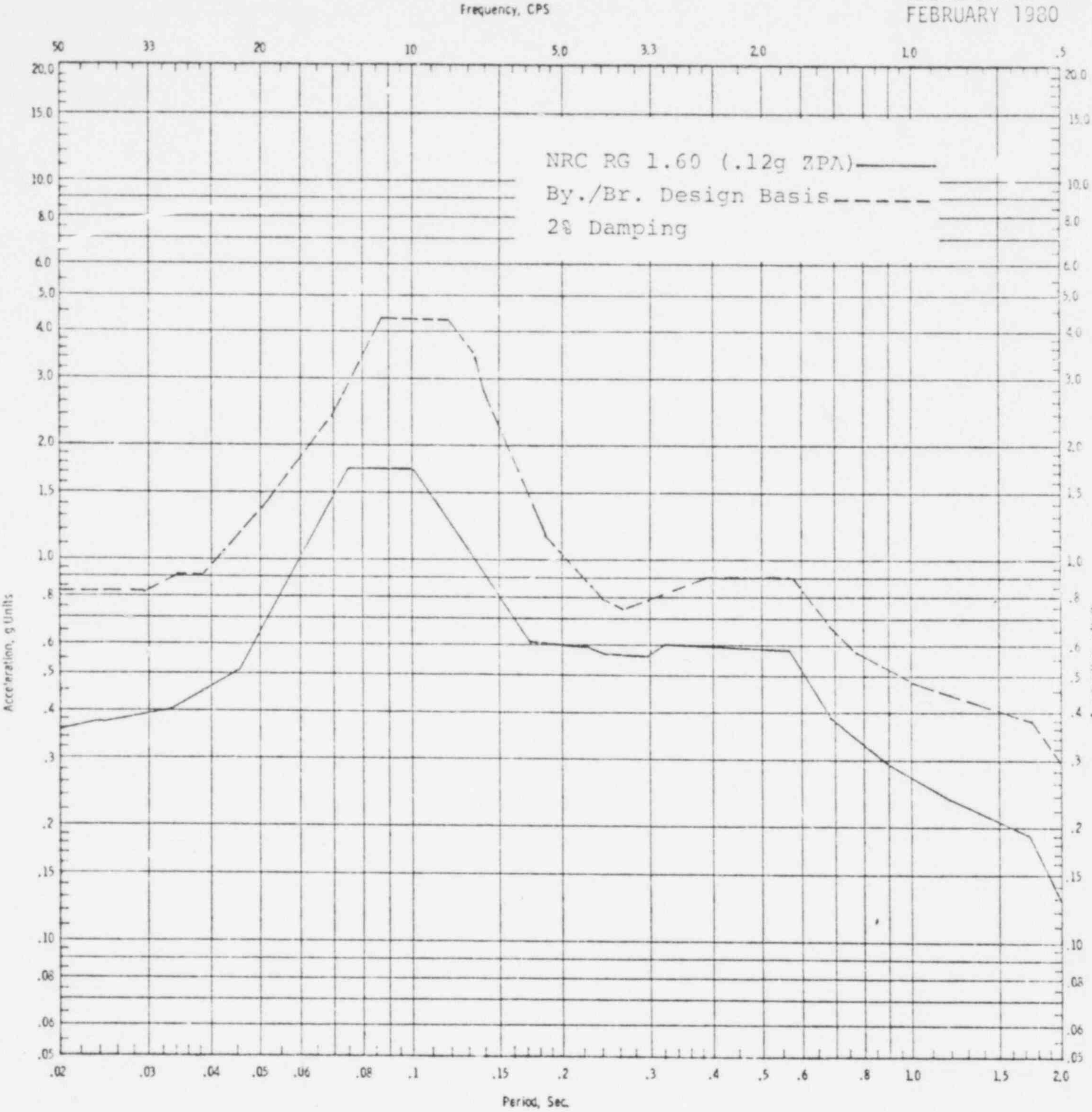
FIGURE Q130.6-52

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: CONTAINMENT BUILDING WALL
ELEVATION: 496'-0"



1842 238

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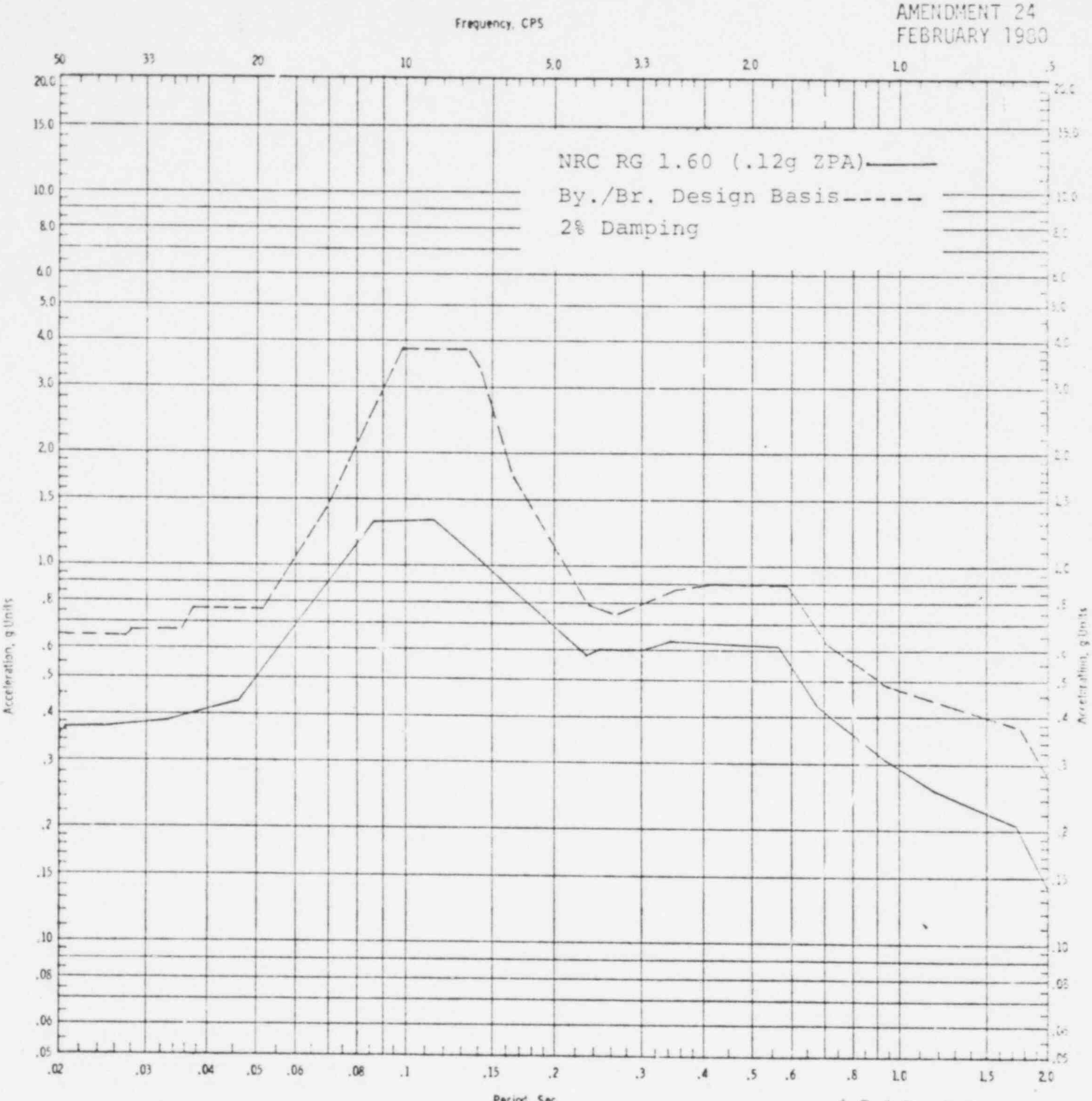
FIGURE Q130.6-53

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS
LOCATION: CONTAINMENT INNER STRUCTURE
ELEVATION: 426'-0"



1842 239

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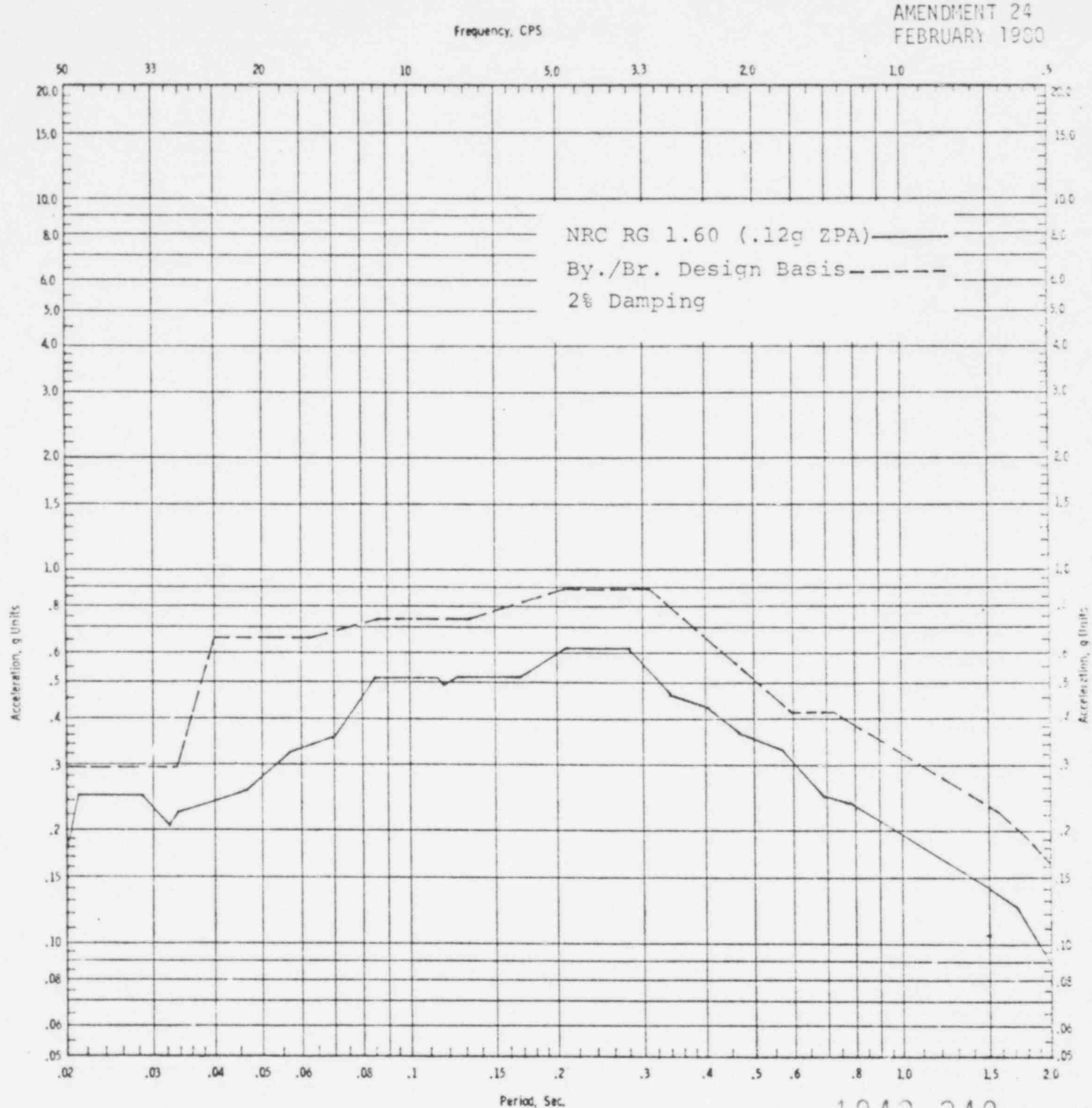
FIGURE Q130.6-54

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, EW
LOCATION: CONTAINMENT INNER STRUCTURE
ELEVATION: 426'-0"



1842 240

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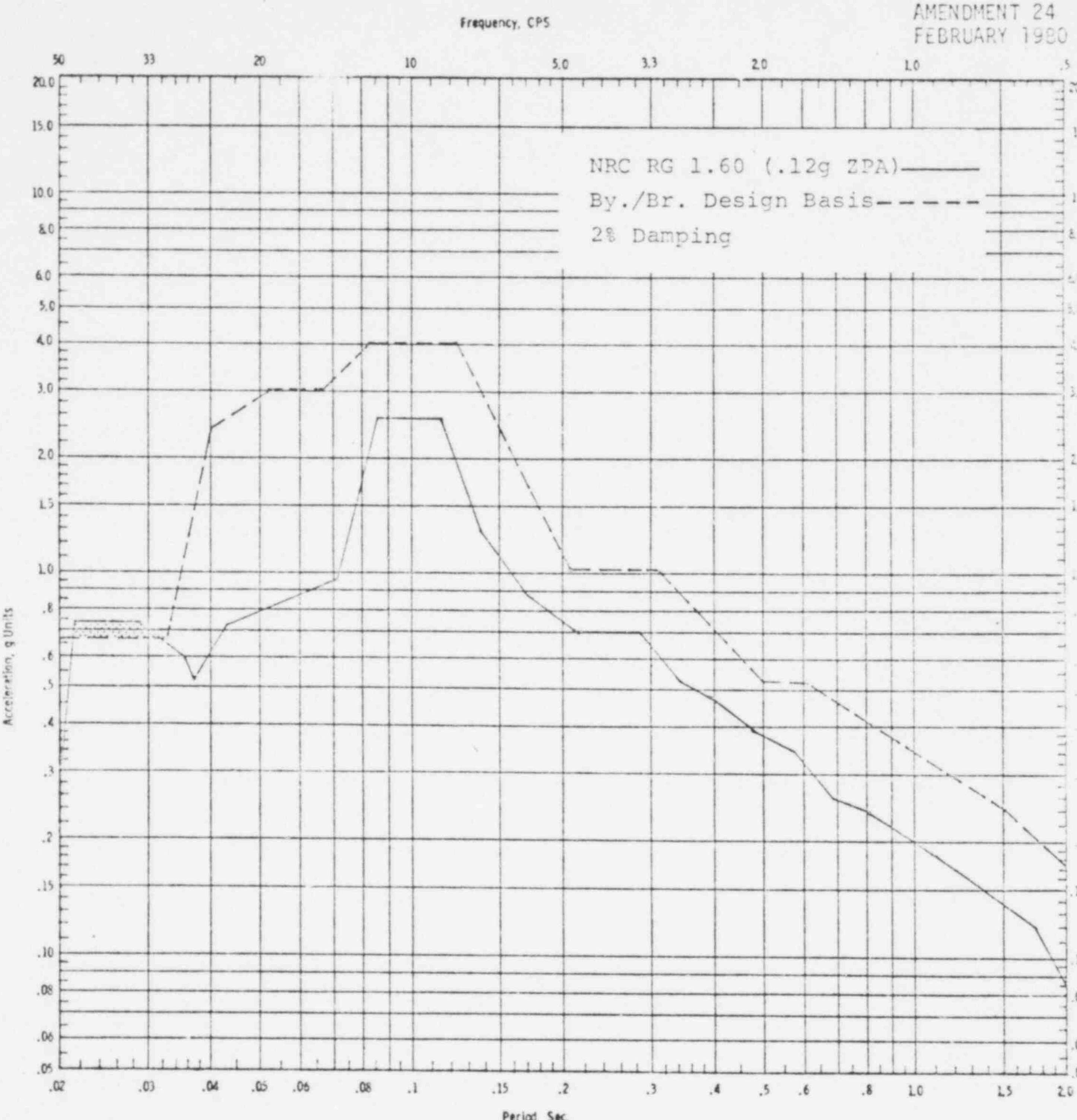
FIGURE Q130.6-55
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: CONTAINMENT INNER STRUCTURAL WALL
ELEVATION: 412'-0"; 426'-0"



1842 241

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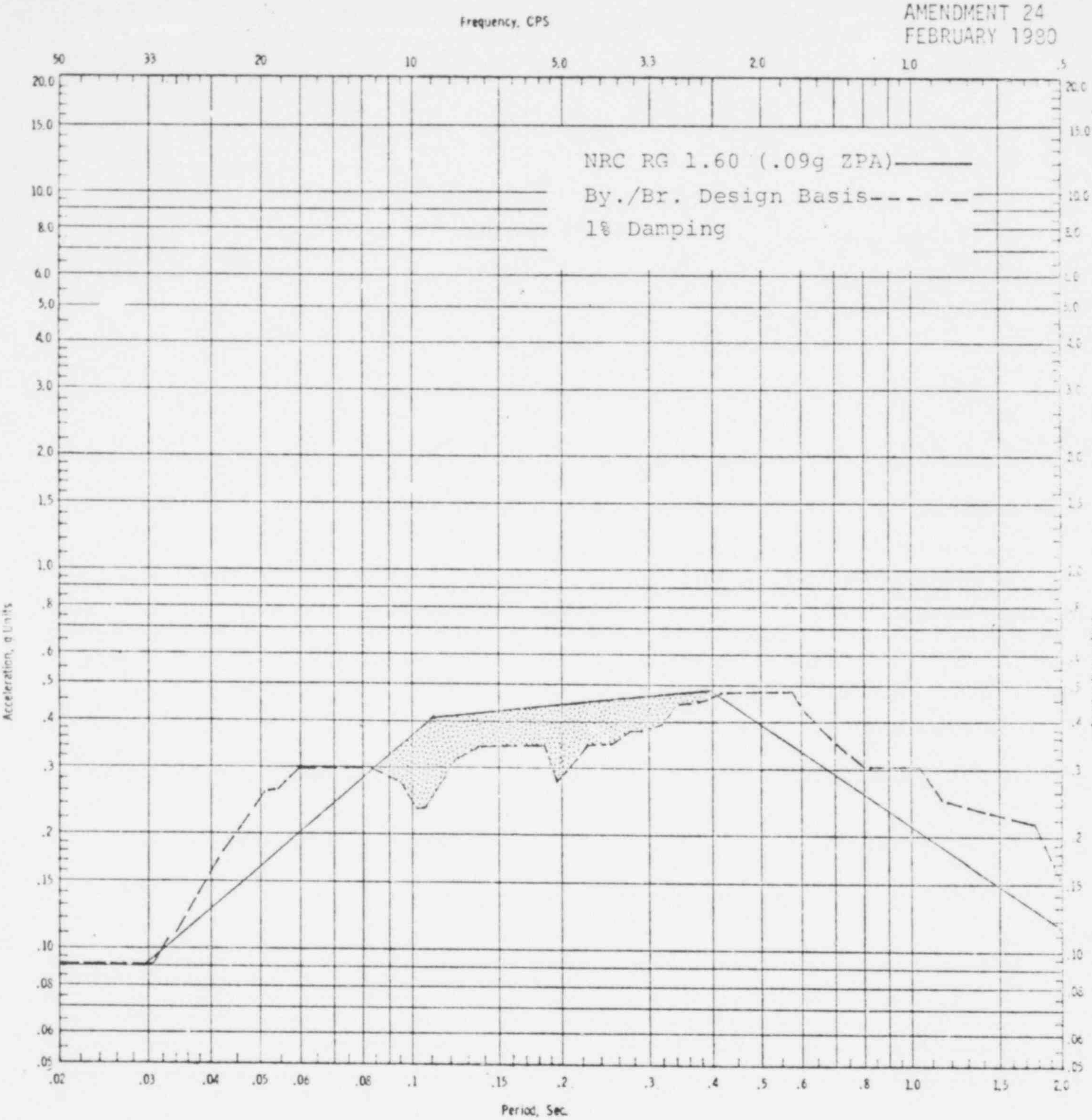
FIGURE Q130.6-56
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, SLAB
LOCATION: CONT. INNER STRUCTURAL SLAB
ELEVATION: 390'-0"; 401'-0", 412'-0"; 426'-0"



1842 242

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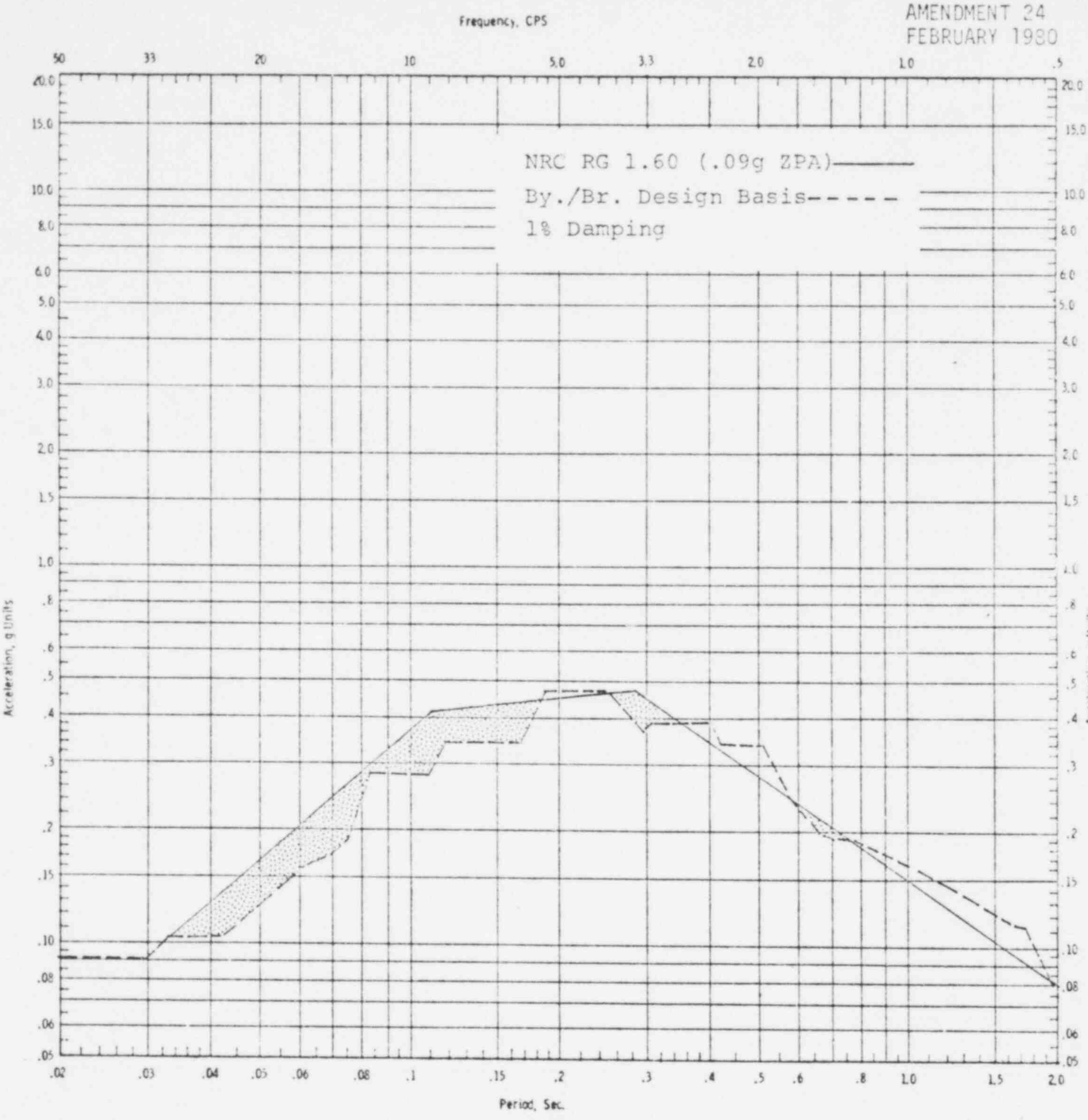
FIGURE Q130.6-57

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, EW AND NS
LOCATION: AUXILIARY AND CONTAINMENT BLDG.
ELEVATION: 330'-0"; 374'-0"



1842 243

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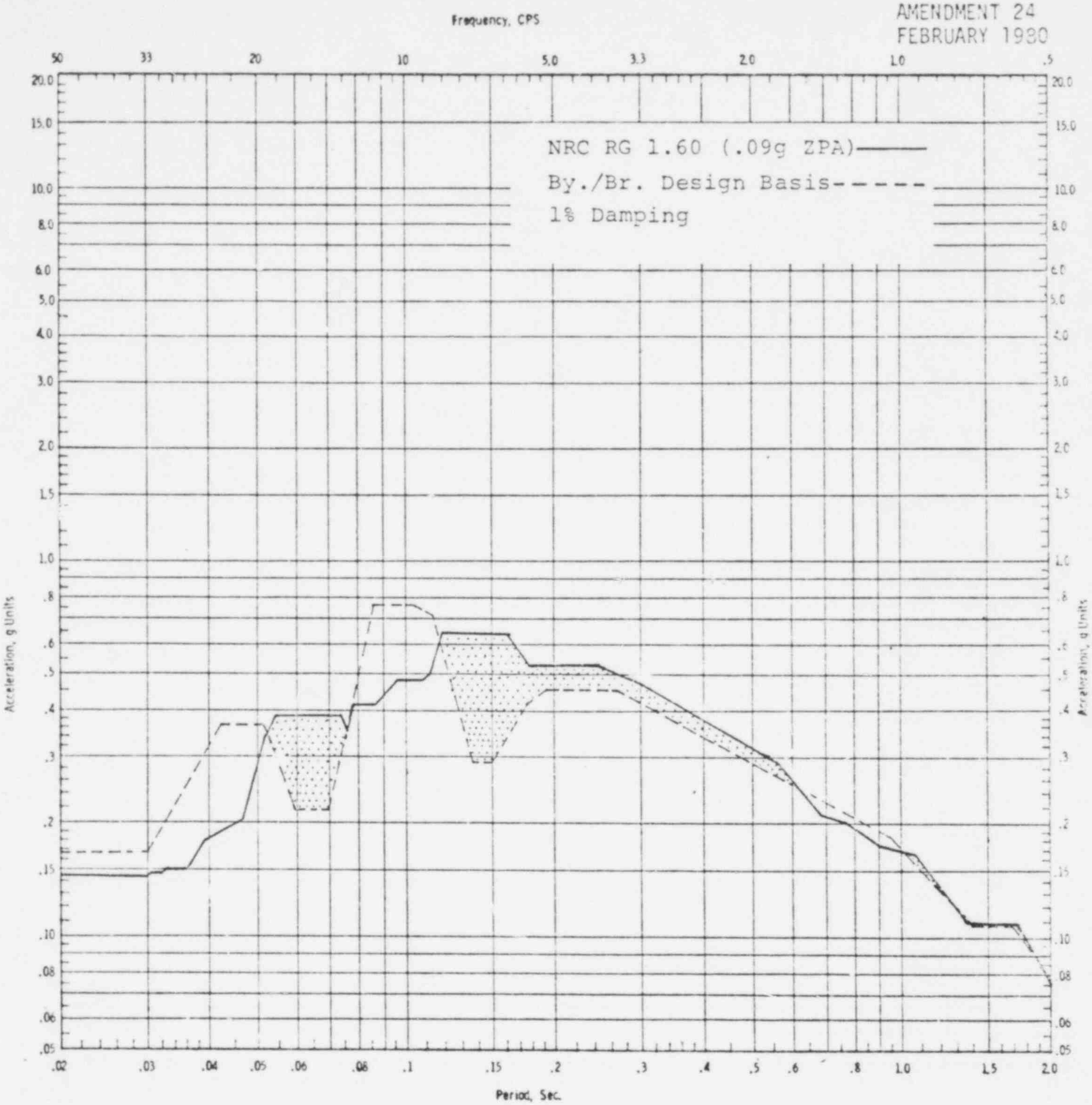
FIGURE Q130.6-58

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL AND SLAB
LOCATION: AUXILIARY AND CONTAINMENT BLDG.
ELEVATION: 330'-0"; 374'-0"



1842 244

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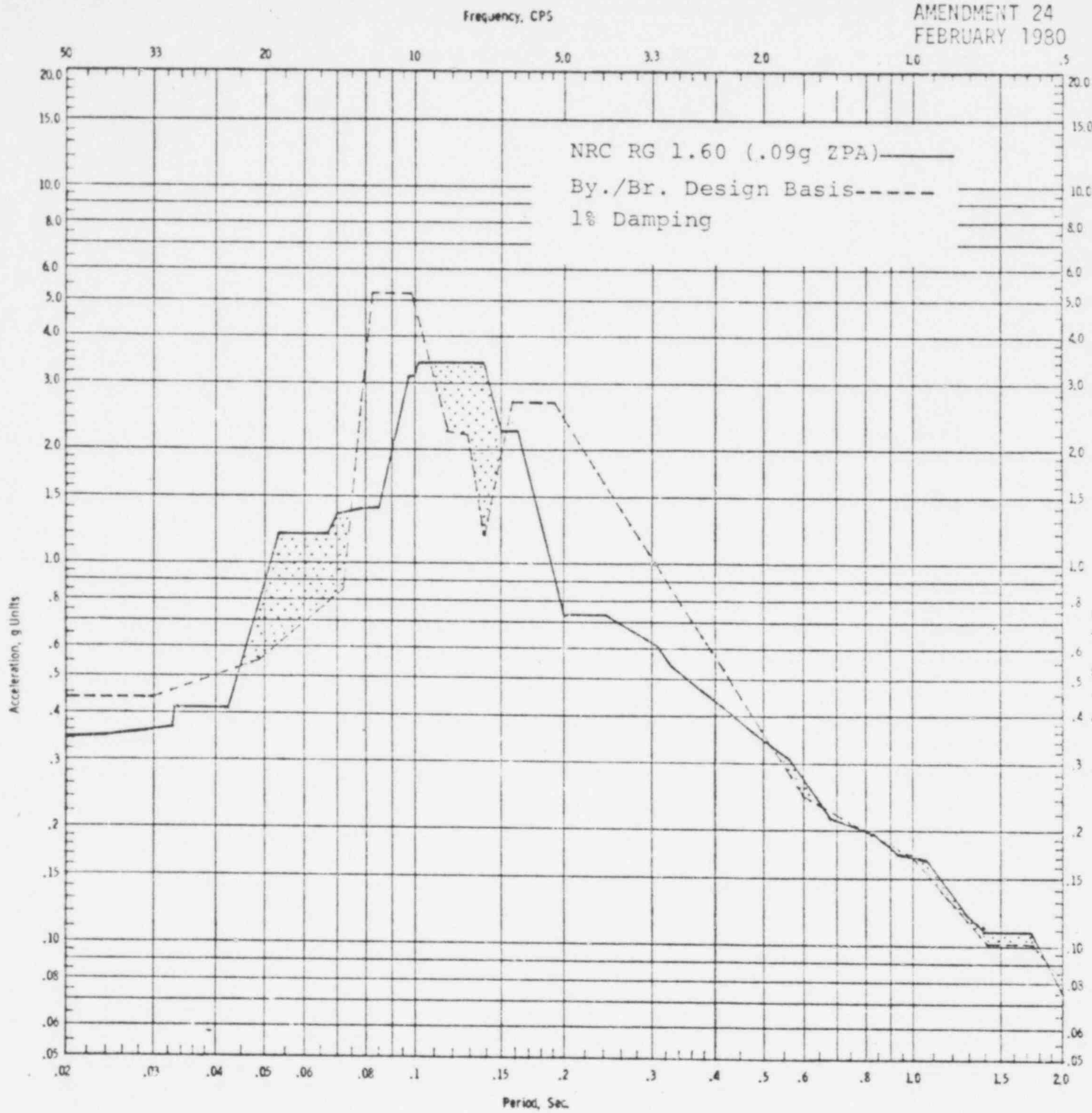
FIGURE Q130.6-59
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 346'-0"; 364'-0"; 383'-0"; 401'-0"



1842 245

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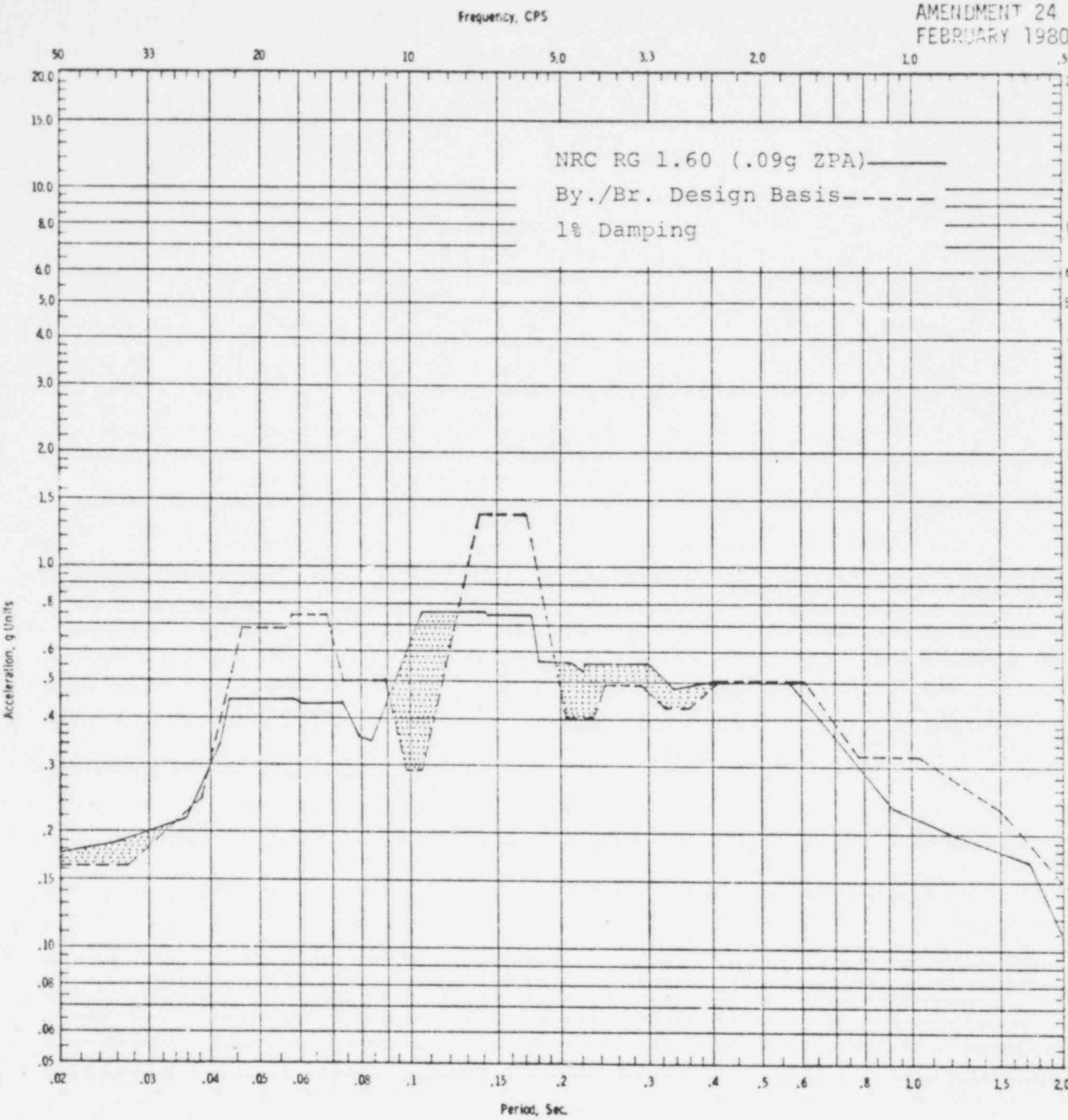
FIGURE Q130.6-60
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 346'-0"; 364'-0"; 383'-0"; 401'-0"



1842 246

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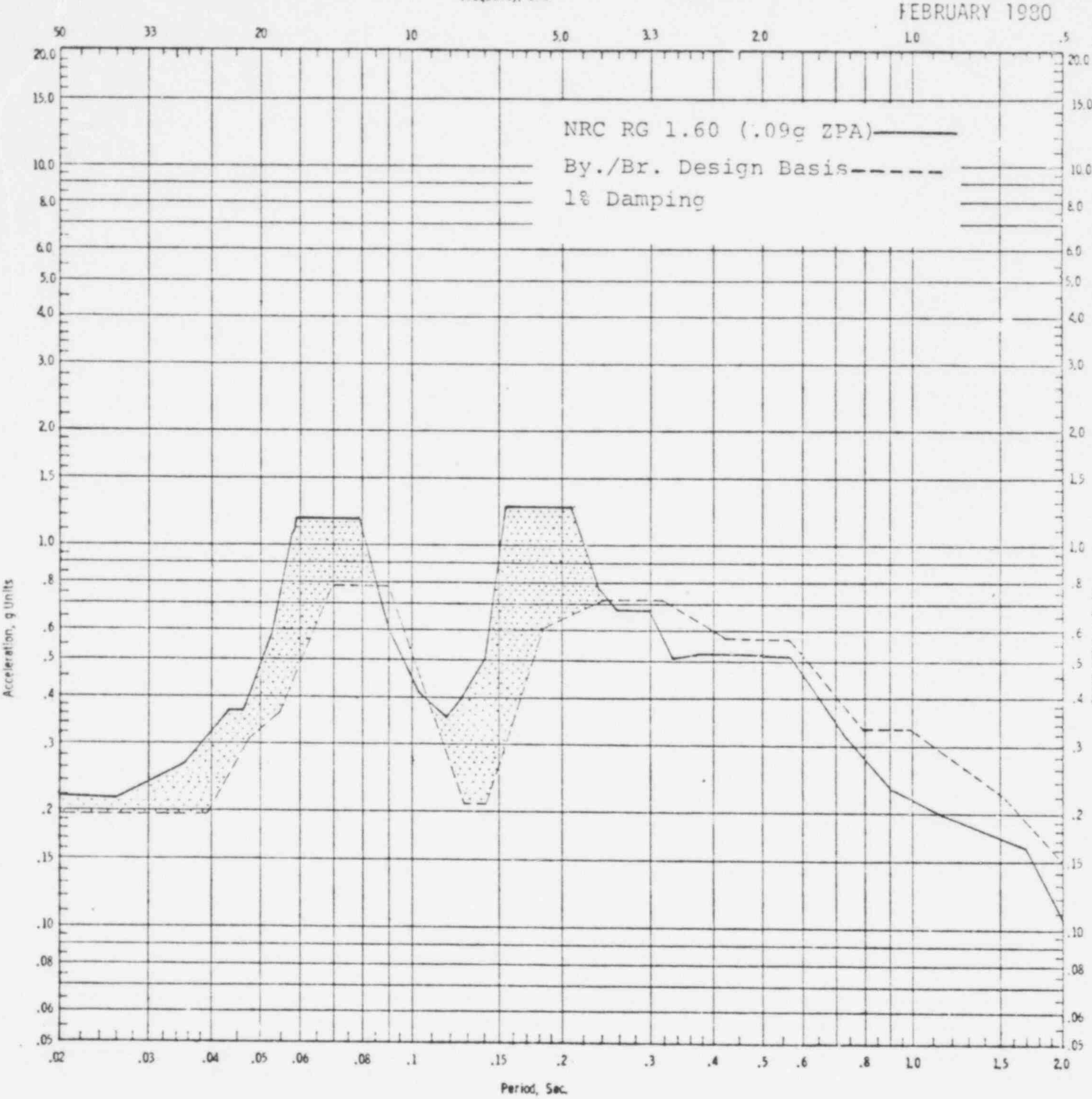
FIGURE Q130.6-61

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING
ELEVATION: 401'-0"



1842 247

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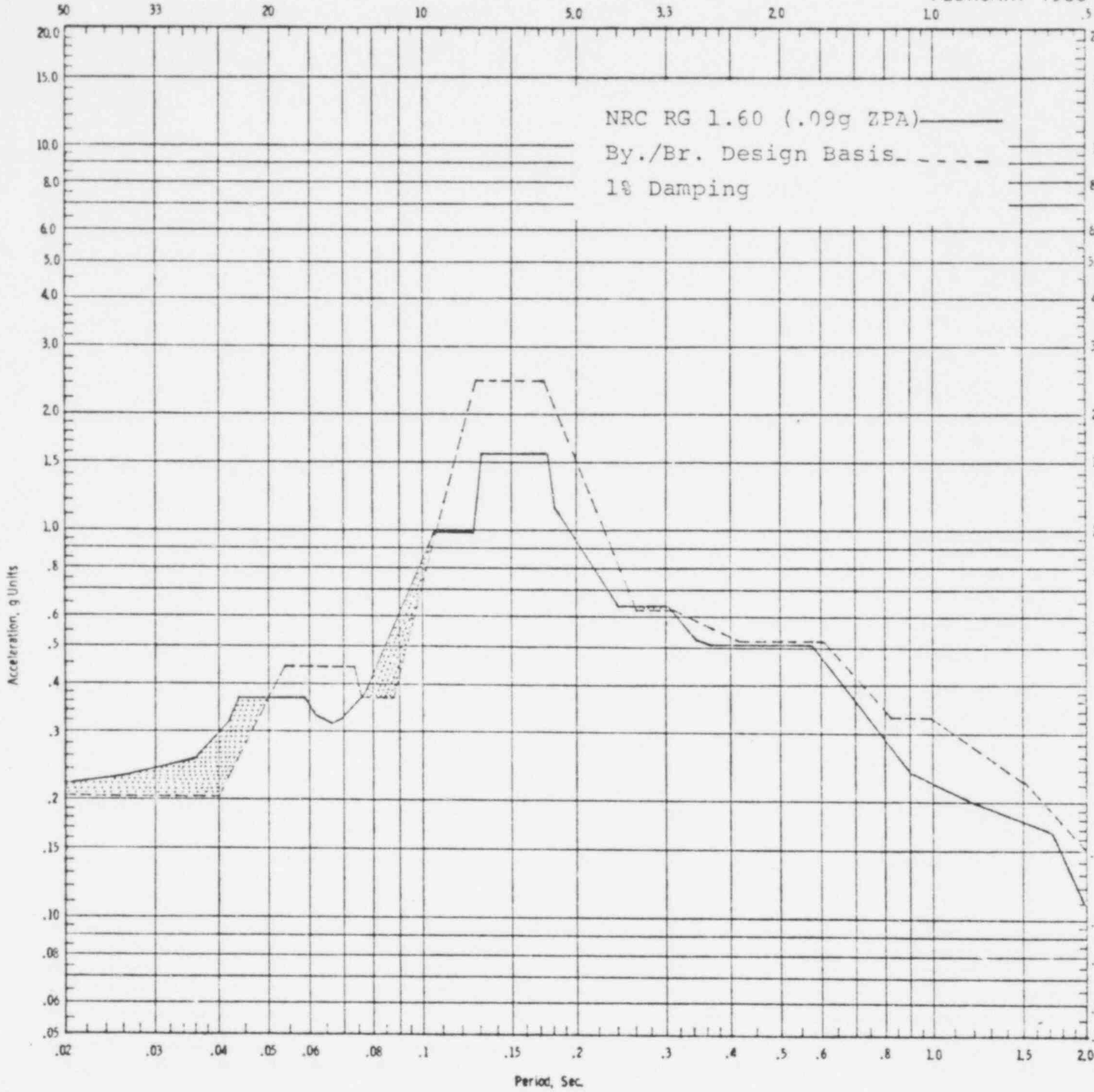
FIGURE Q130.6-62

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING
ELEVATION: 401'-0"



1842 248

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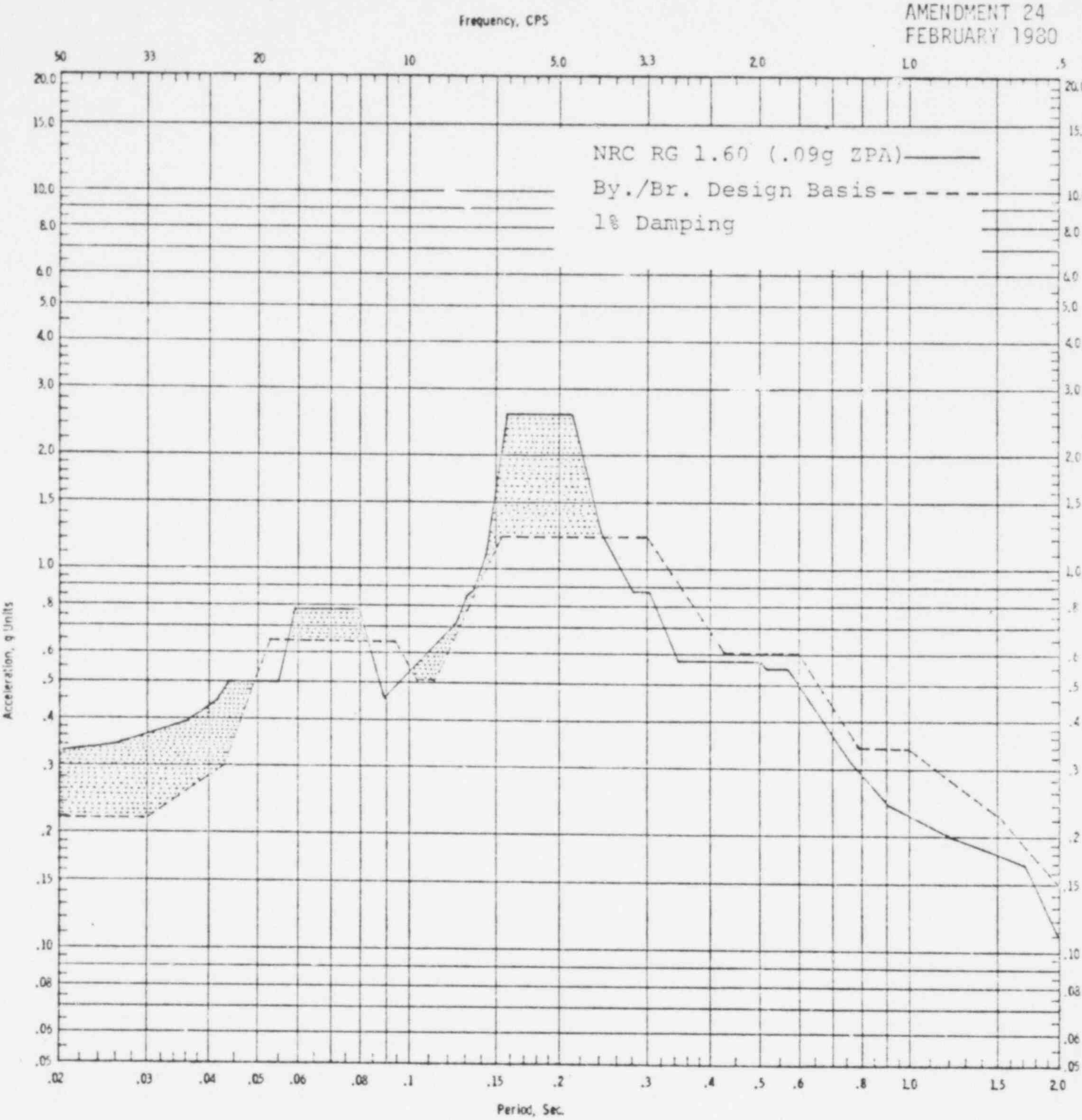
FIGURE Q130.6-63
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 426'-0"



1842 249

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FIGURE Q130.6-64
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIONTAL, EW
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 426'-0"

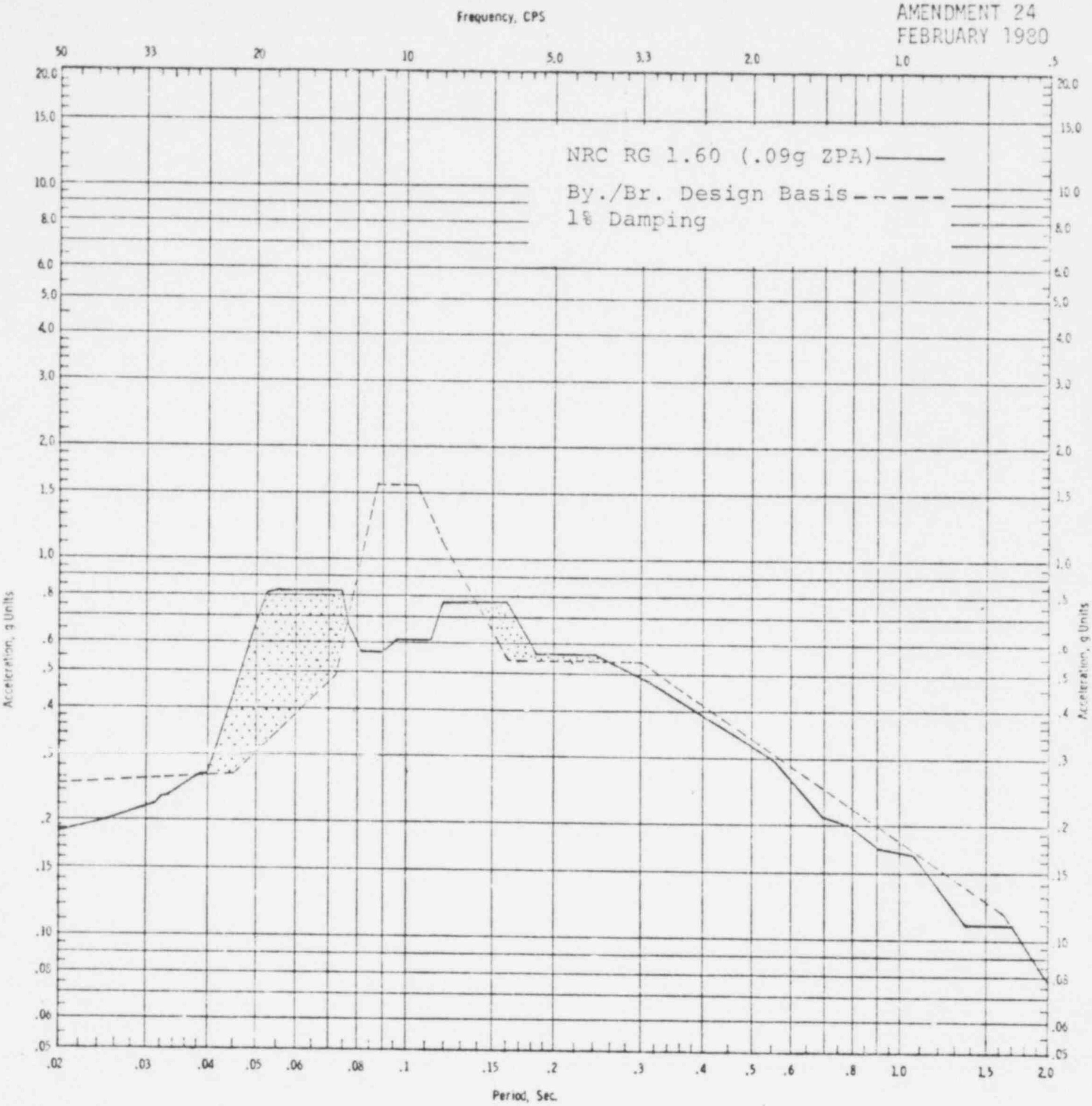

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FIGURE Q130.6-65

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 426'-0"; 439'-0"; 451'-0"

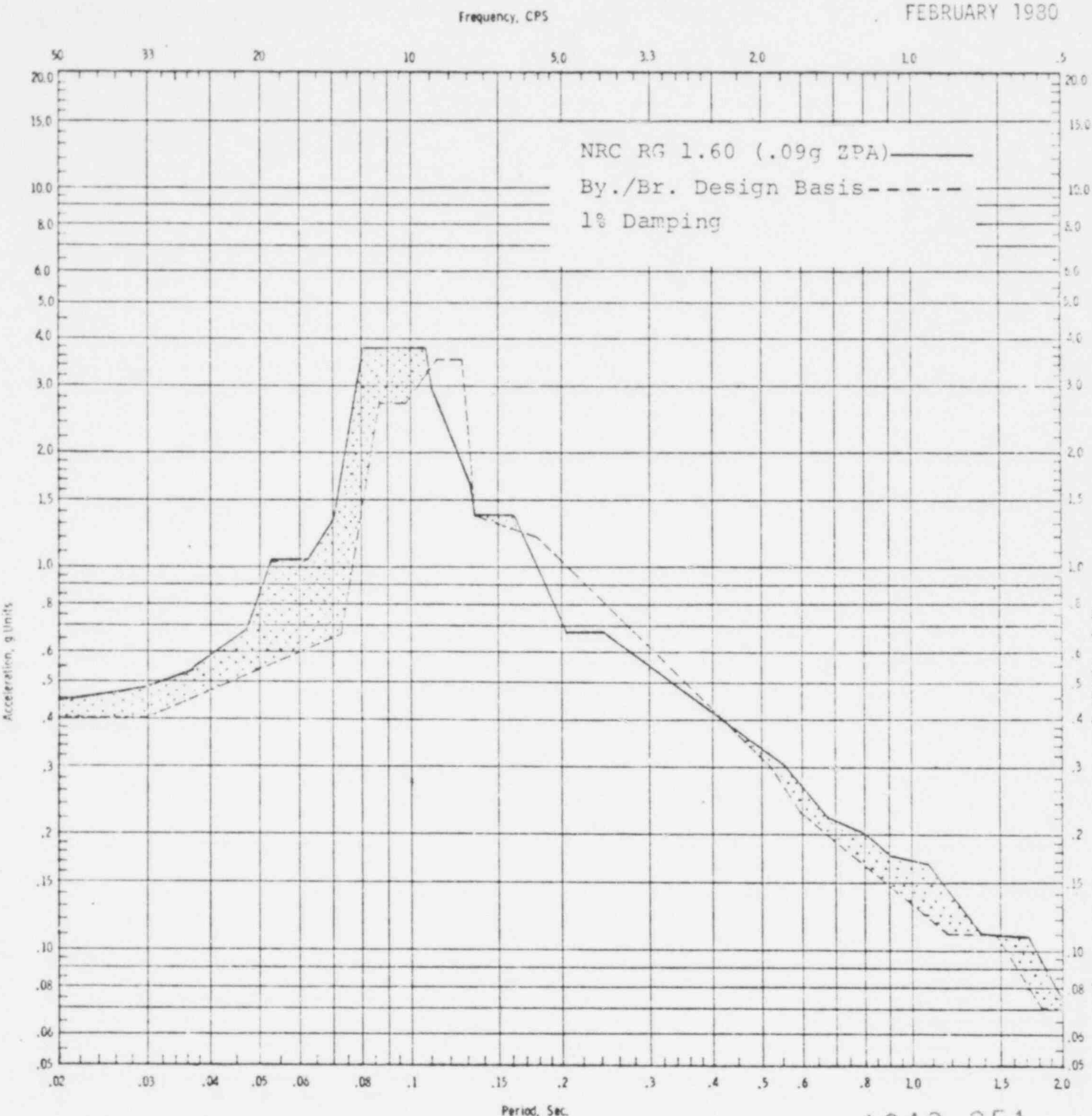

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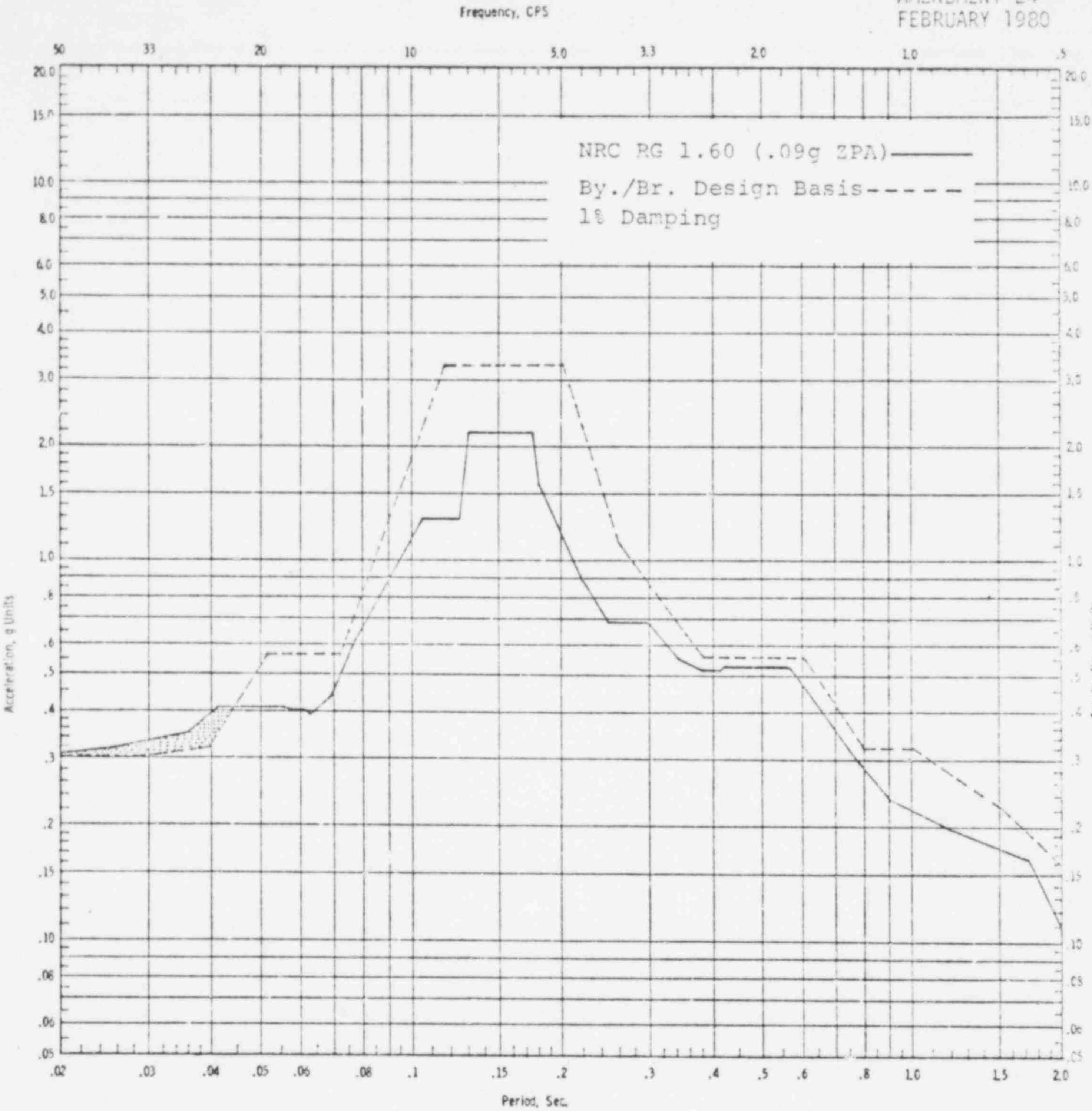
FIGURE Q130.6-66

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 426'-0"; 439'-0"; 451'-0"



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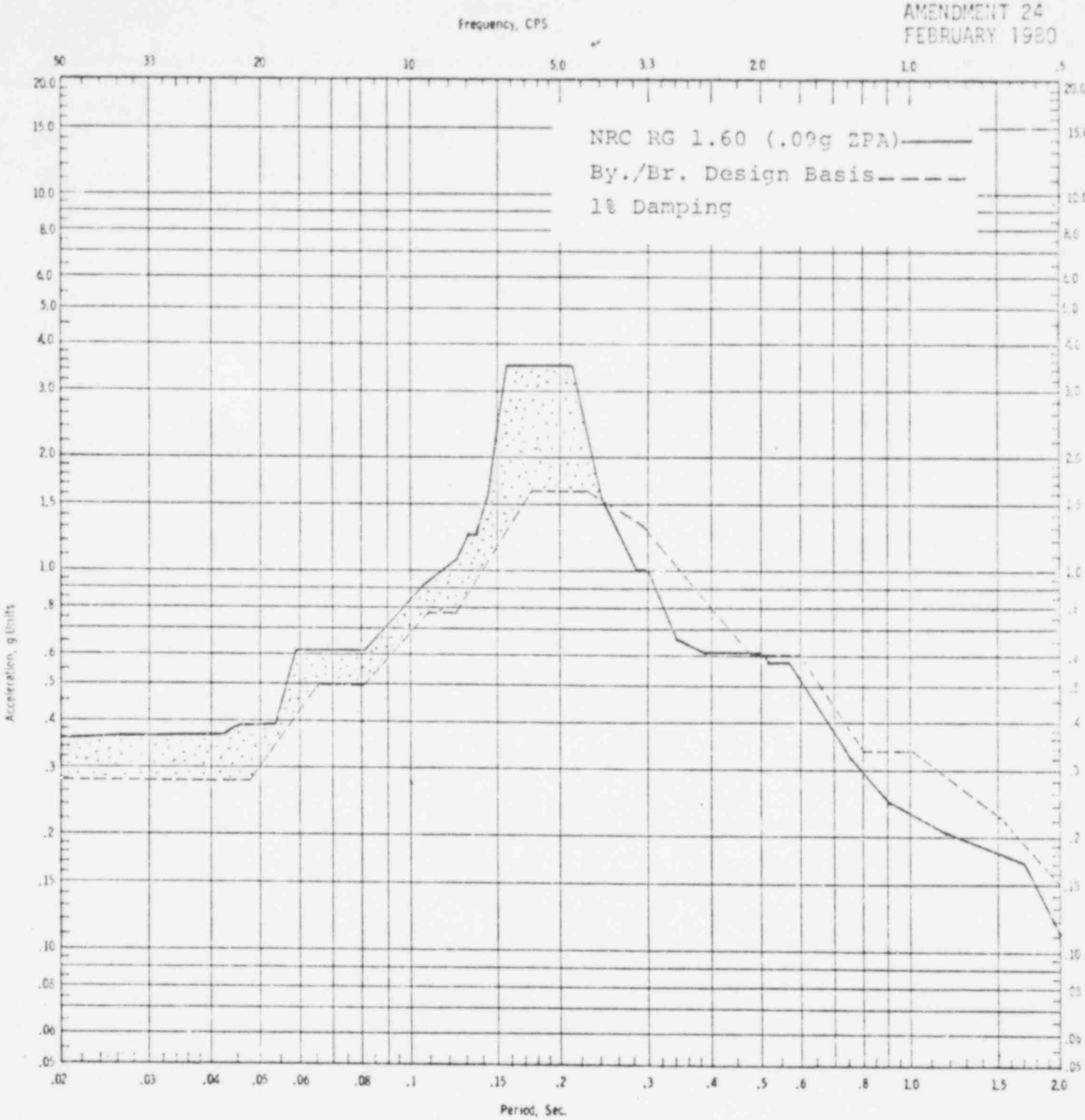
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-67
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 451'-0"



1842 253

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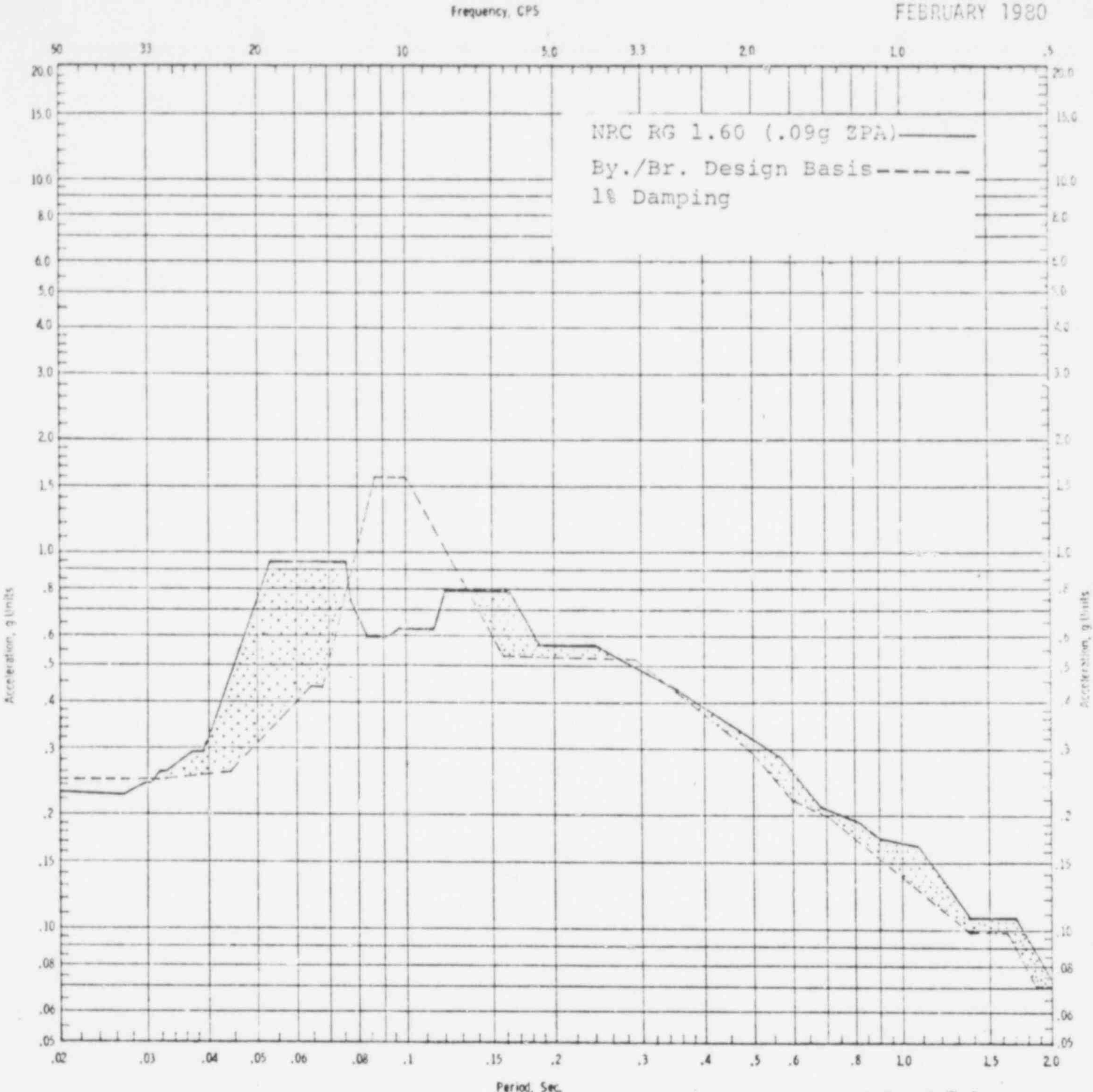
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-68
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 451'-0"



1842 254

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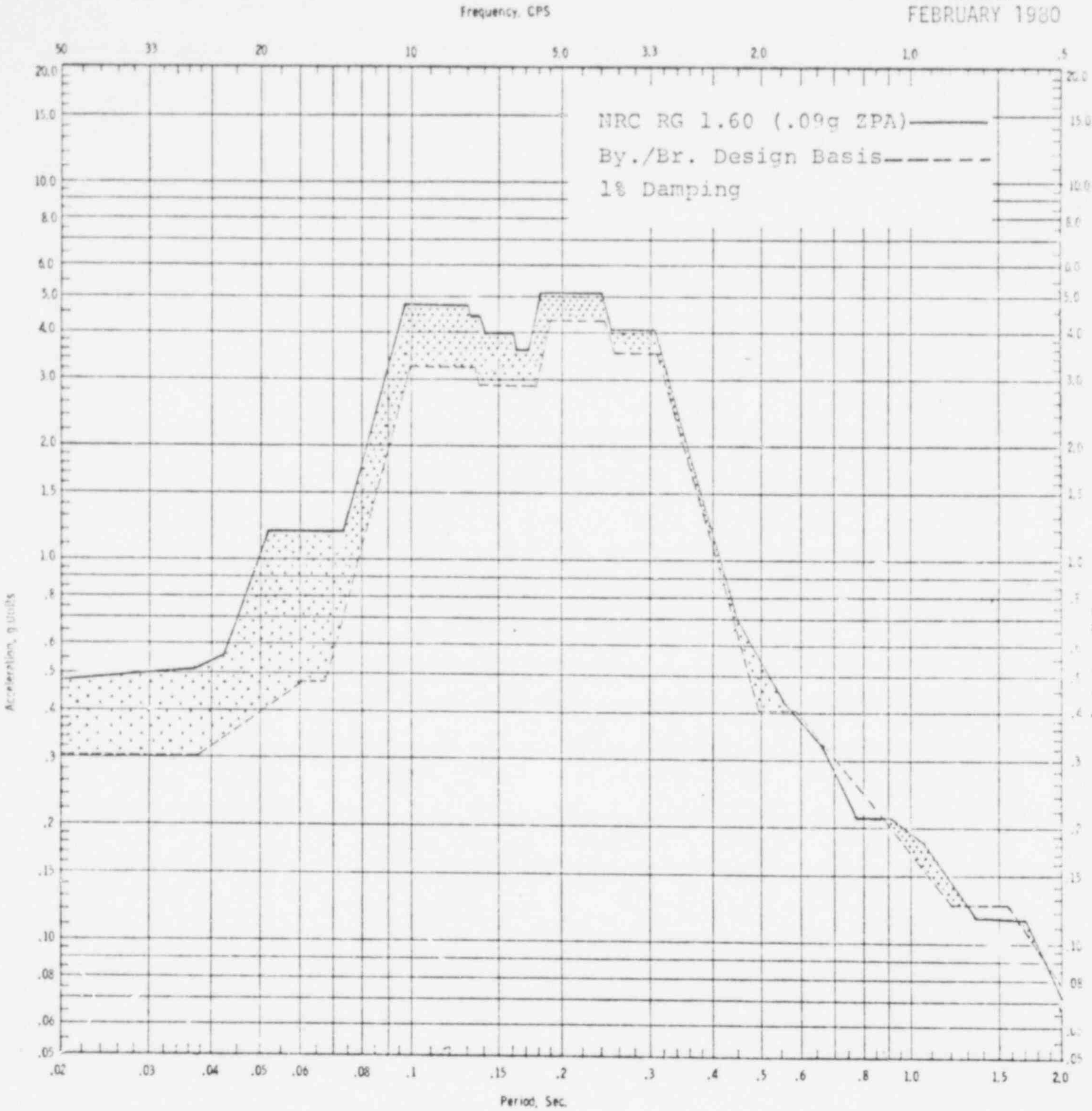
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-69
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 467'-0"; 473'-0"; 477'-0"; 485'-0"



1842 255

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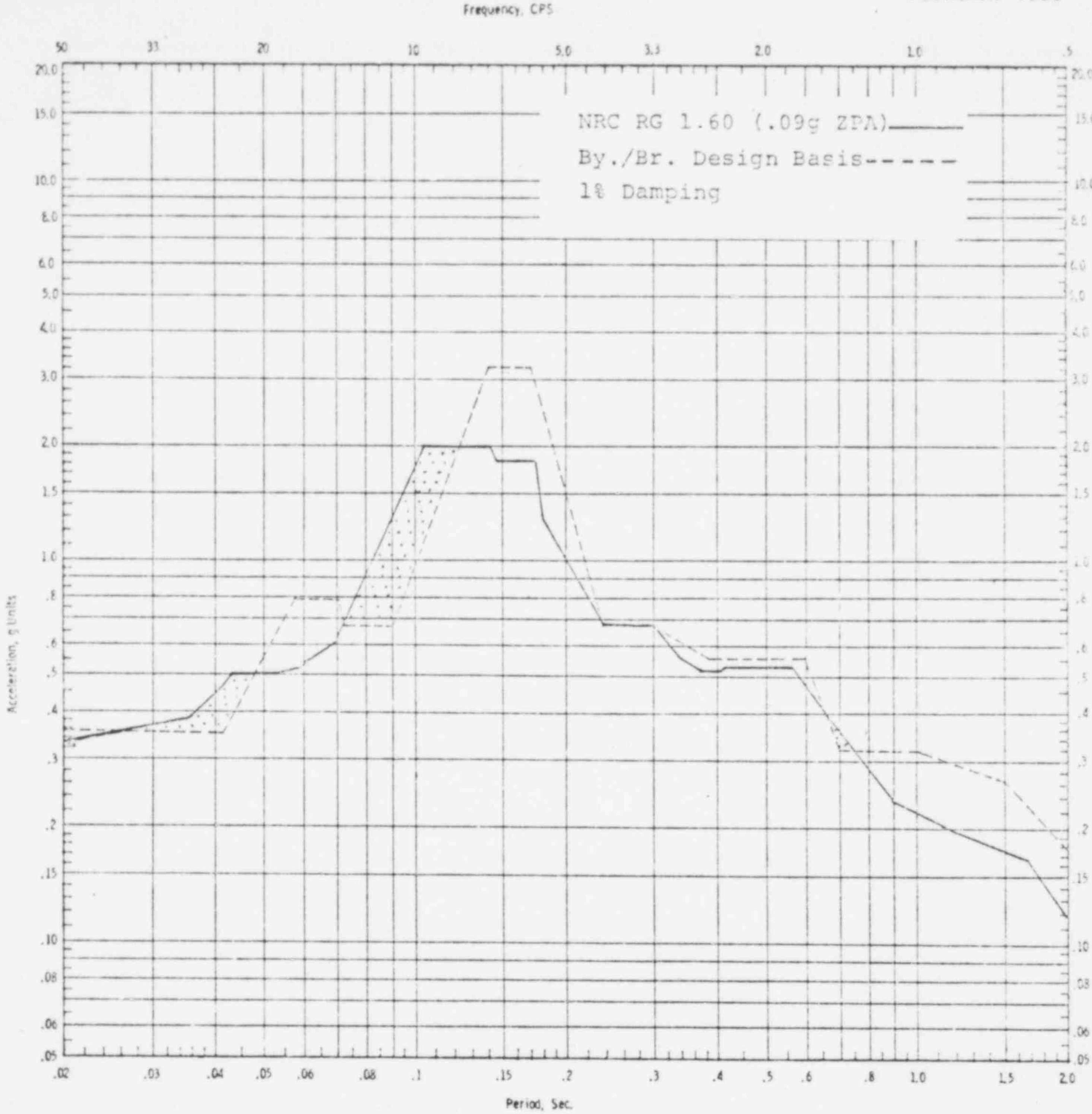
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-70

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 467'-0"; 477'-0"



1842 256

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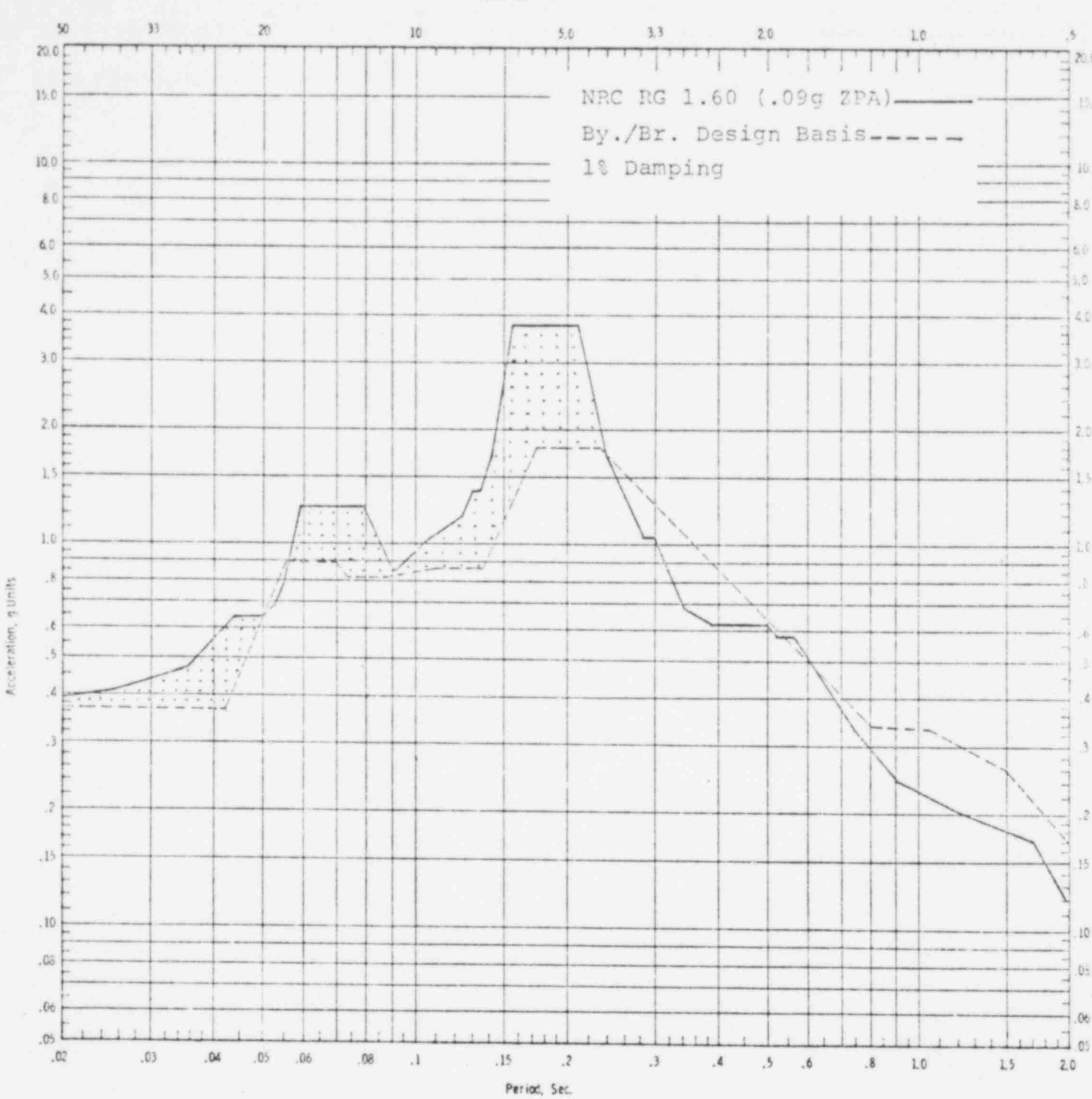
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-71

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING
ELEVATION: 477'-0"



1842 257

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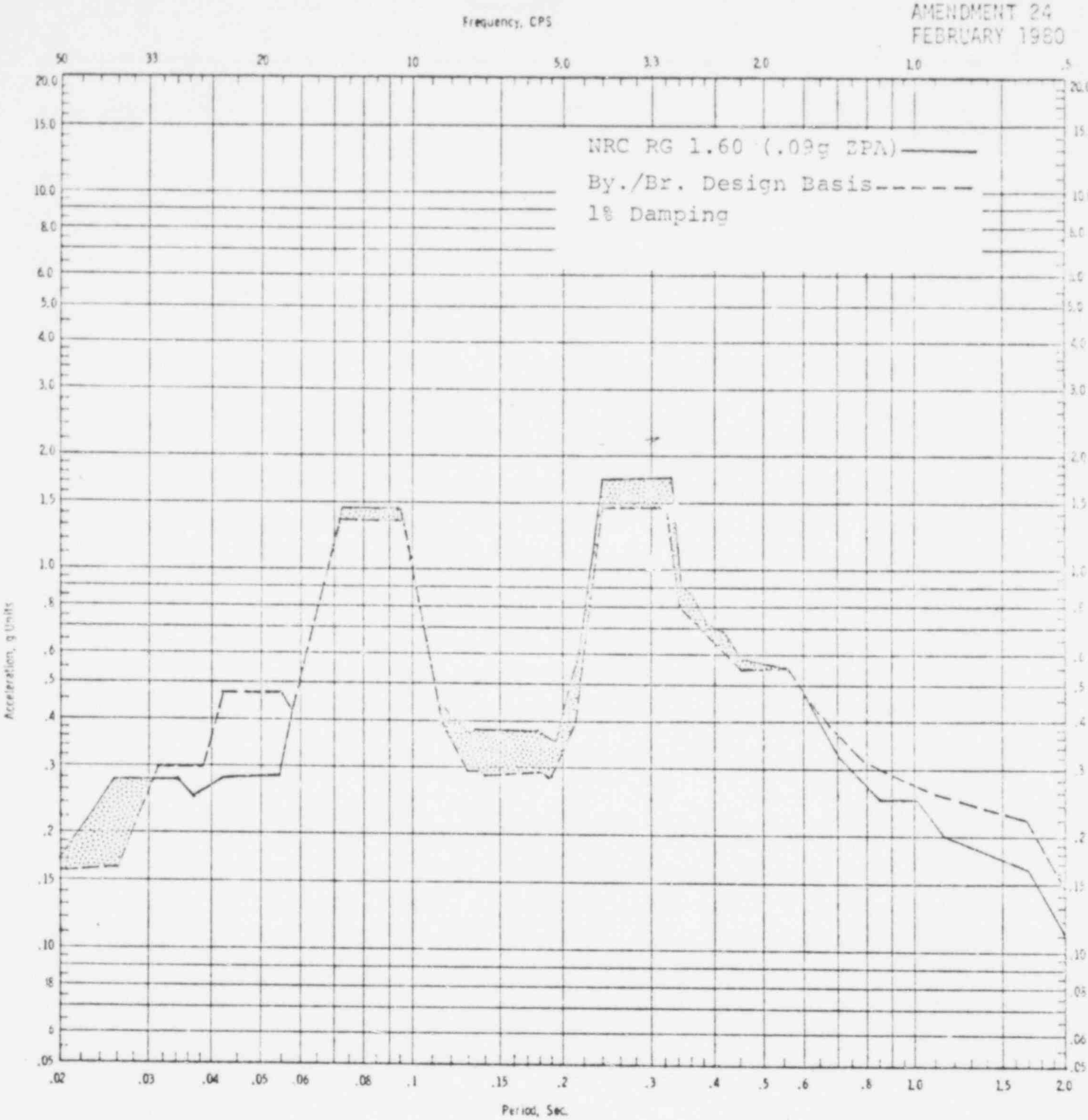
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-72

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING
ELEVATION: 477'-0"



1842 258

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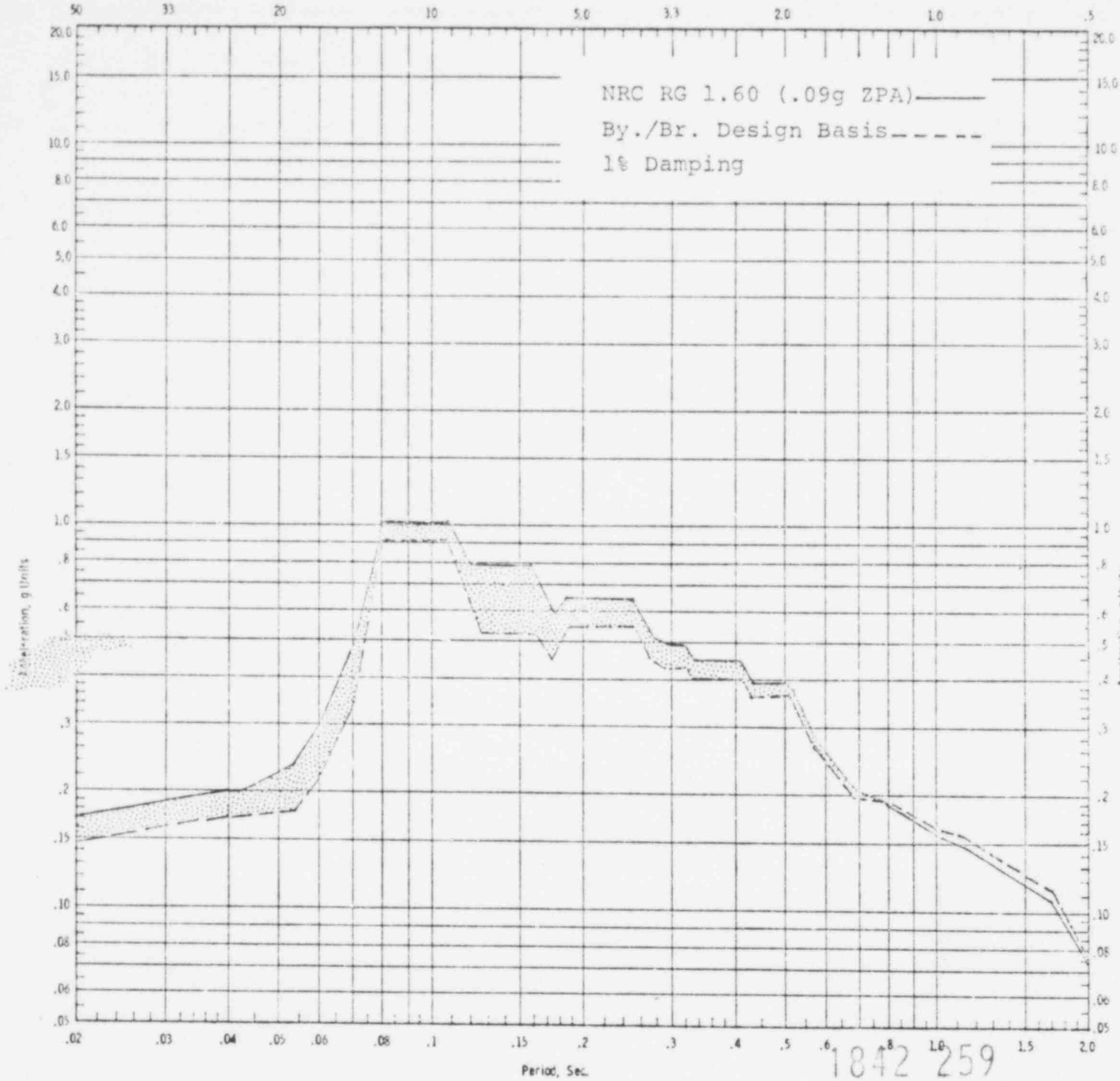
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-73

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: CONTAINMENT BUILDING
ELEVATION: 424'-0"; 436'-0"



1842 259

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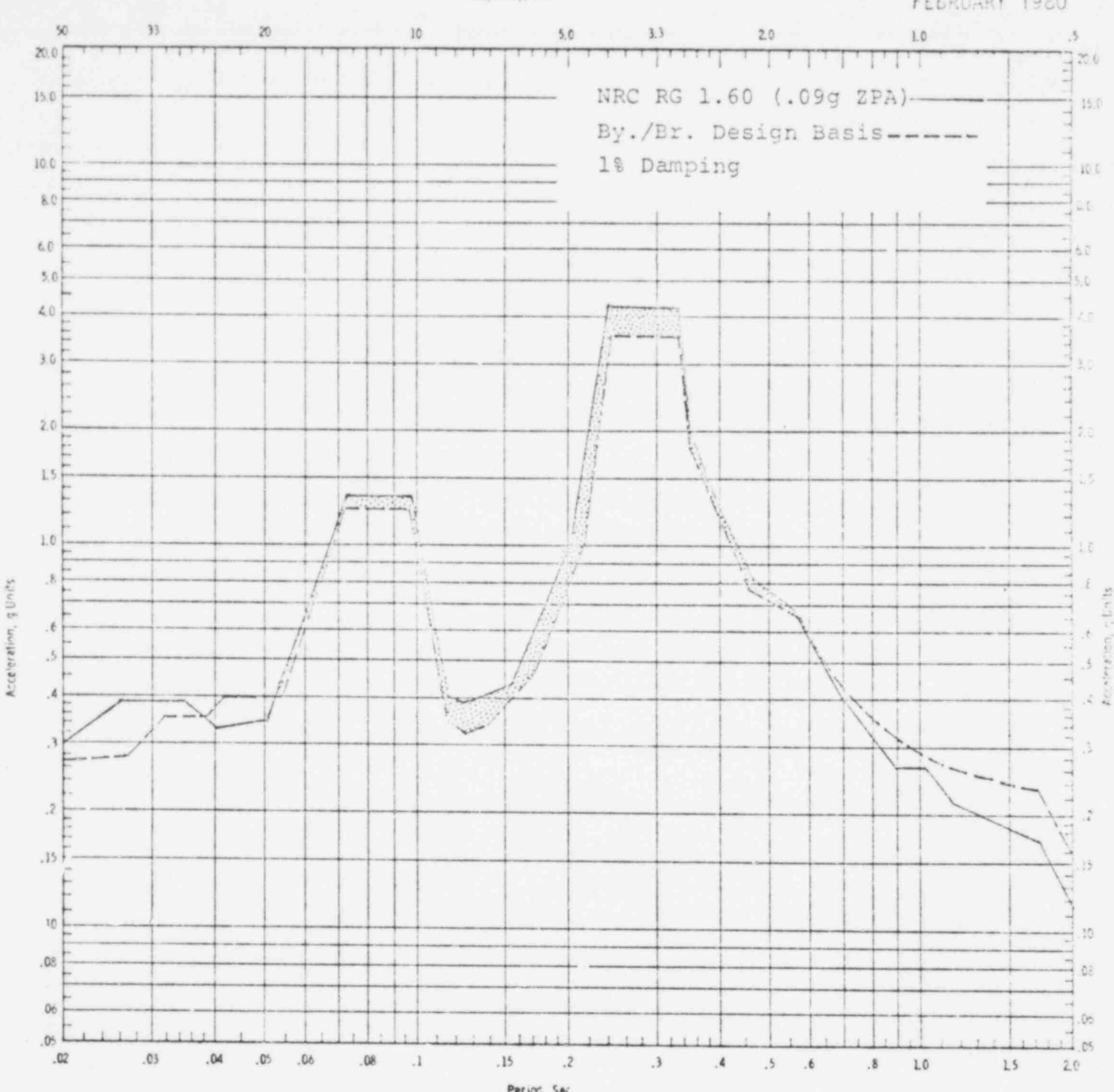
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-74

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: CONTAINMENT BUILDING WALL
ELEVATION: 424'-0"; 436'-0"



1842 260

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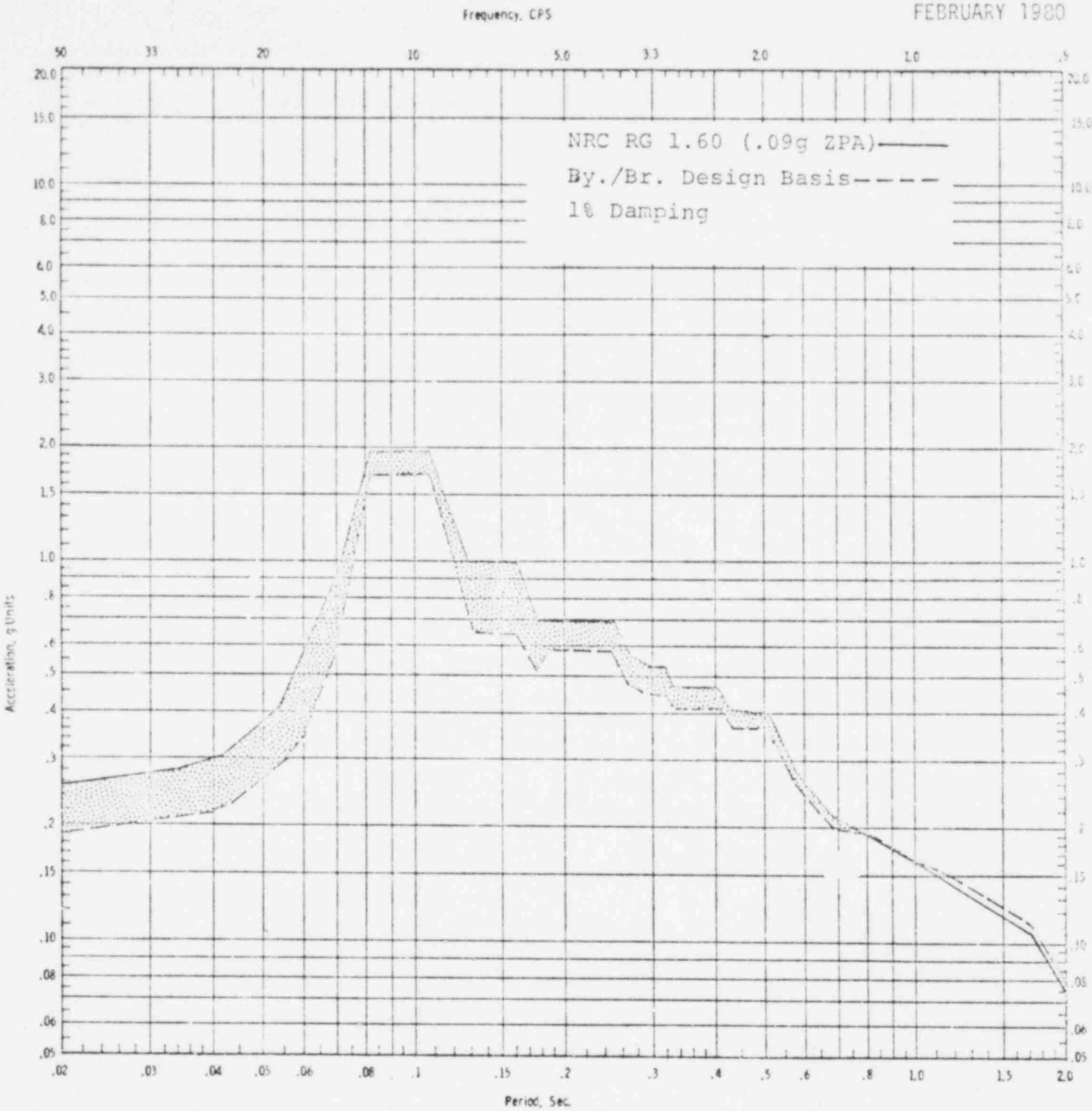
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-75

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS AND EW
LOCATION: CONTAINMENT BUILDING
ELEVATION: 496'-0"



1842 261

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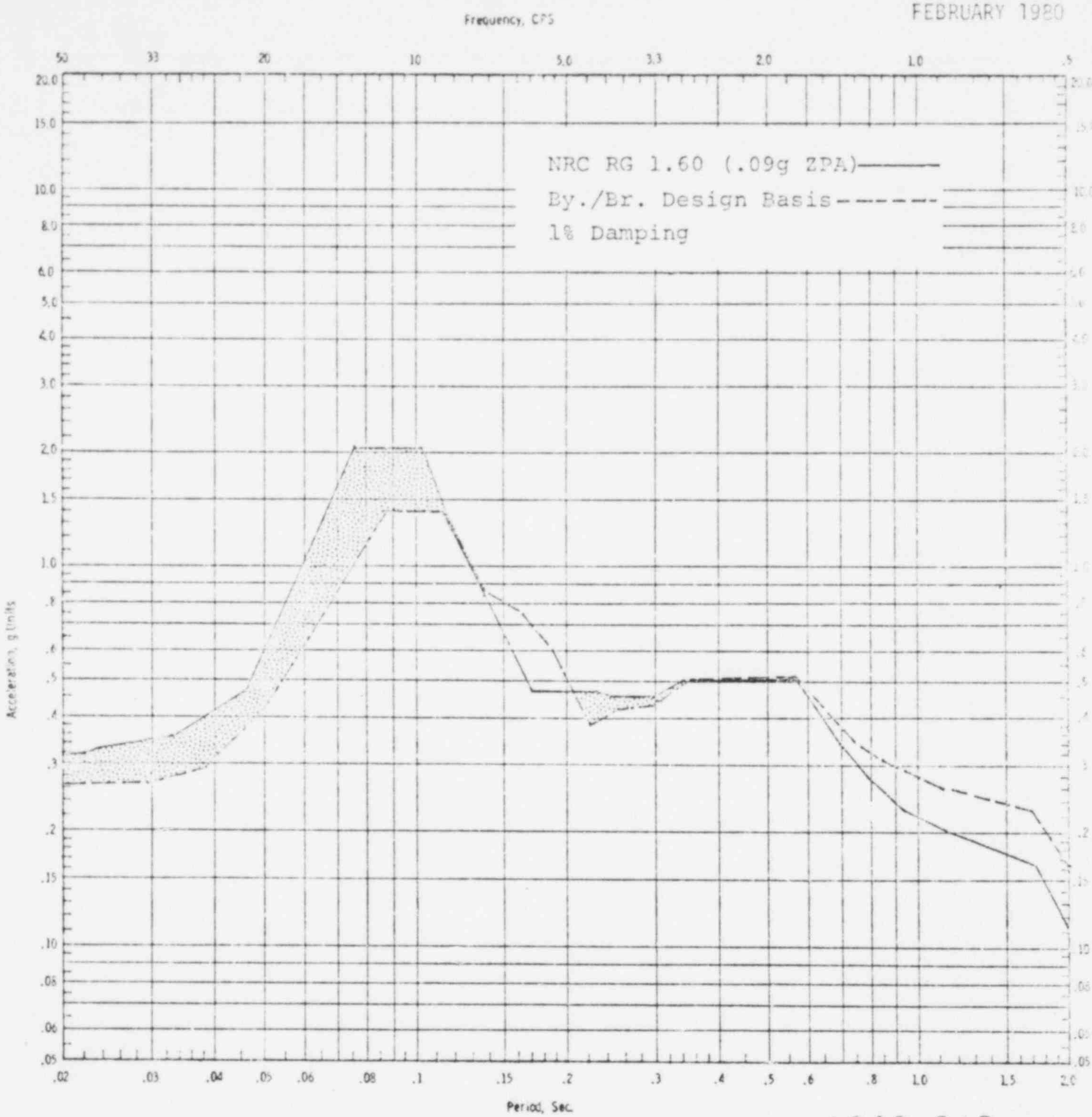
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-76

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: CONTAINMENT BUILDING WALL
ELEVATION: 496'-0"



1842 262

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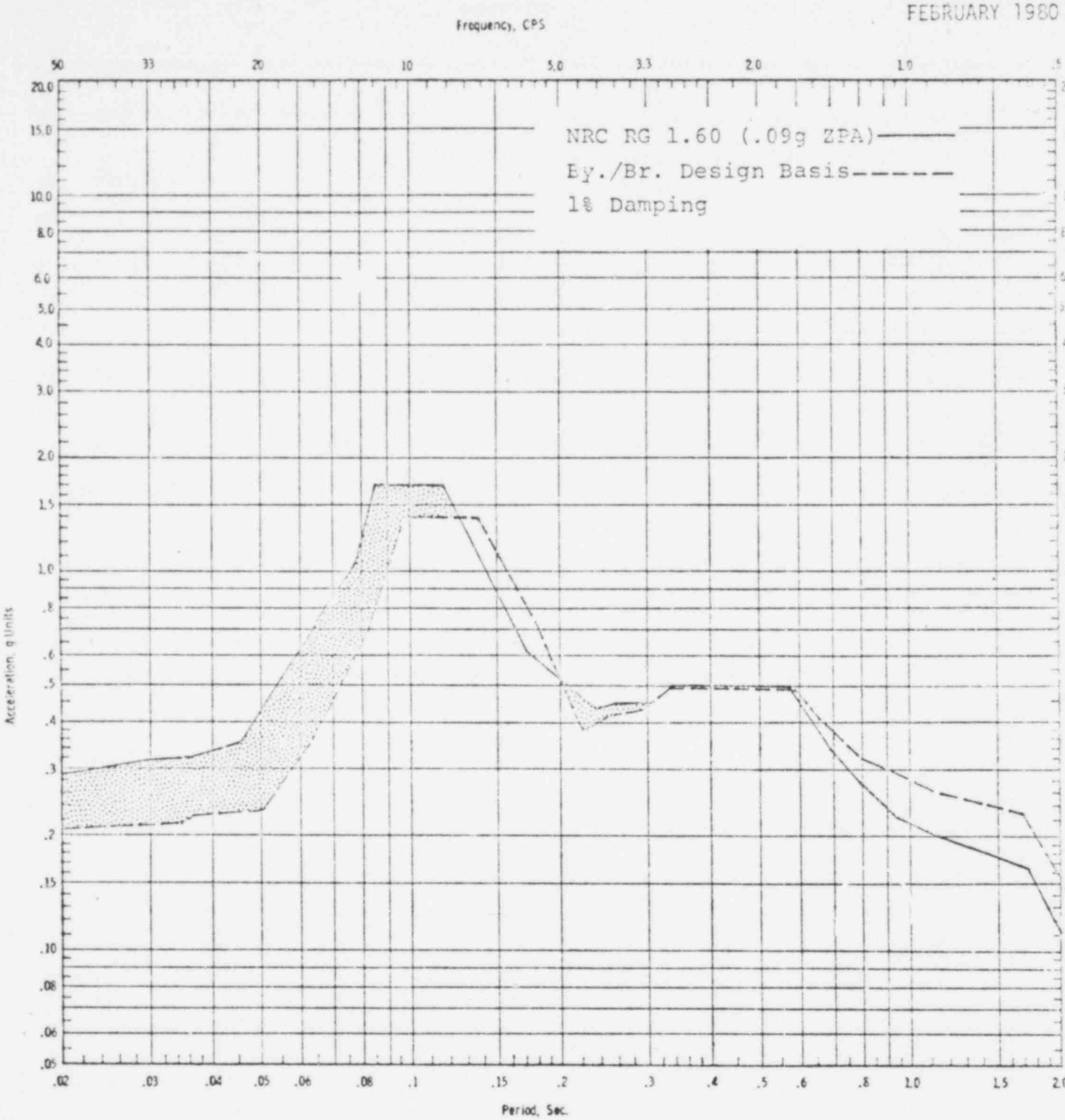
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-77

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, NS
LOCATION: CONTAINMENT INNER STRUCTURES
ELEVATION: 426'-0"



1842 263

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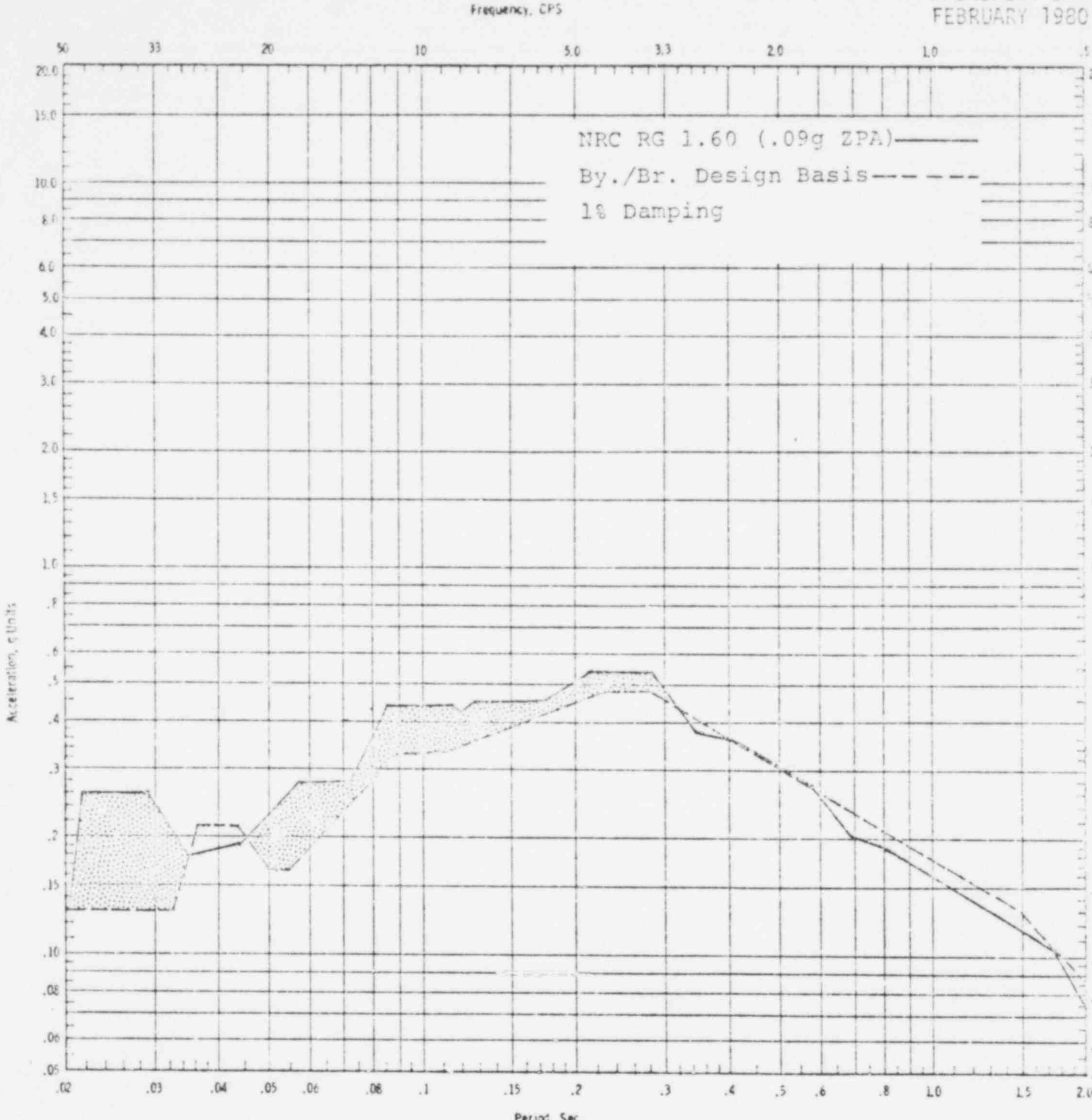
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-78

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, HORIZONTAL, EW
LOCATION: CONTAINMENT INNER STRUCTURE
ELEVATION: 426'-0"



1842 264

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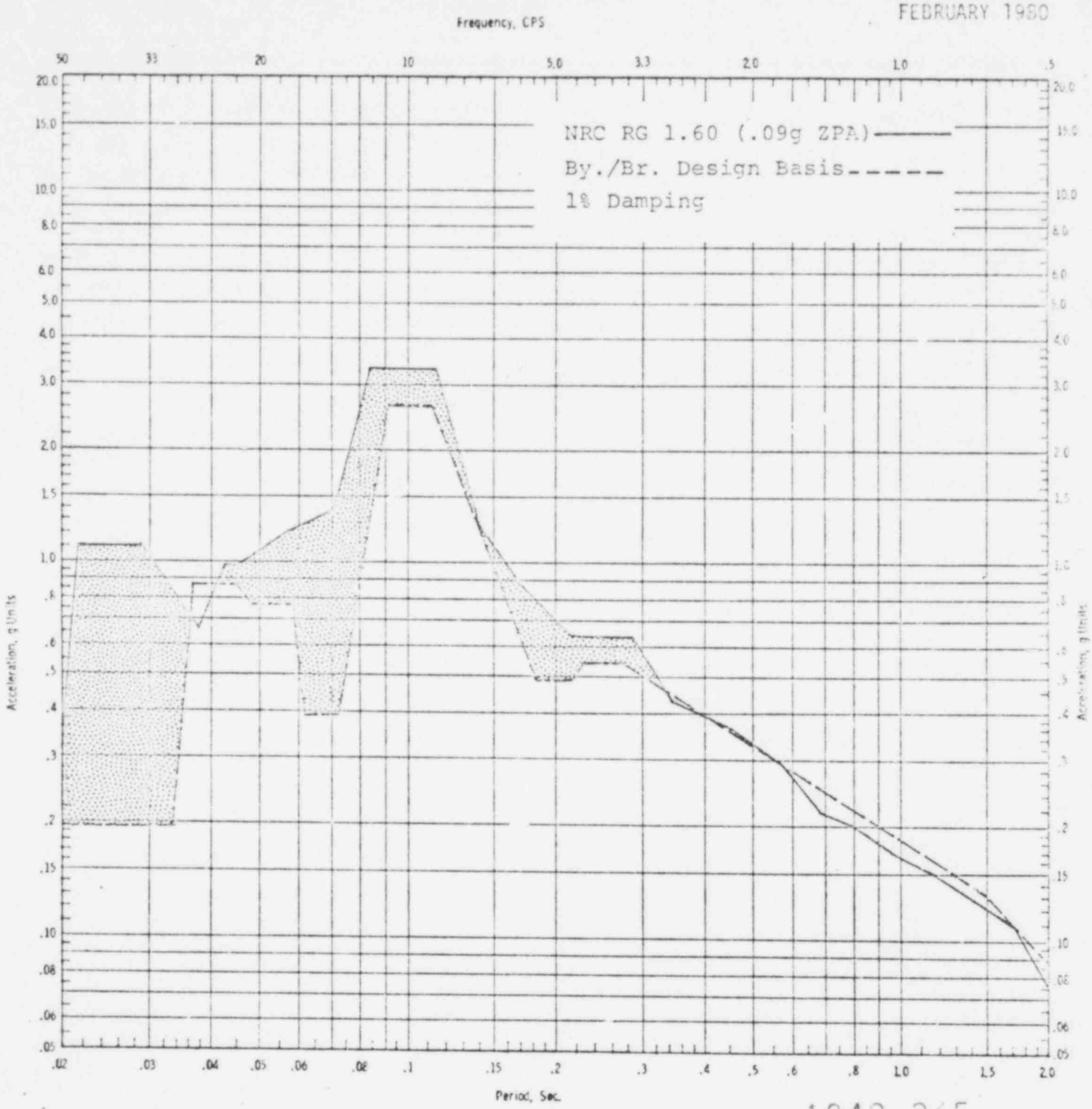
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-79
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, WALL
LOCATION: CONTAINMENT INNER STRUCTURE WALL
ELEVATION: 412'-0"; 426'-0"



1842 265

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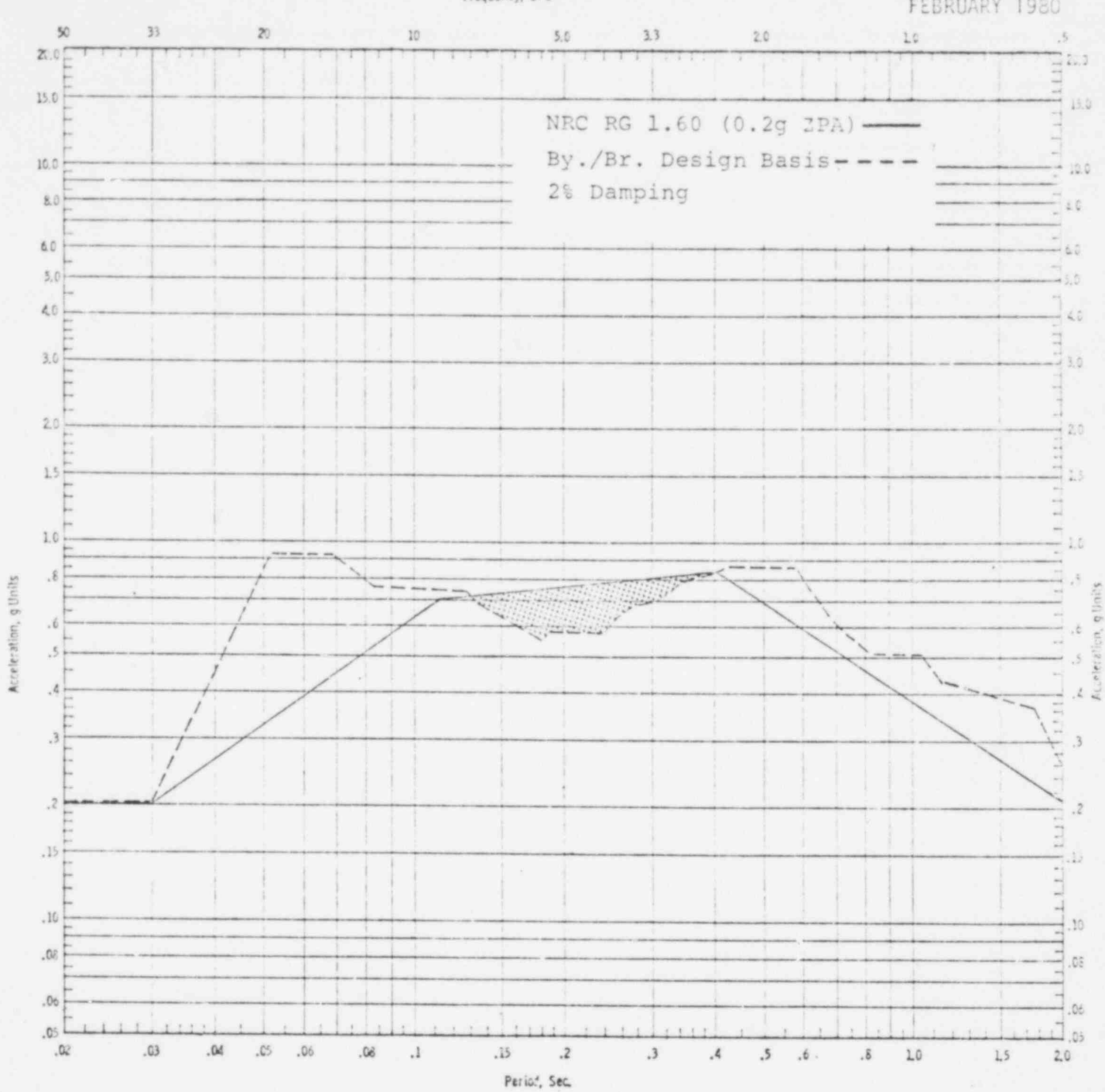
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-80
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: OBE, VERTICAL, SLAB
LOCATION: CONT. INNER STRUCTURE SLAB
ELEVATION: 390'-0"; 401'-0"; 412'-0"; 426'-0"



1842 266

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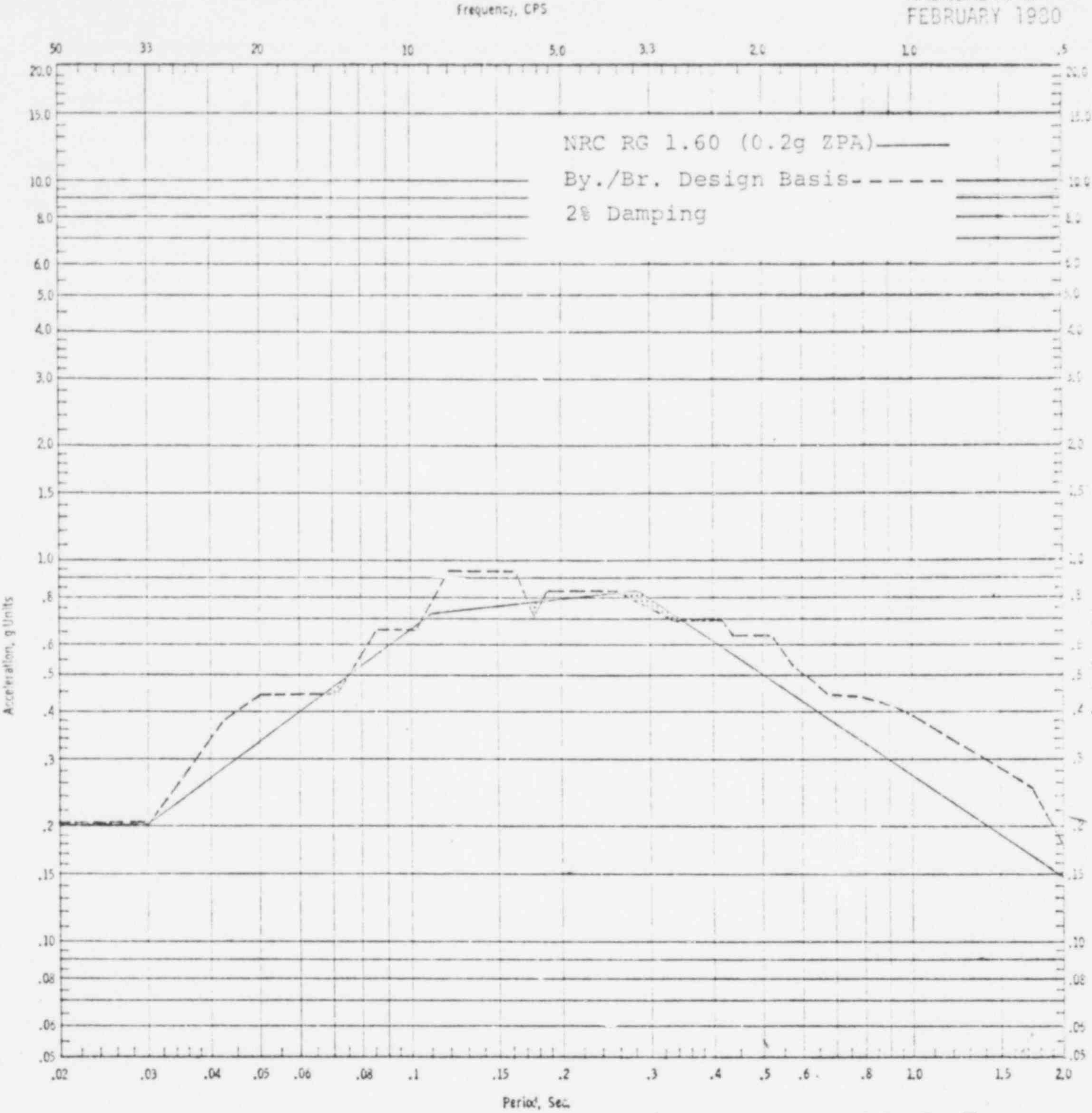
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-81
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS AND EW
LOCATION: AUXILIARY AND CONTAINMENT BUILDINGS
ELEVATION: 330'-0"; 374'-0"



1842 267

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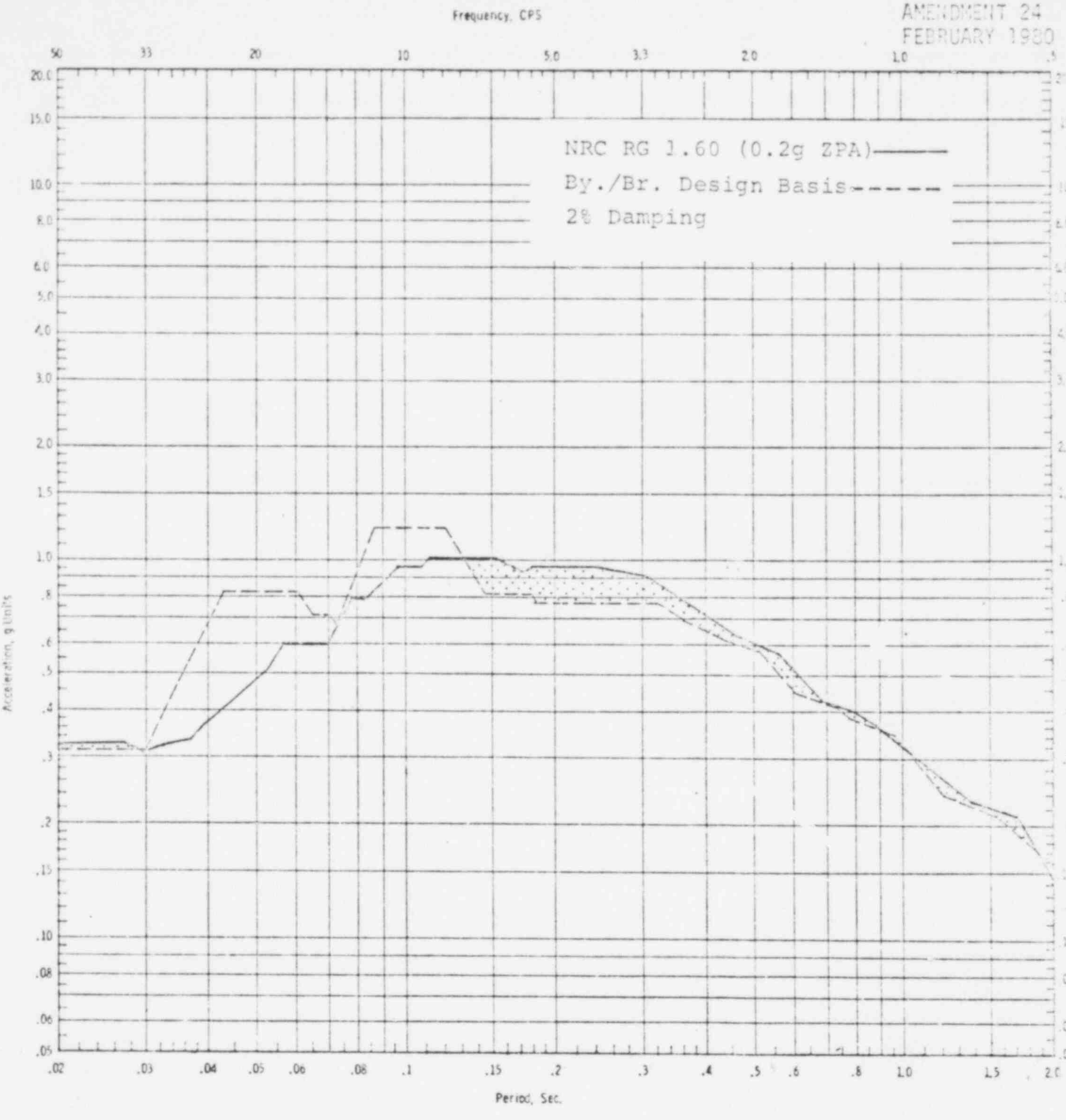
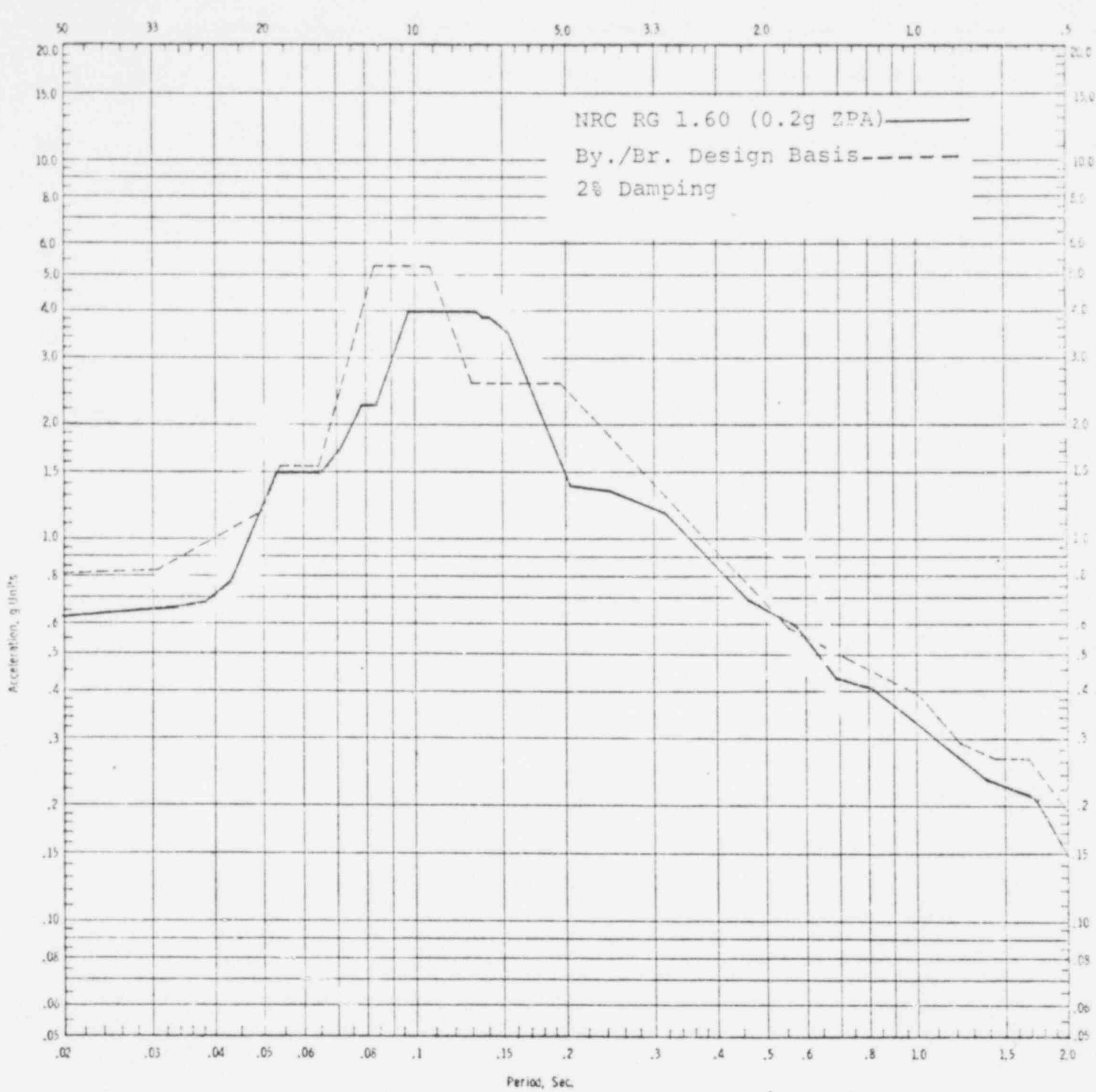
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-82
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL AND SLAB
LOCATION: AUXILIARY AND CONTAINMENT BUILDINGS
ELEVATION: 330'-0"; 374'-0"



1842 268

BYRON/BRAIDWOOD STATIONS FINAL SAFETY ANALYSIS REPORT
FIGURE Q130.6-83 COMPARISON OF B/B AND RG 1.60 SPECTRA EXCITATION: SSE, VERTICAL, WALL LOCATION: AUXILIARY BUILDING WALL ELEVATION: 346'-0"; 364'-0"; 383'-0"; 401'-0"

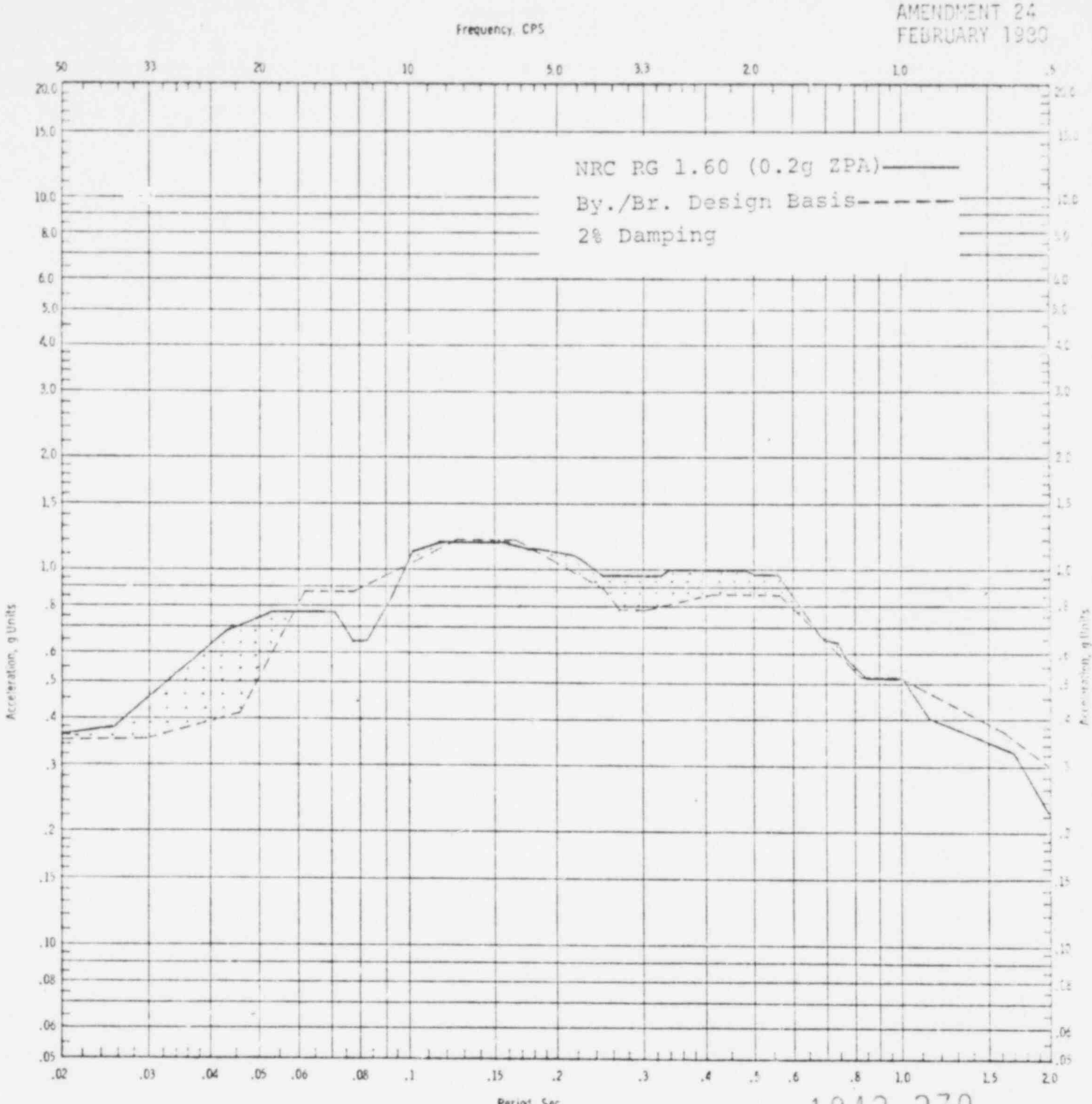


1842 269

BYRON/BRAIDWOOD STATIONS

FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-84
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 346'-0"; 364'-0"; 383'-0"; 401'-0"



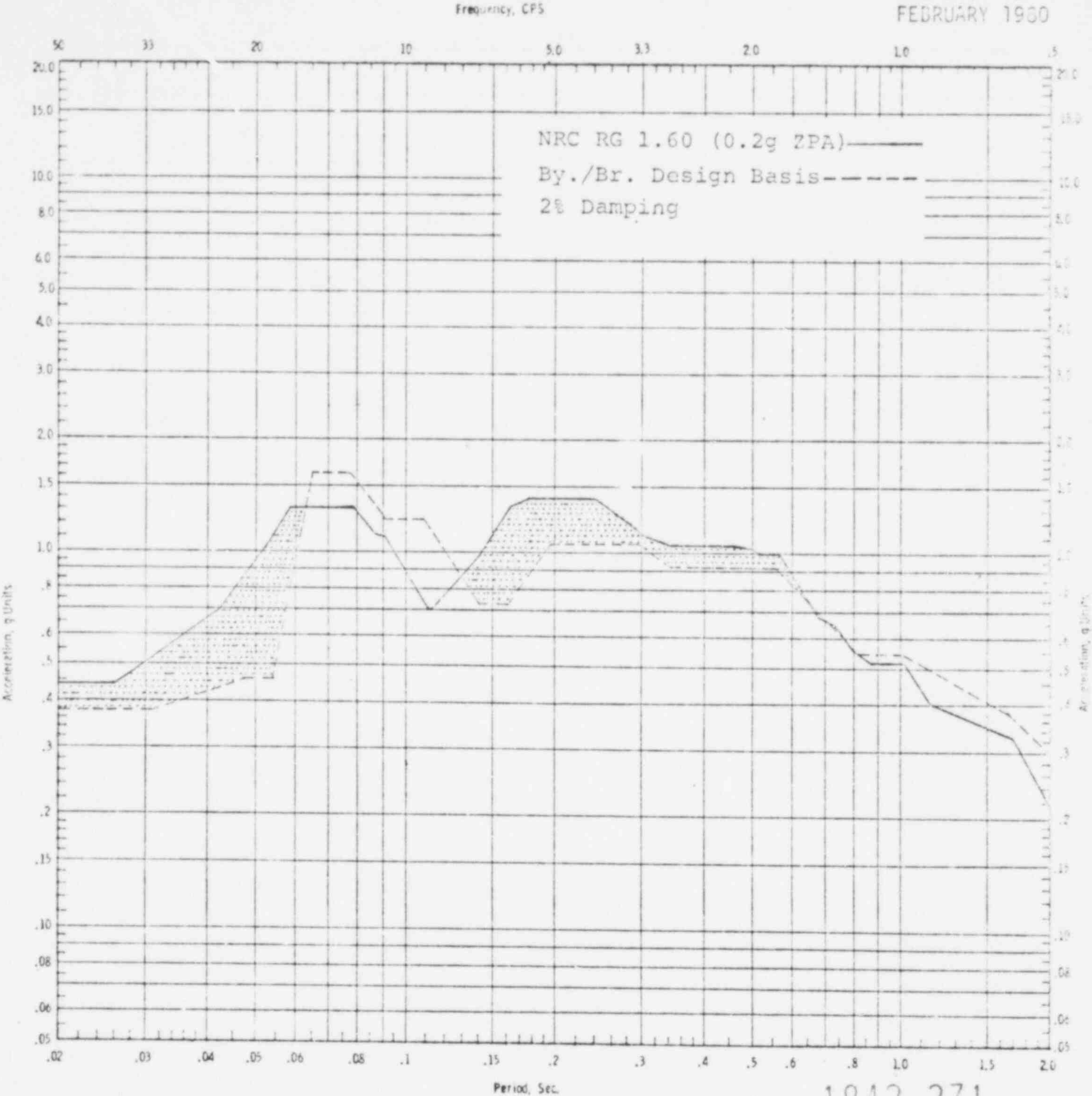
1842 270

BYRON/BRAIDWOOD STATIONS

FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-85

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, ~~SLAB~~ NS
LOCATION: AUXILIARY BUILDING
ELEVATION: 401'-0"



1842 271

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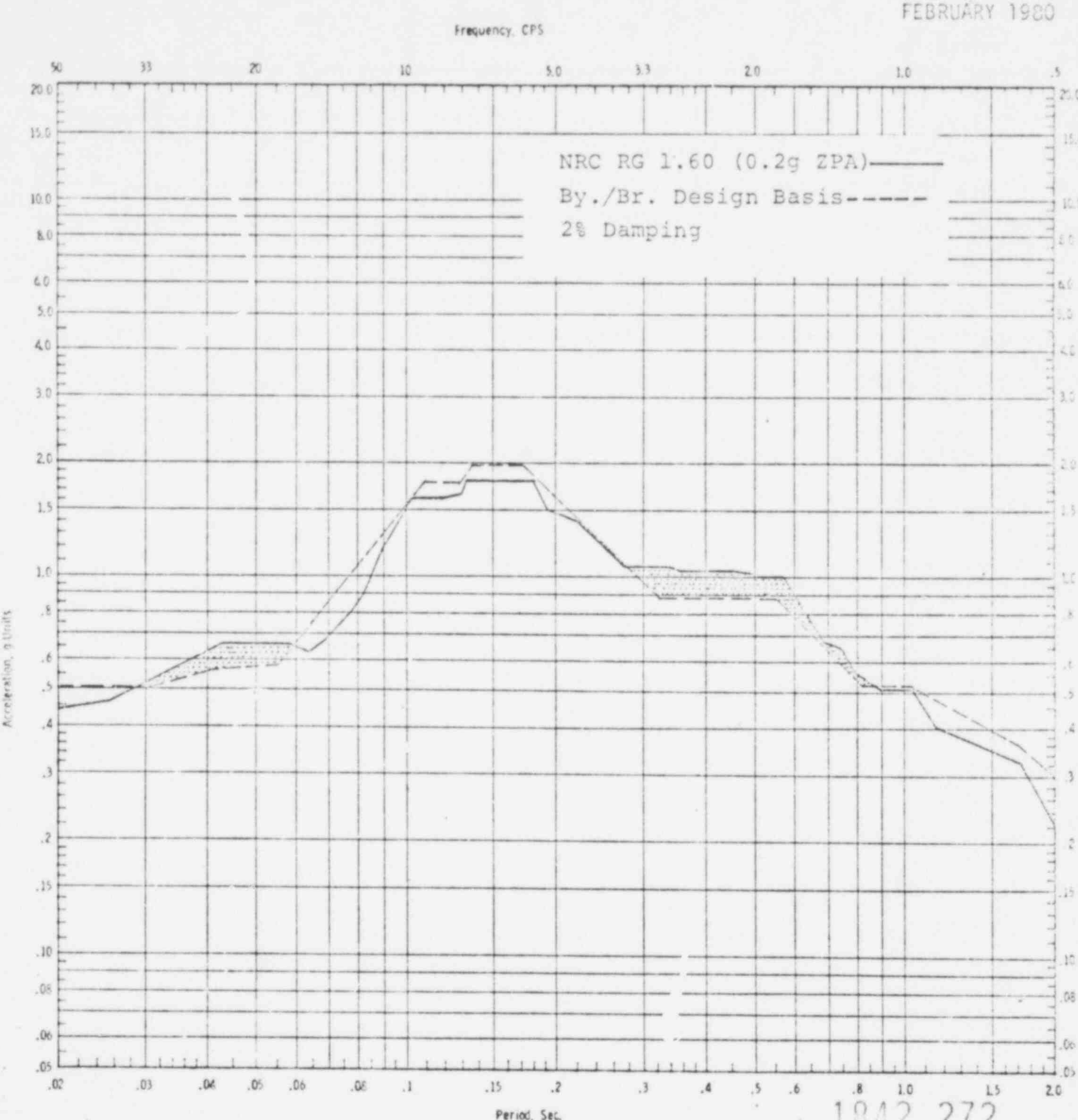
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-86

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING
ELEVATION: 401'-0"



1842 272

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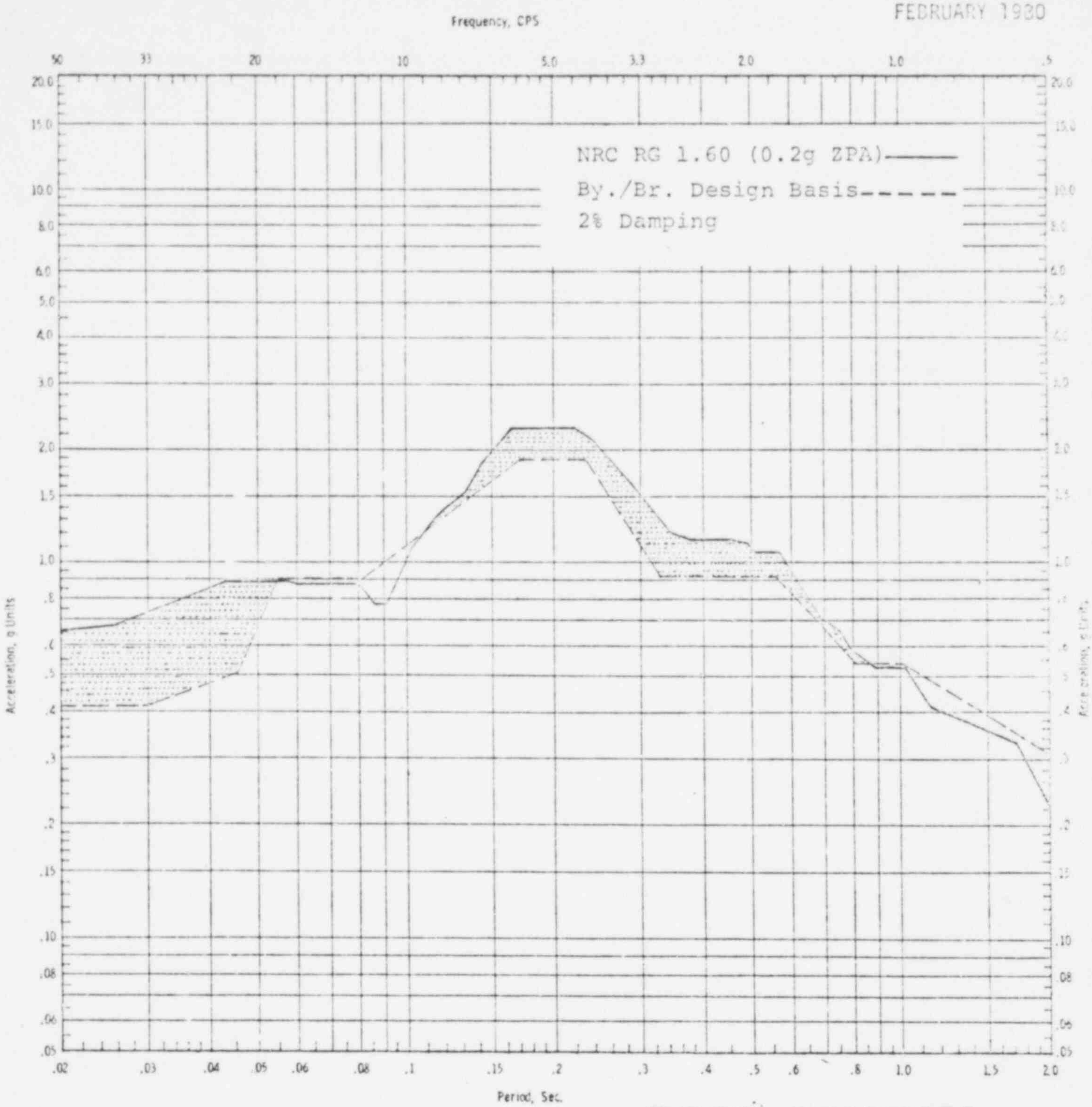
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-87
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 426'-0"



POOR ORIGINAL

1842 273

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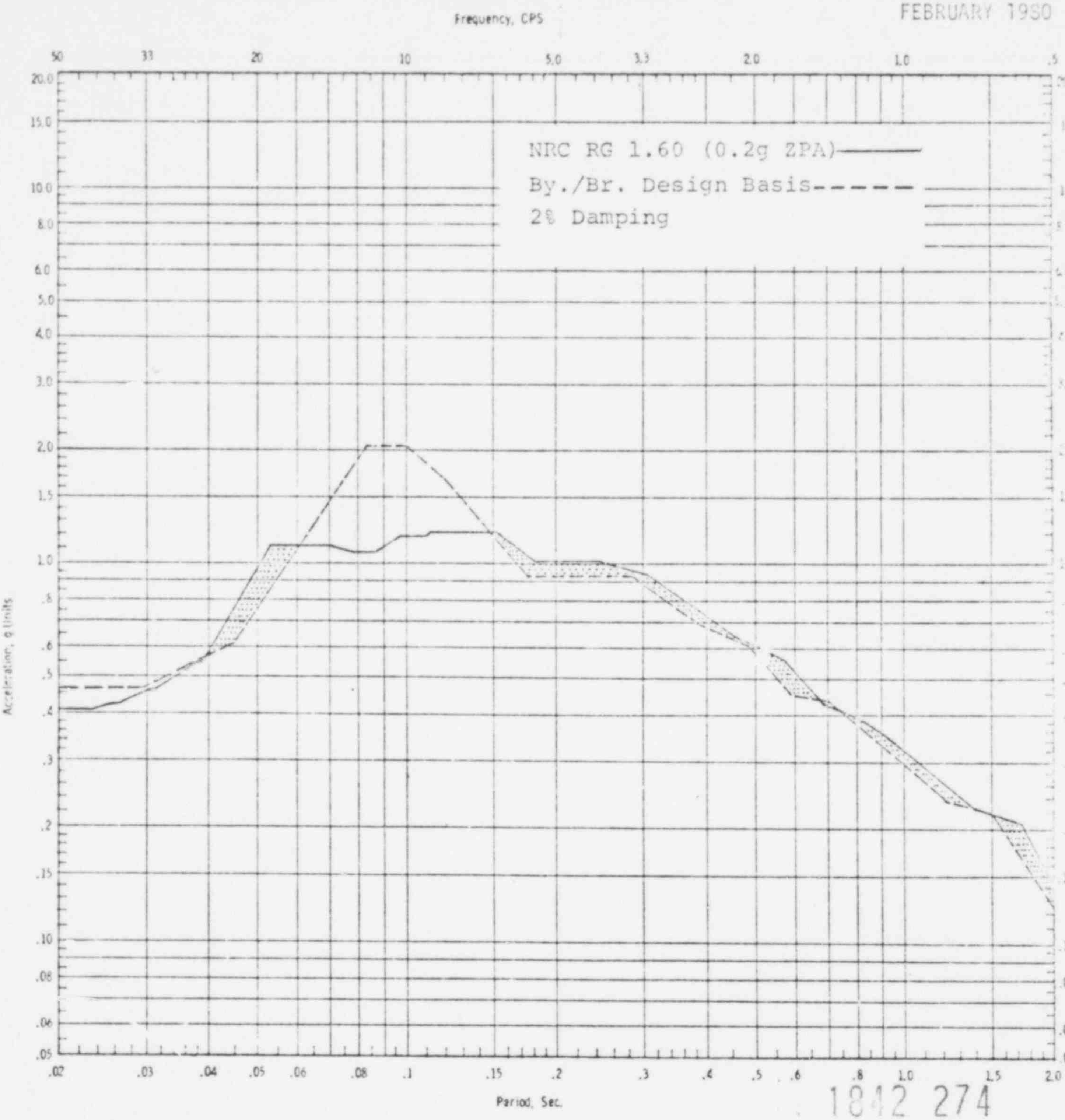
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-88
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 426'-0"



1842 274

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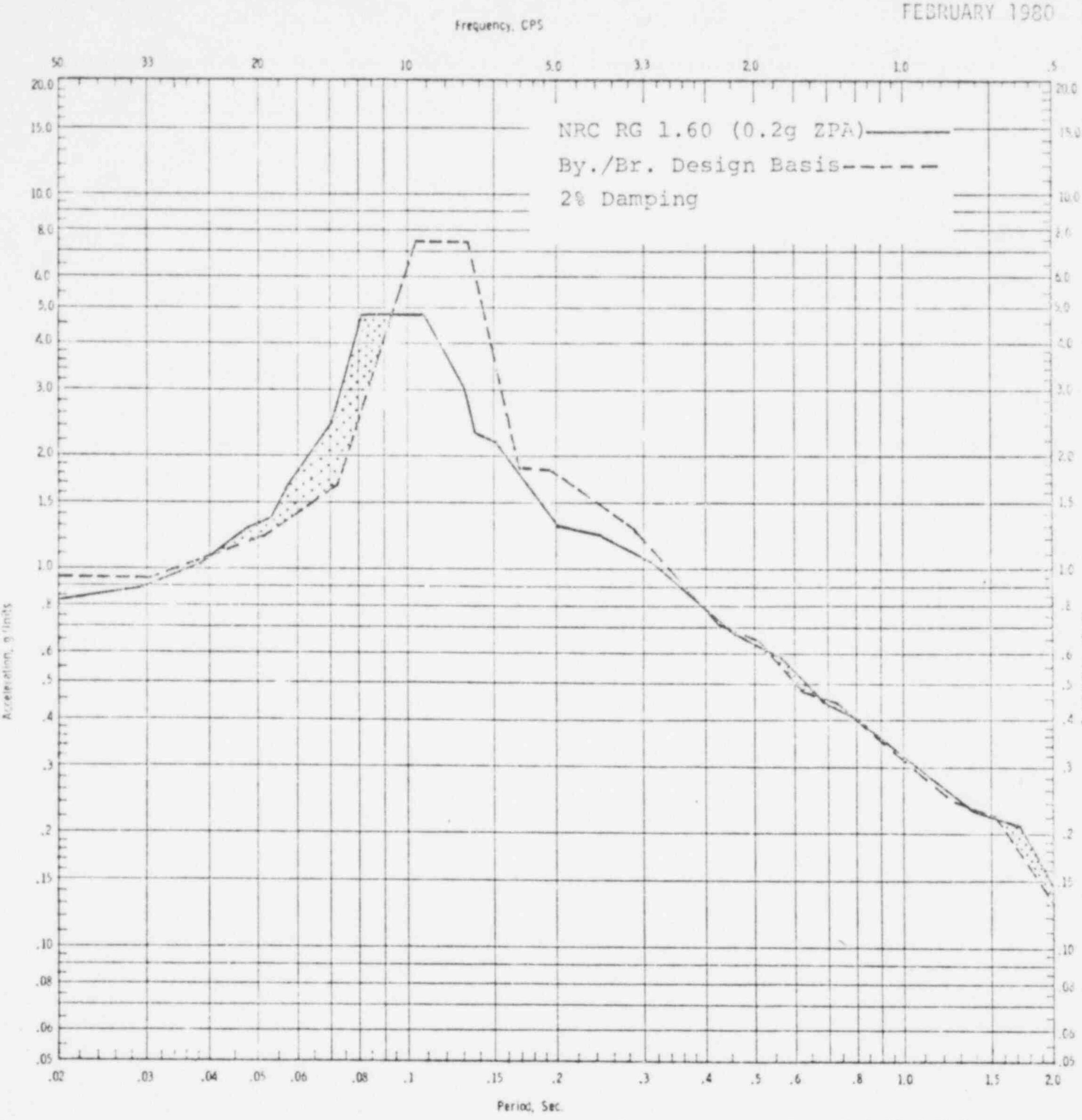
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-89

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 426'-0"; 439'-0"; 451'-0"



POOR ORIGINAL

1842 275

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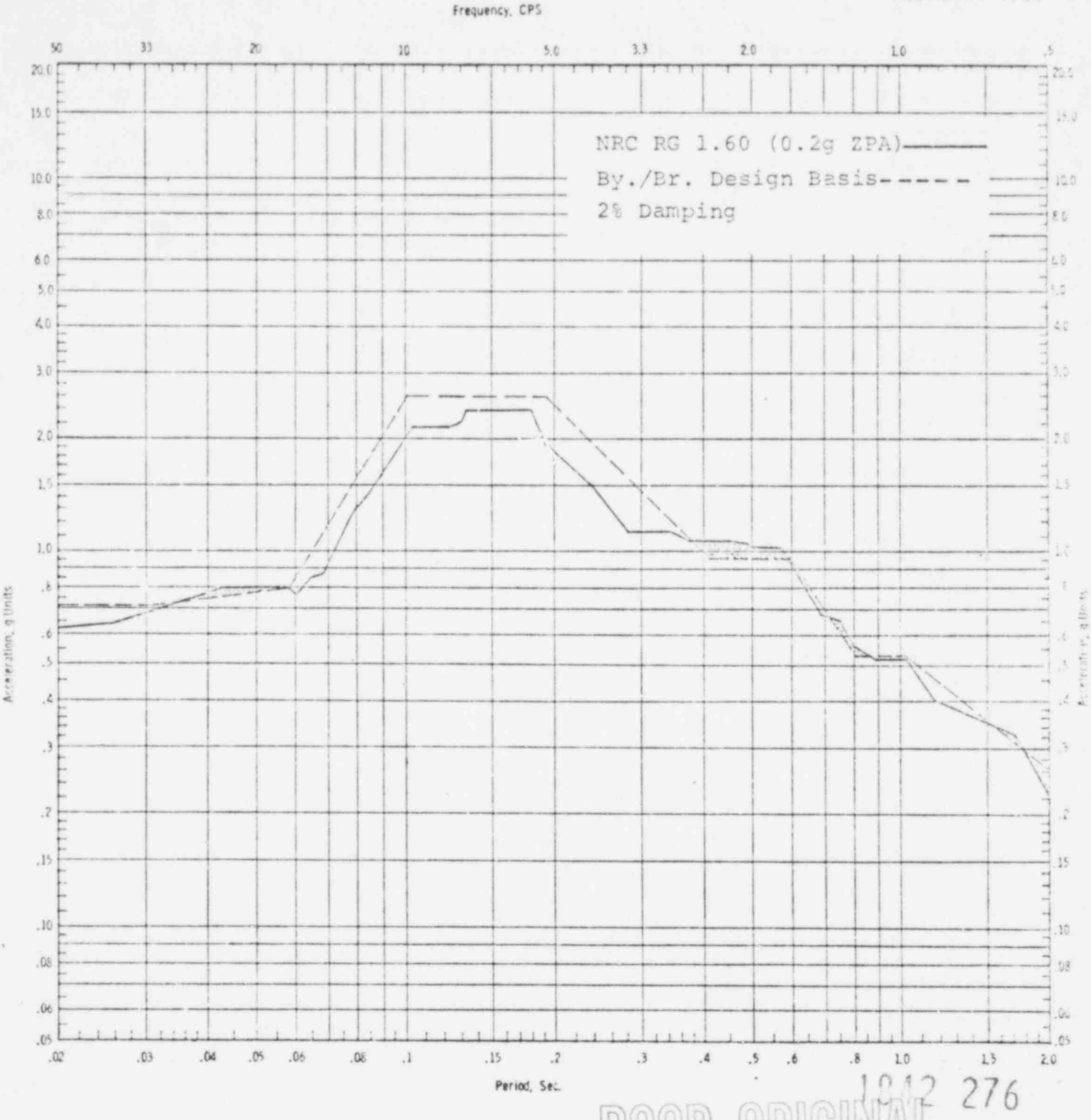
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-90

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 426'-0"; 439'-0"; 451'-0"



1042 276

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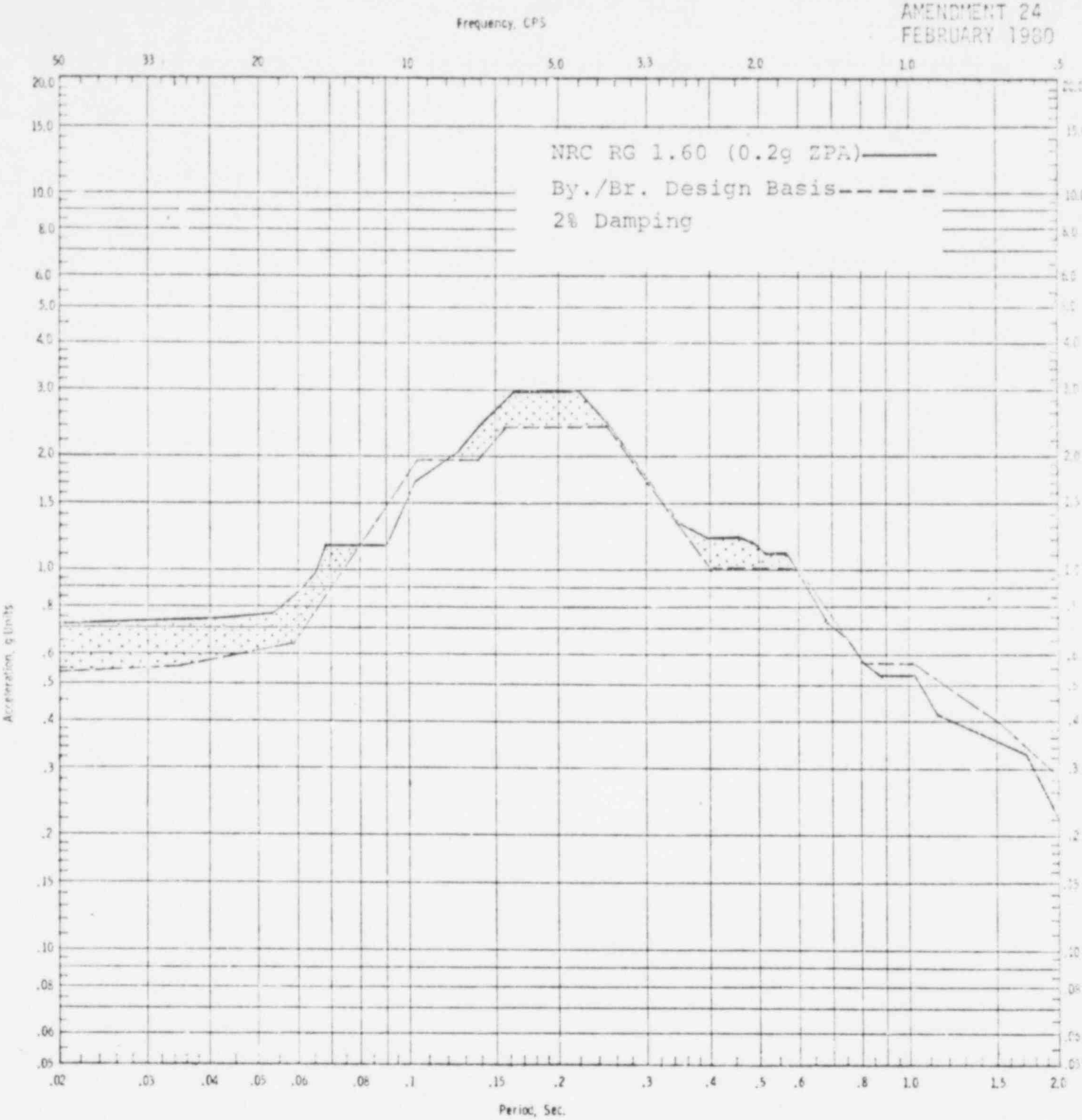
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-91
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 451'-0"



POOR ORIGINAL

1041 277

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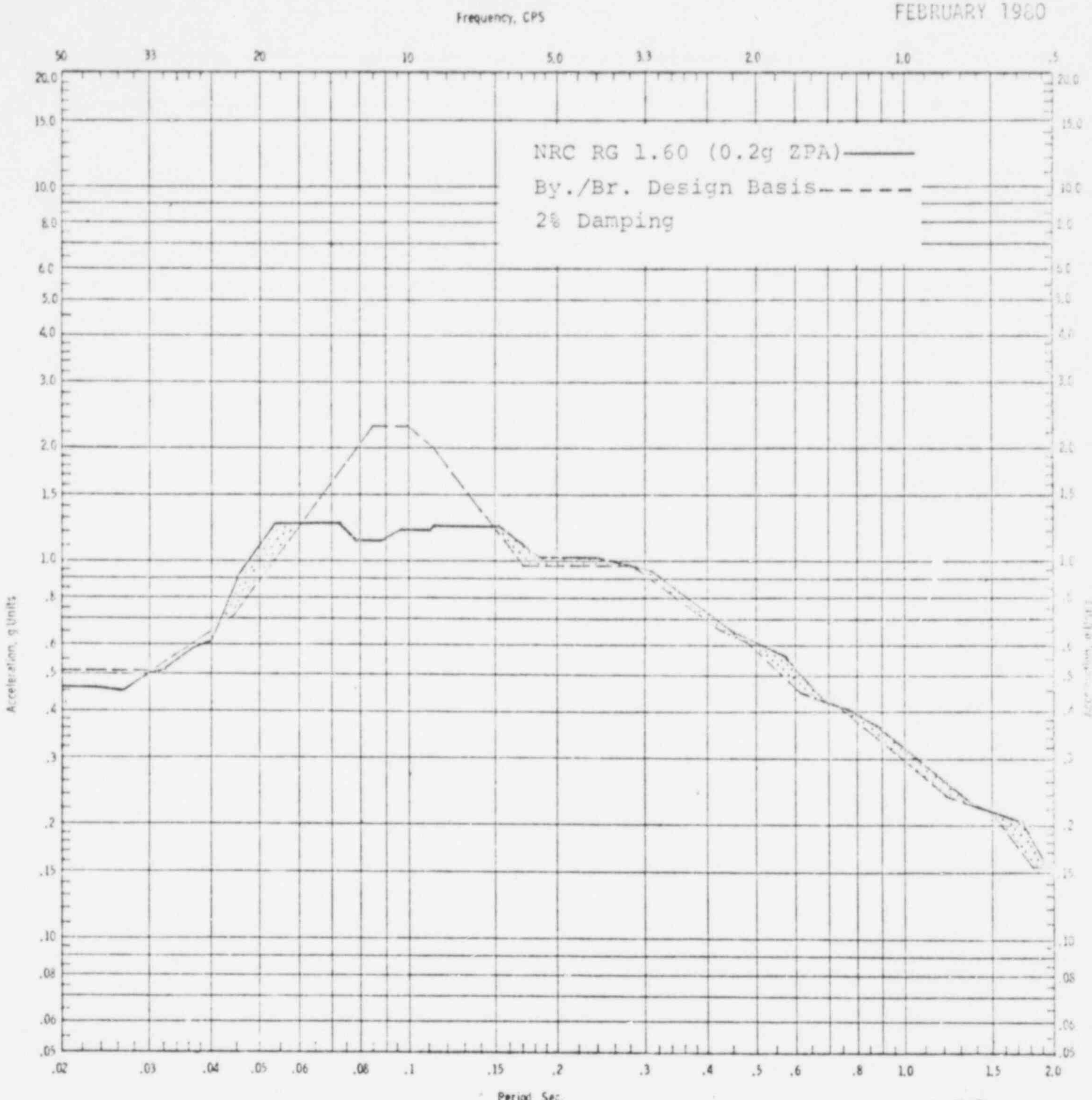
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-92
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING, TURBINE BUILDING, HEATER BAY
ELEVATION: 451'-0"



1942 278

POOR ORIGINAL

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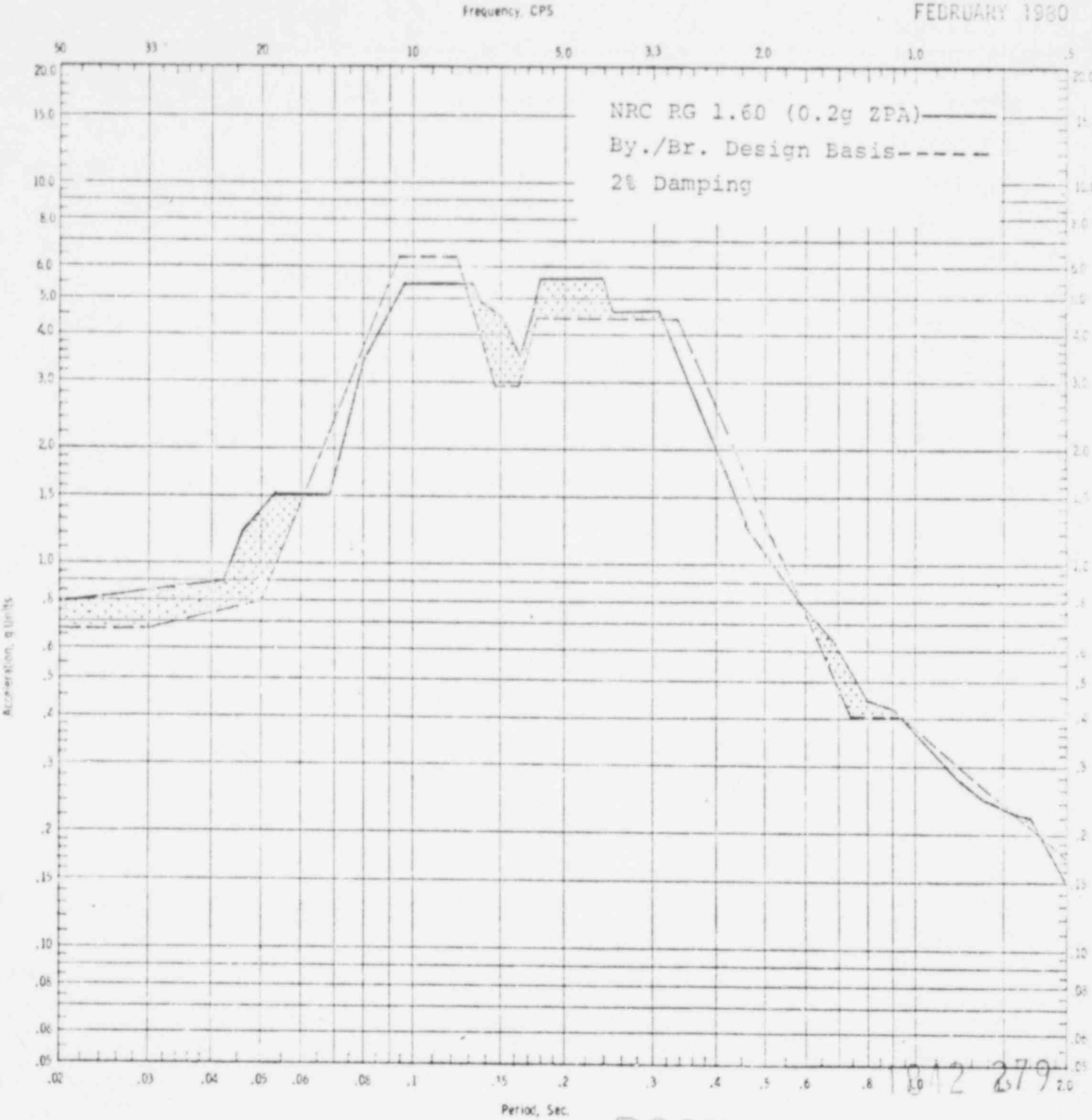
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-93
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: AUXILIARY BUILDING WALL
ELEVATION: 467'-0"; 473'-0"; 477'-0"; 485'-0"

AMENDMENT 24
FEBRUARY 1980



1842 279

POOR ORIGINAL

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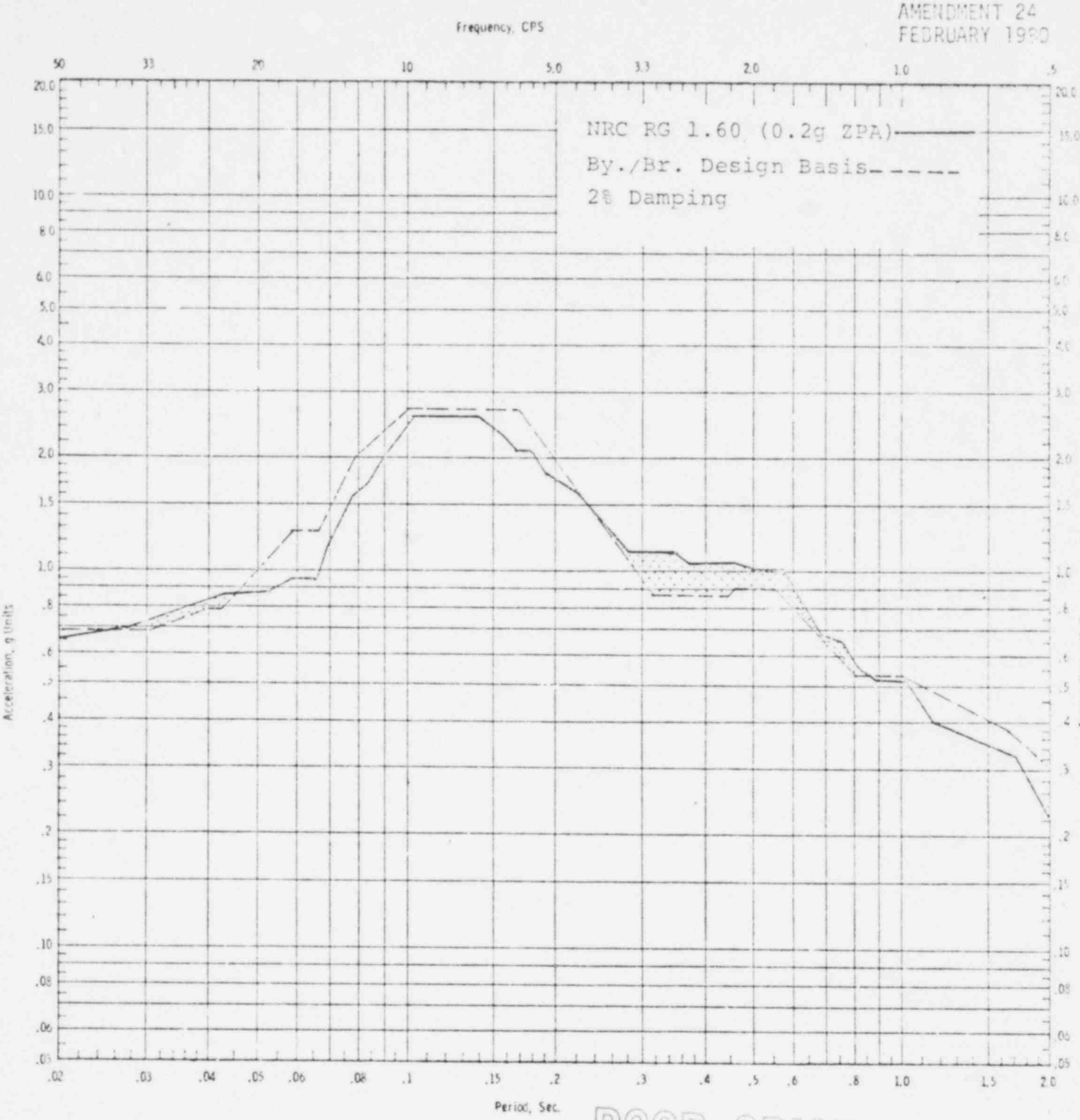
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-94

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, SLAB
LOCATION: AUXILIARY BUILDING SLAB
ELEVATION: 467'-0"; 477'-0"



 1842 280

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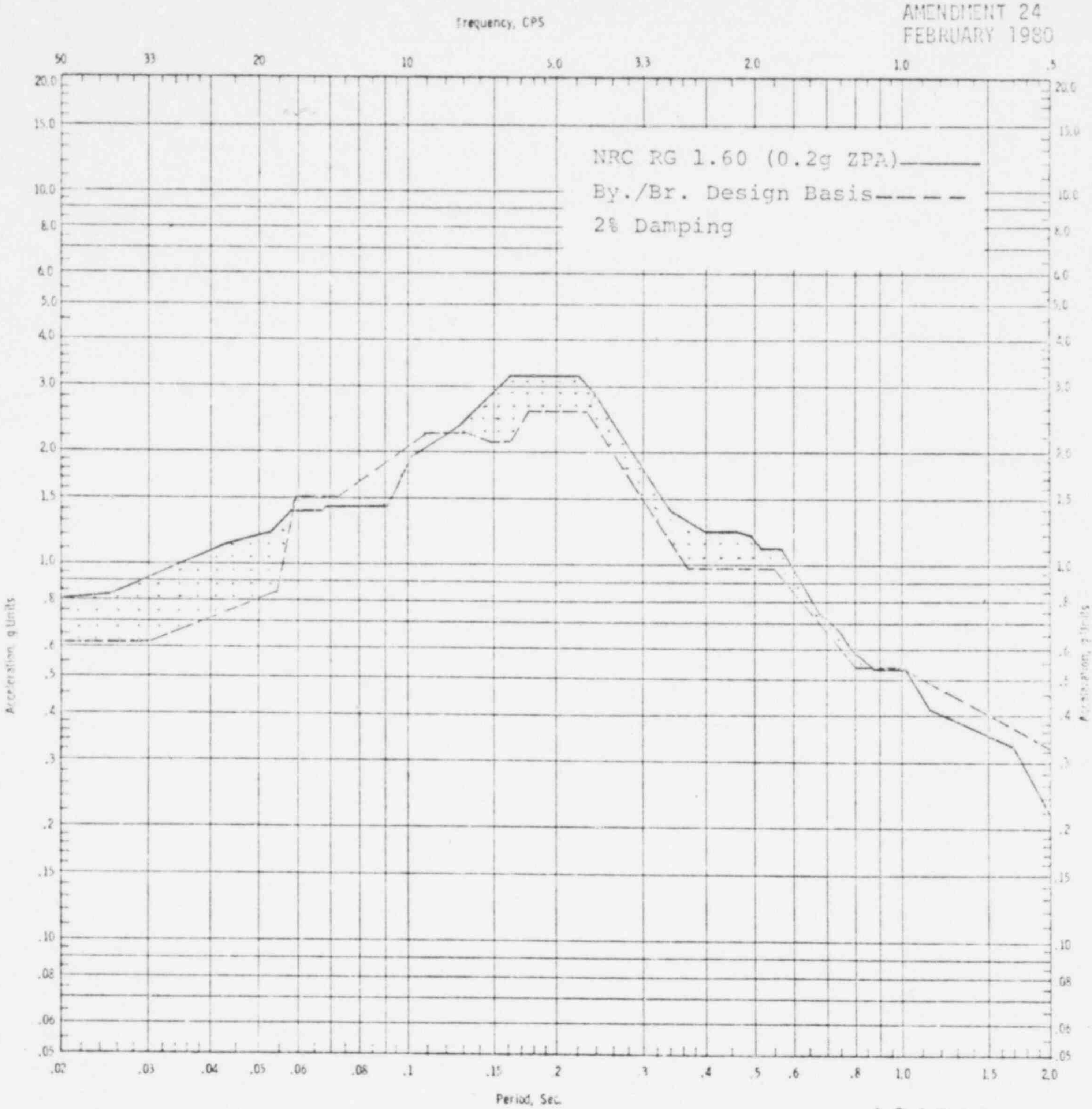
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-95

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS
LOCATION: AUXILIARY BUILDING
ELEVATION: 477'-0"



1842 281

POOR ORIGINAL

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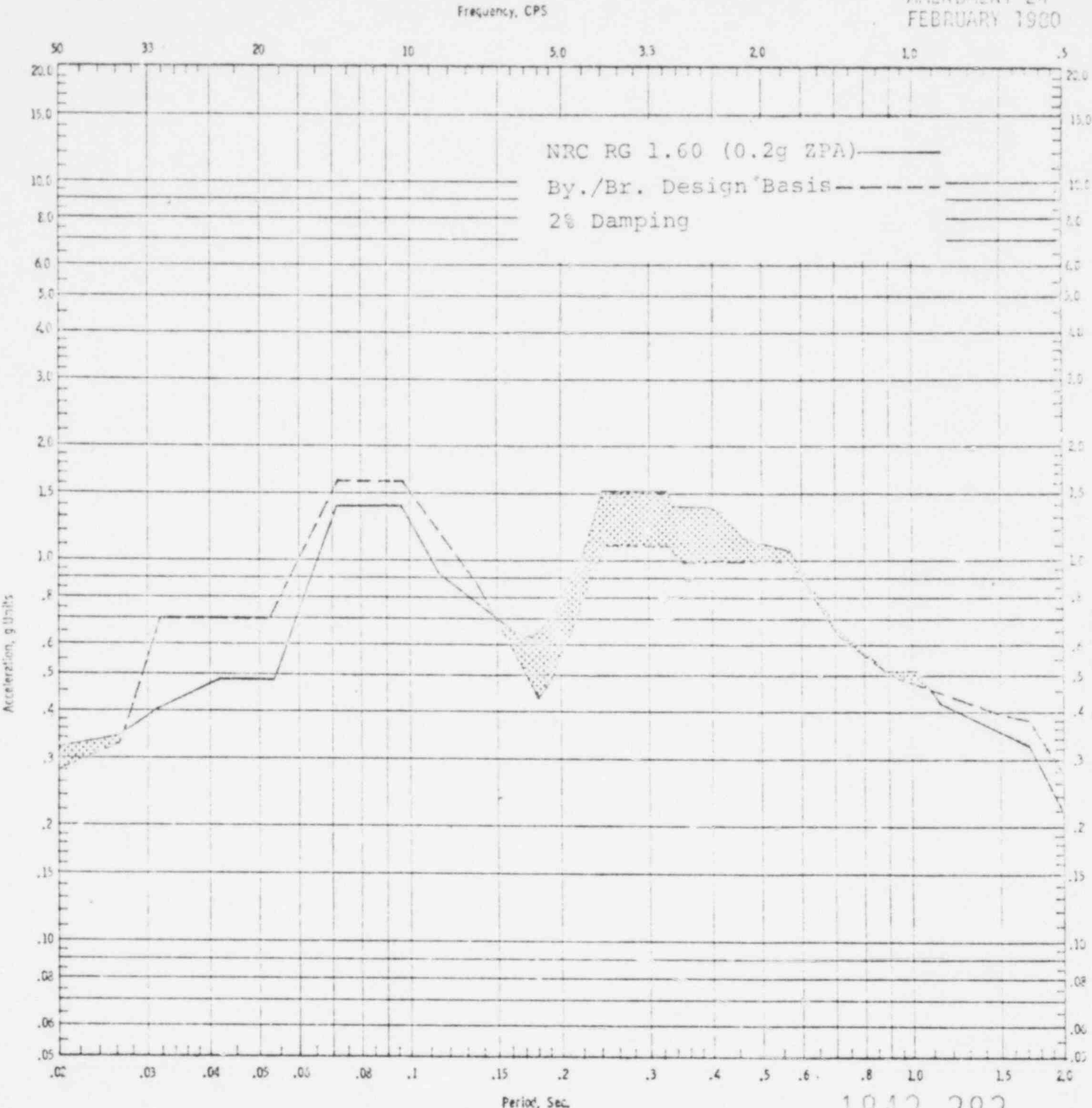
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-96

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, EW
LOCATION: AUXILIARY BUILDING
ELEVATION: 477'-0"



1842 282

POOR ORIGINAL

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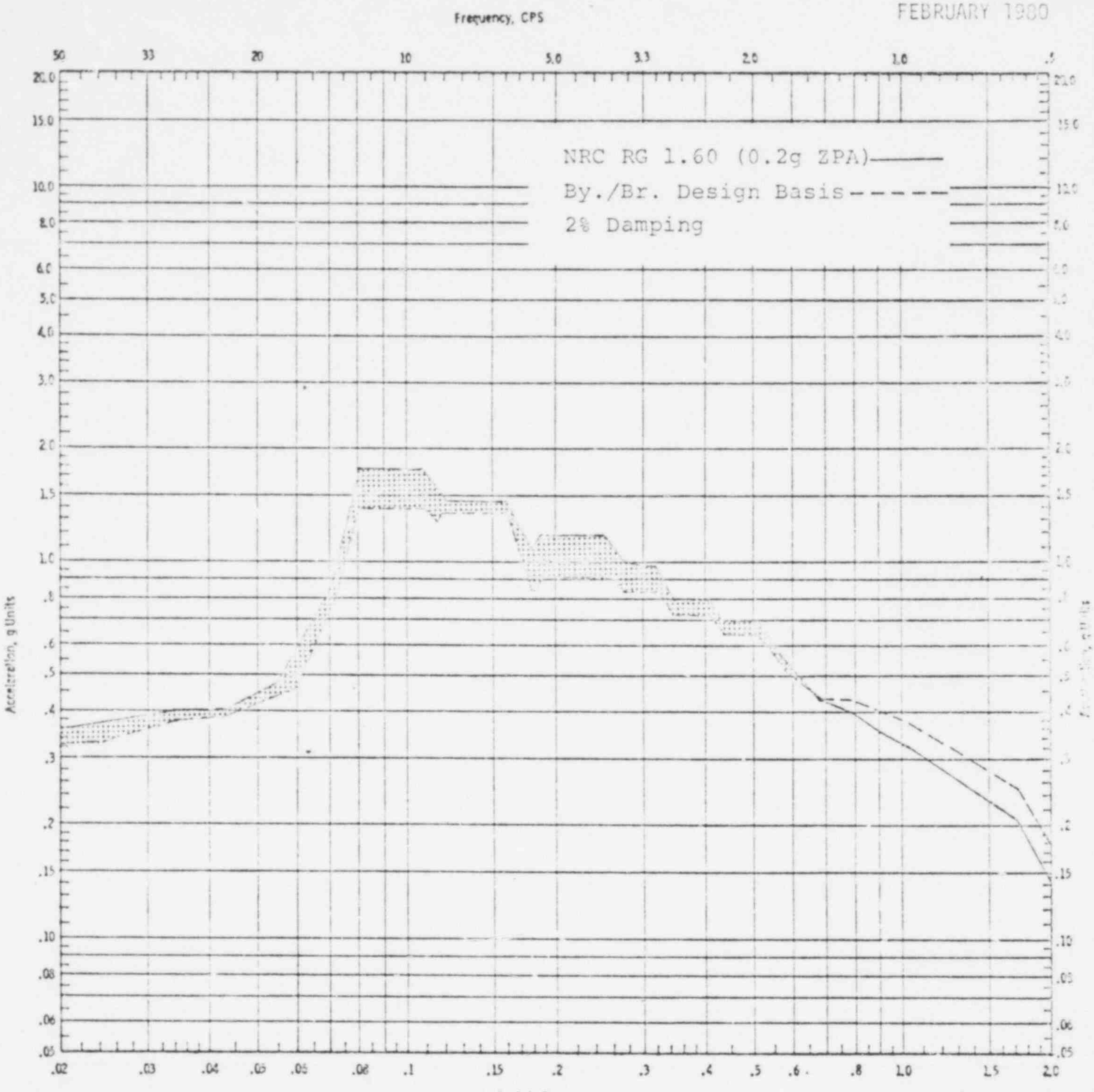
FIGURE Q130.6-97

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS AND EW
LOCATION: CONTAINMENT BUILDING
ELEVATION: 424'-0"; 436'-0"



POOR ORIGINAL

1842 283

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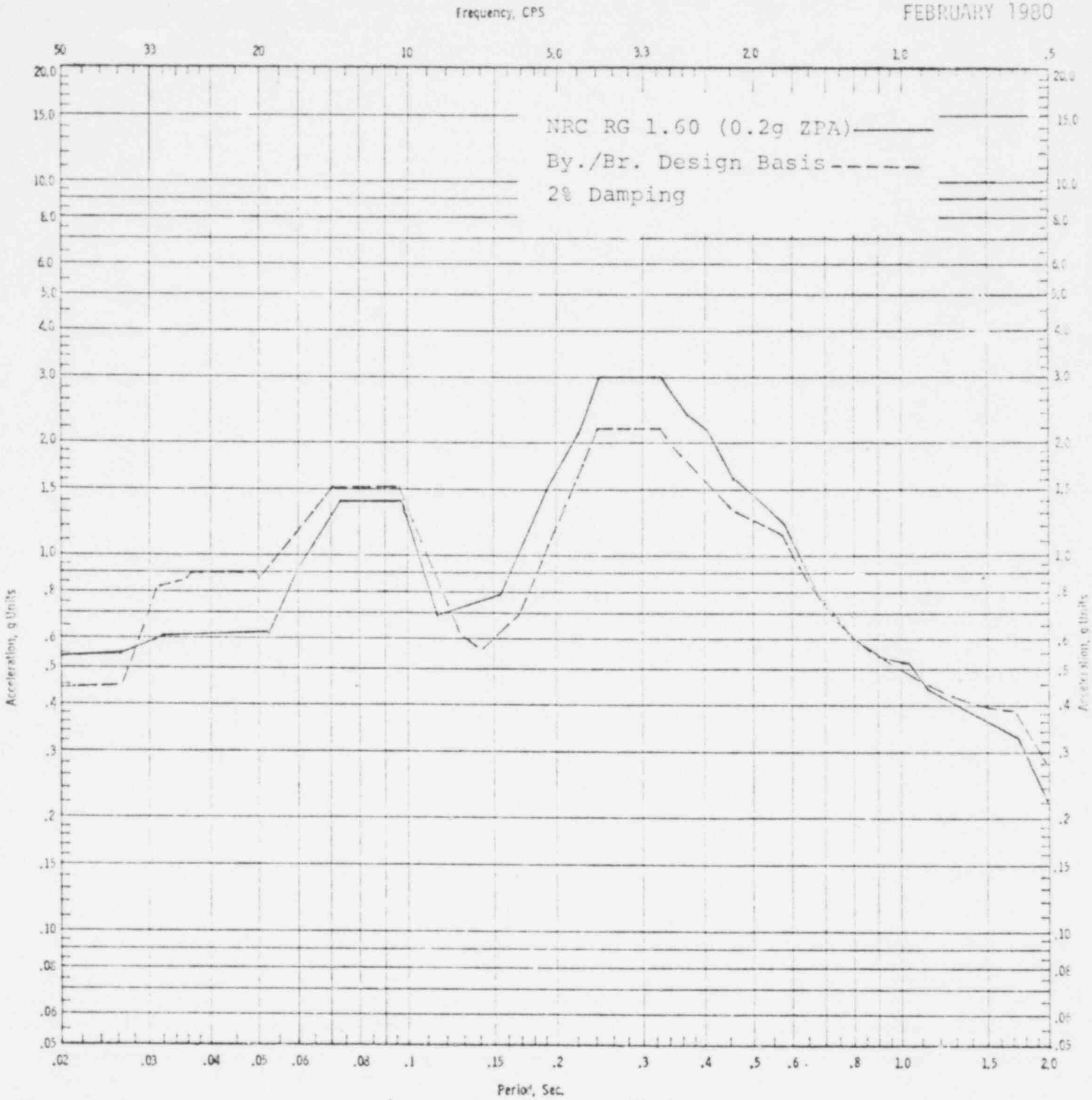
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-98

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: CONTAINMENT BUILDING WALL
ELEVATION: 424'-0"; 436'-0"



POOR ORIGINAL

1842 284

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FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-99

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS AND EW
LOCATION: CONTAINMENT BUILDING
ELEVATION: 496'-0"

POOR ORIGINAL

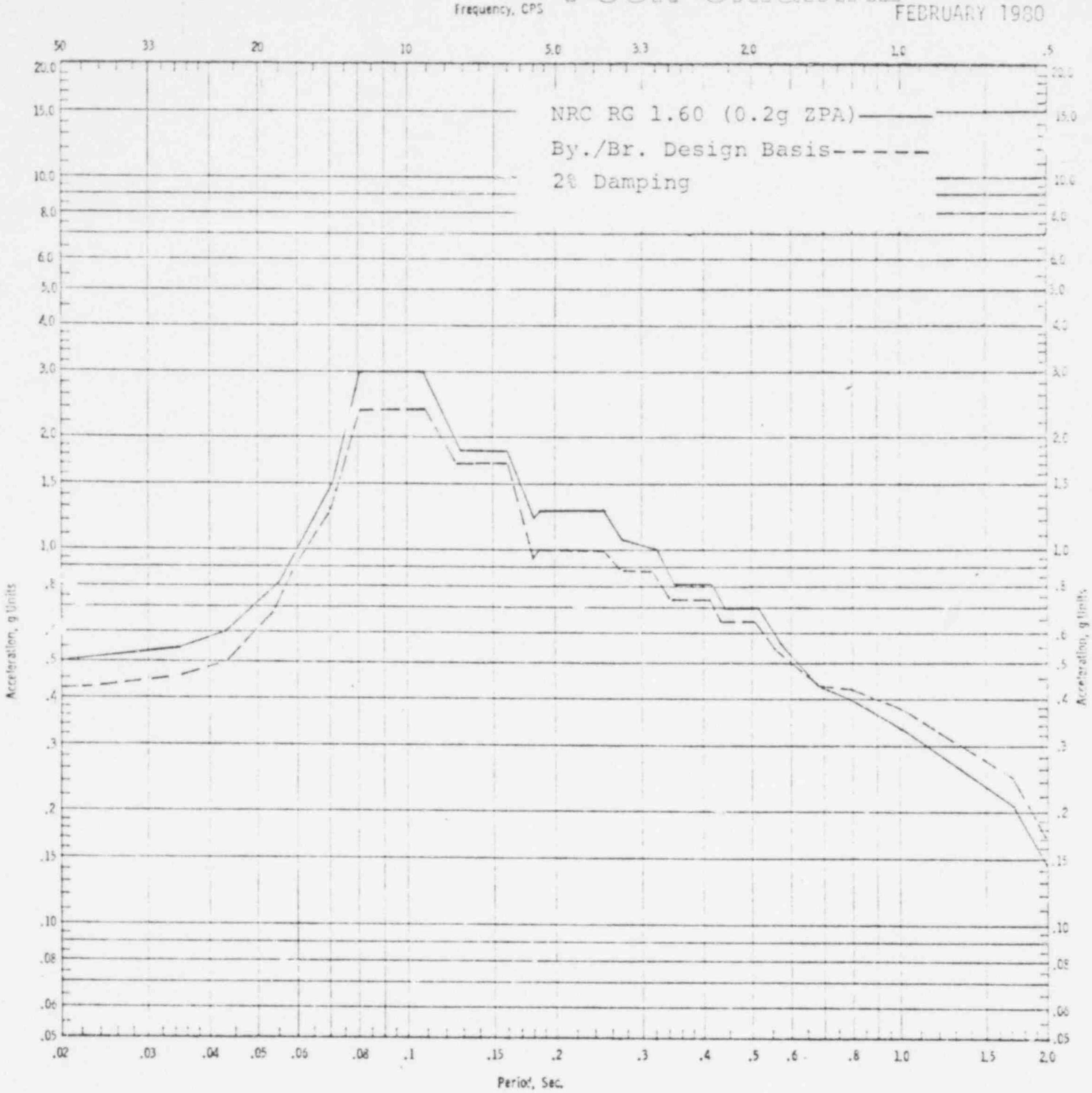

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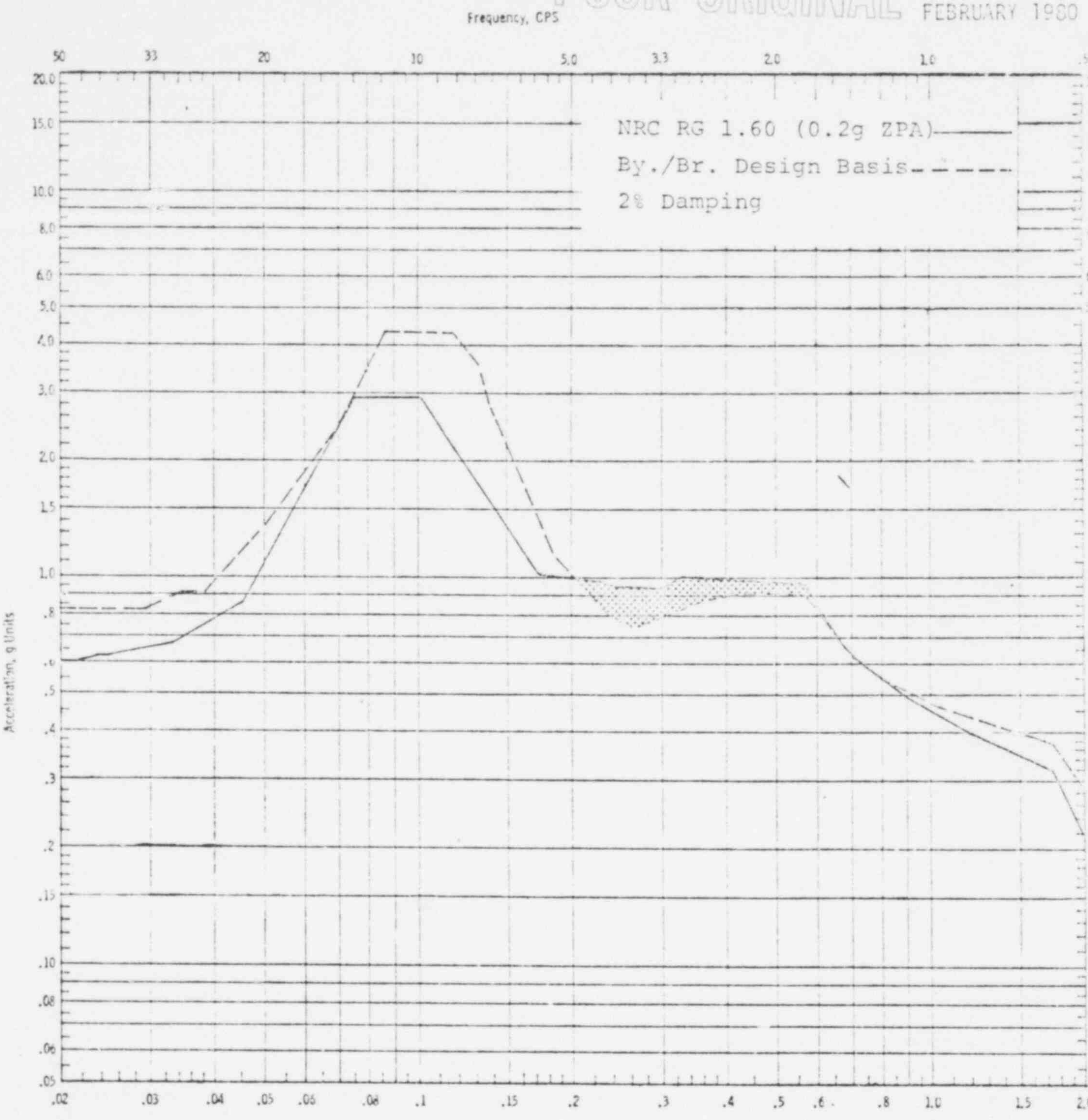
FIGURE Q130.6-100

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: CONTAINMENT BUILDING WALL
ELEVATION: 496'-0"



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FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-101

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, NS
LOCATION: CONTAINMENT INNER STRUCTURES
ELEVATION: 426'-0"

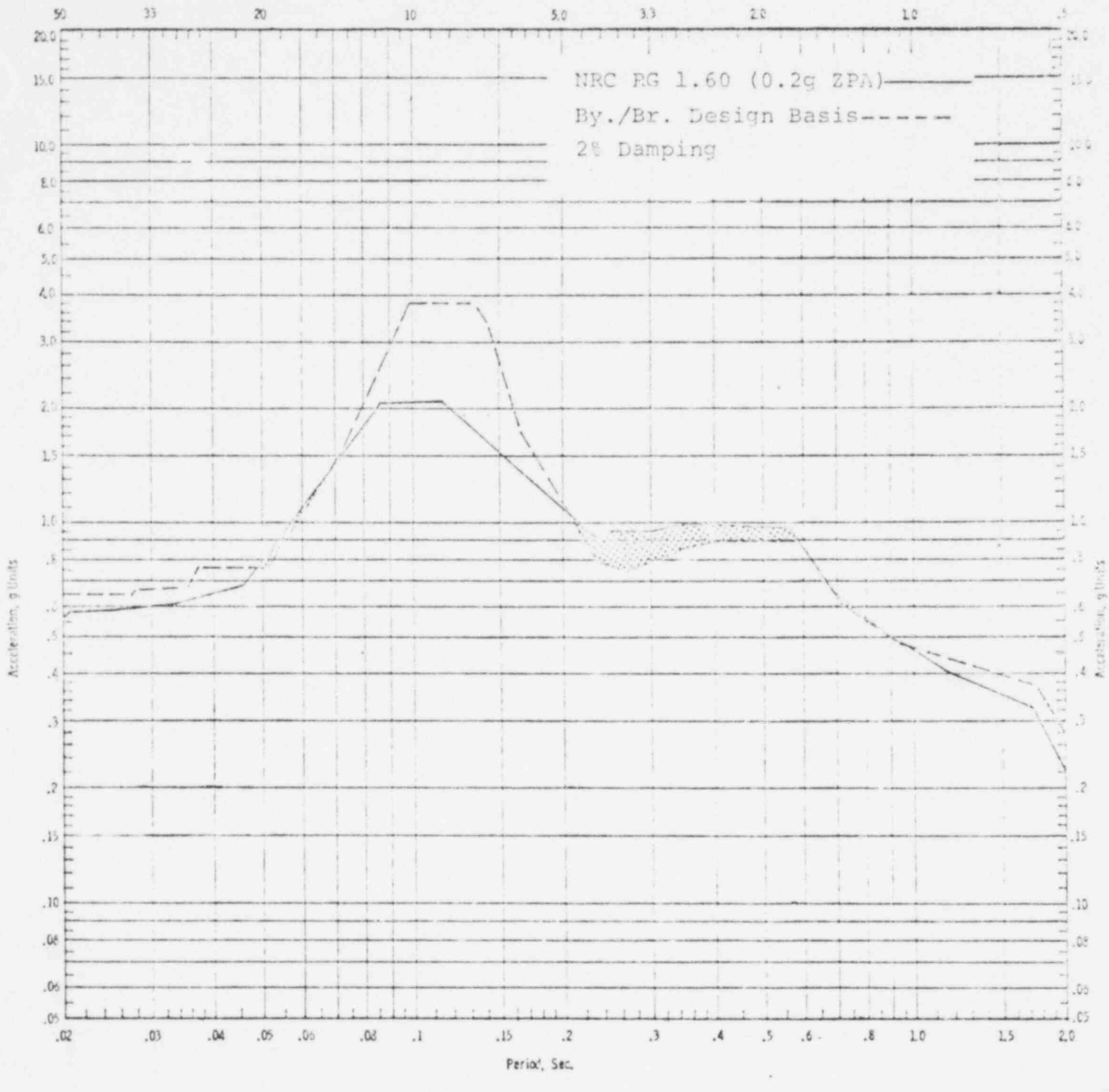

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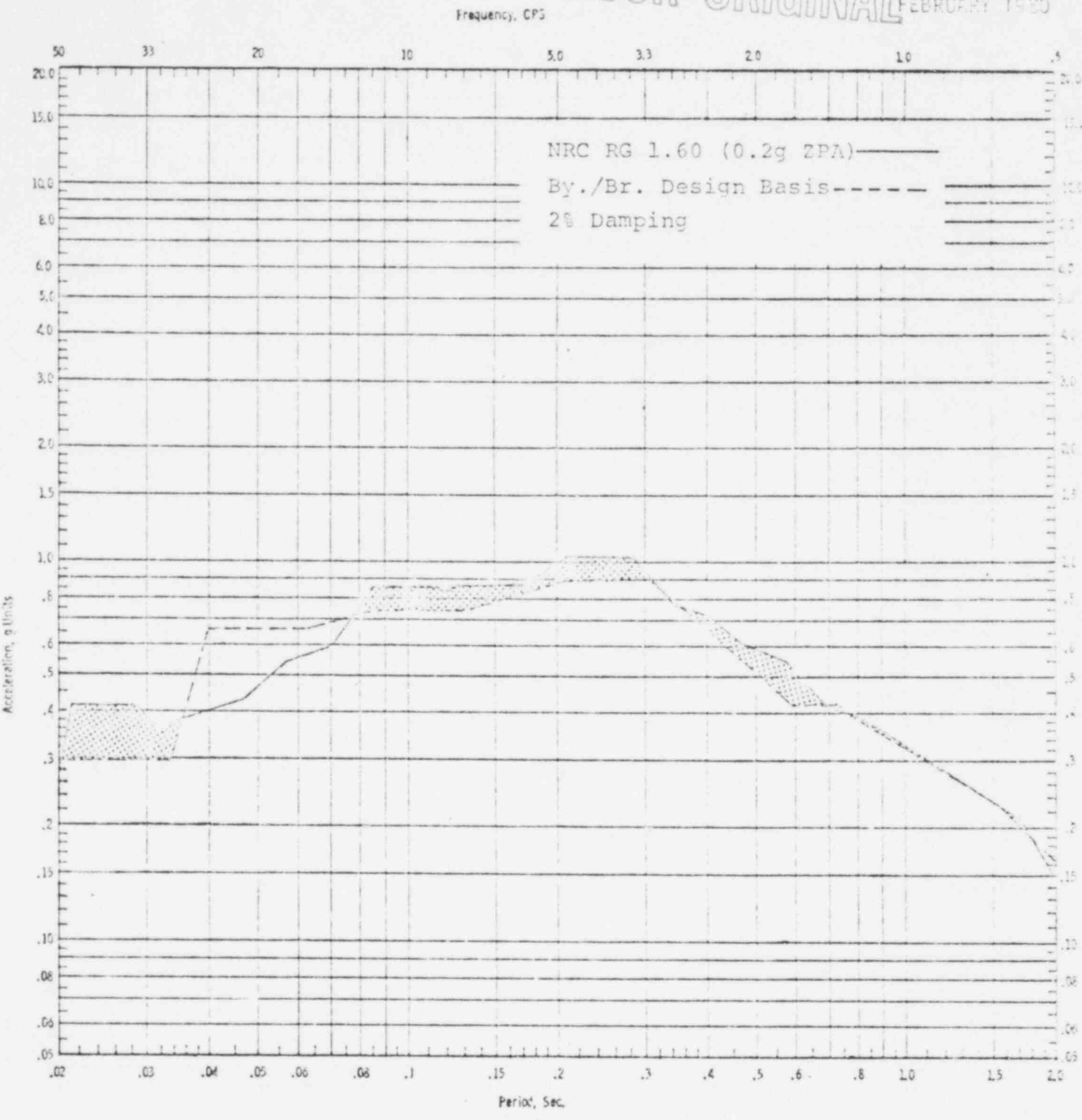
FIGURE Q130.6-102

COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, HORIZONTAL, EW
LOCATION: CONTAINMENT INNER STRUCTURE
ELEVATION: 426'-0"



1842 288

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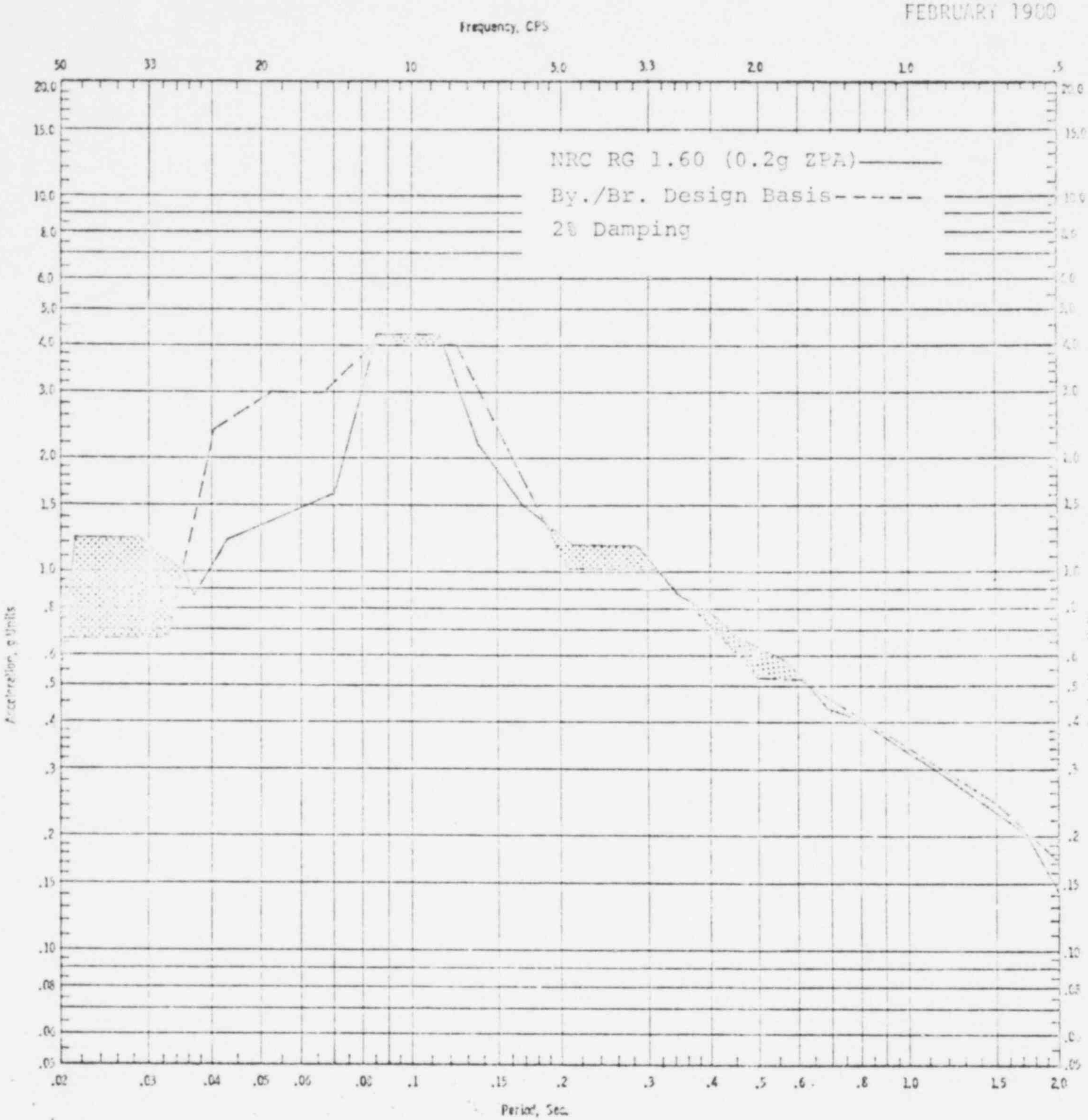
FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-103
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, WALL
LOCATION: CONTAINMENT INNER STRUCTURAL WALL
ELEVATION: 412'-0"; 426'-0"



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POOR ORIGINAL

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FINAL SAFETY ANALYSIS REPORT

FIGURE Q130.6-104
COMPARISON OF B/B AND RG 1.60 SPECTRA
EXCITATION: SSE, VERTICAL, SLAB
LOCATION: CONT. INNER STRUCTURAL SLAB
ELEVATION: 390'-0"; 401'-0"; 412'-0"; 426'-0"

QUESTION 130.09

The river screen house at the Byron Station is founded on soil. Soil-structure interaction analysis was performed using the finite element method. It is the staff's position that the methods for implementing the soil-structure interaction analysis should include both the half-space lumped spring and mass representation and the finite element approaches. Category I structures, systems, and components should be designed to responses obtained by any one of the following methods:

a) Envelope of results of the two methods.

b) Results of one method with conservative design consideration of impact from the use of the other method.

c) Combination of (a) and (b) with provision of adequate conservatism in design.

Therefore, we request that you compare the responses obtained by the half-space (lumped parameter) approach to those obtained by the finite element approach at a few typical locations.

Floor response spectra should be provided at least at the basemat, an intermediate elevation, and an upper elevation. For the lumped parameter representation, the variation of soil properties should be considered.

RESPONSE

The soil-structure interaction responses are generated using the half-space lumped parameter approach. A soil shear modulus corresponding to a low value (10^{-4}%) of strain is used in the analysis. The lower and upper bounds of the soil properties are considered (see Figure 2.5-89 of the FSAR). The soil properties under the river screen house vary with depth. The average soil properties shown in Table 130.09-1 were used in the elastic half-space soil spring analysis. The translational, rocking and vertical soil-spring constants are computed based on these soil properties and formulas provided in Reference 1. The numerical values of soil spring constants are shown in Table 130.09-2.

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The horizontal floor response spectra at the basemat (el. 664'), an intermediate elevation (el. 702'), and the roof (el. 744') are presented in Figures 130.09-1 through 130.09-6 for the OBE and in Figures 130.09-7 through 130.09-12 for the SSE. The response spectra are generated for 1% damping for OBE and 2% damping for SSE. The dot-dash line represents the design basis, using the finite element method (FEM). The solid line and dash line are those obtained by the half-space solution using the lower and upper bounds, respectively, of the soil properties. Table 130.09-3 lists the comparison of the selected shear wall forces obtained using the soil spring soil-structure interaction (SSI) response spectra and the finite element SSI response spectra. Figures 130.09-13 and 130.09-14 provide the locations of the shear walls. The shear walls were evaluated to these higher forces and the stresses were found to be within the allowable.

The vertical soil-structure interaction analysis using the half-space approach has also been performed. The vertical floor response spectra at the basemat (el. 664'), and intermediate elevation (el. 702'), and the roof (el. 744') are presented in Figures 130.09-15 through 130.09-17 for the OBE and in Figures 130.09-18 through 130.09-20 for the SSE. The response spectra are generated for 1% damping for OBE and 2% damping for SSE. The dot-dash line represents the design basis, using the finite element method (FEM). The solid line and dash line are those obtained by the half-space solution using the lower and upper bounds, respectively, of the soil properties.

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The higher responses, when the soil spring method is used, can be attributed directly to the conservative assumptions which are made in the analysis as compared to those used in the finite element method: (i) the river screen house is a deeply embedded structure, yet the soil spring method used required that the embedment be neglected; (ii) the soil properties vary with depth, as shown in Figure 2.5-89 of the FSAR; an average soil layer property was used in the soil spring method; (iii) the soil shear modulus corresponding to low shear strain and no material damping were used in the soil spring method, while more realistic strain-dependent shear modulus and damping values were used in the finite element method; (iv) in the present B/B seismic design criteria, RG 1.60 spectra are obtained at the surface and deconvolution analysis is used to obtain foundation elevation motions in the free field. These free field motions were used in the finite element SSI analysis; in the present soil spring analysis the RG 1.60 spectra are applied at the foundation elevation.

In view of these assumptions, we feel that the soil spring SSI results are overly conservative. Accordingly, mechanical and electrical components and equipment will not be qualified to meet these overly conservative floor response spectra.

REFERENCE

1. "Analysis for Soil-Structure Interaction Effects for Nuclear Power Plants," Report by the Ad-Hoc Group on SSI of the Structural Division of ASCE, November 1978.

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TABLE 130.09-1 AVERAGE SOIL PROPERTIES AT THE RIVER SCREEN HOUSE SITE

	Shear Modulus (K/FT^2)	Poisson's Ratio	Weight Density (KIP/FT^3)
Lower Bound	3324	0.42	0.123
Upper Bound	4627	0.42	0.123

Table 130.09-2 Spring and Dashpot Constants Numerical Values

Parameter*	Units	(Upper Bound)	(Lower Bound)
Translational Stiffness, K_x	lb/in	10.994×10^7	7.898×10^7
Translational Stiffness, K_y	lb/in	10.994×10^7	7.898×10^7
Rocking Stiffness, K_ψ^x	lb-in/rad	8.106×10^{13}	5.823×10^{13}
Rocking Stiffness, K_ψ^y	lb-in/rad	3.127×10^{13}	2.246×10^{13}
Translational Damping, C_x	lb-sec/in	3.259×10^6	2.763×10^6
Translational Damping, C_y	lb-sec/in	3.259×10^6	2.763×10^6
Rocking Damping, C_ψ^x	lb-in-sec/rad	1.459×10^{12}	1.236×10^{12}
Rocking Damping, C_ψ^y	lb-in-sec/rad	3.935×10^{11}	3.335×10^{11}
Vertical Stiffness, K_z	lb/in	14.350×10^7	10.310×10^7
Vertical Damping, C_z	lb-sec/in	6.278×10^6	4.510×10^6

*The foundation shape and coordinate axes considered in the analysis are shown below:

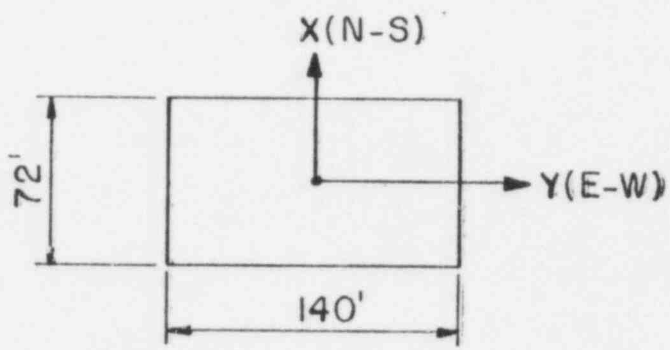

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Table 130.09-3 Comparison of Shear Wall Forces From Finite Element and Soil Spring Approaches

Shear Wall Spring No.	OBE FEM* (kips)	OBE SSM** (kips)	SSE FEM (kips)	SSE SSM (kips)
X-1011	154	271	287	497
X-1012	198	356	391	670
X-1013	33	61	73	120
X-1014	33	61	73	120
X-1015	88	163	198	325
X-1016	28	53	65	106
X-1017	28	53	65	106
X-1018	46	86	108	175
Y-1021	9	16	22	35
Y-1022	9	16	22	35
Y-1023	102	185	250	403
Y-1024	62	114	155	247
Y-1025	63	115	155	250
Y-1026	168	311	424	670
Y-1027	170	314	424	680

*Finite element method
**Soil spring method

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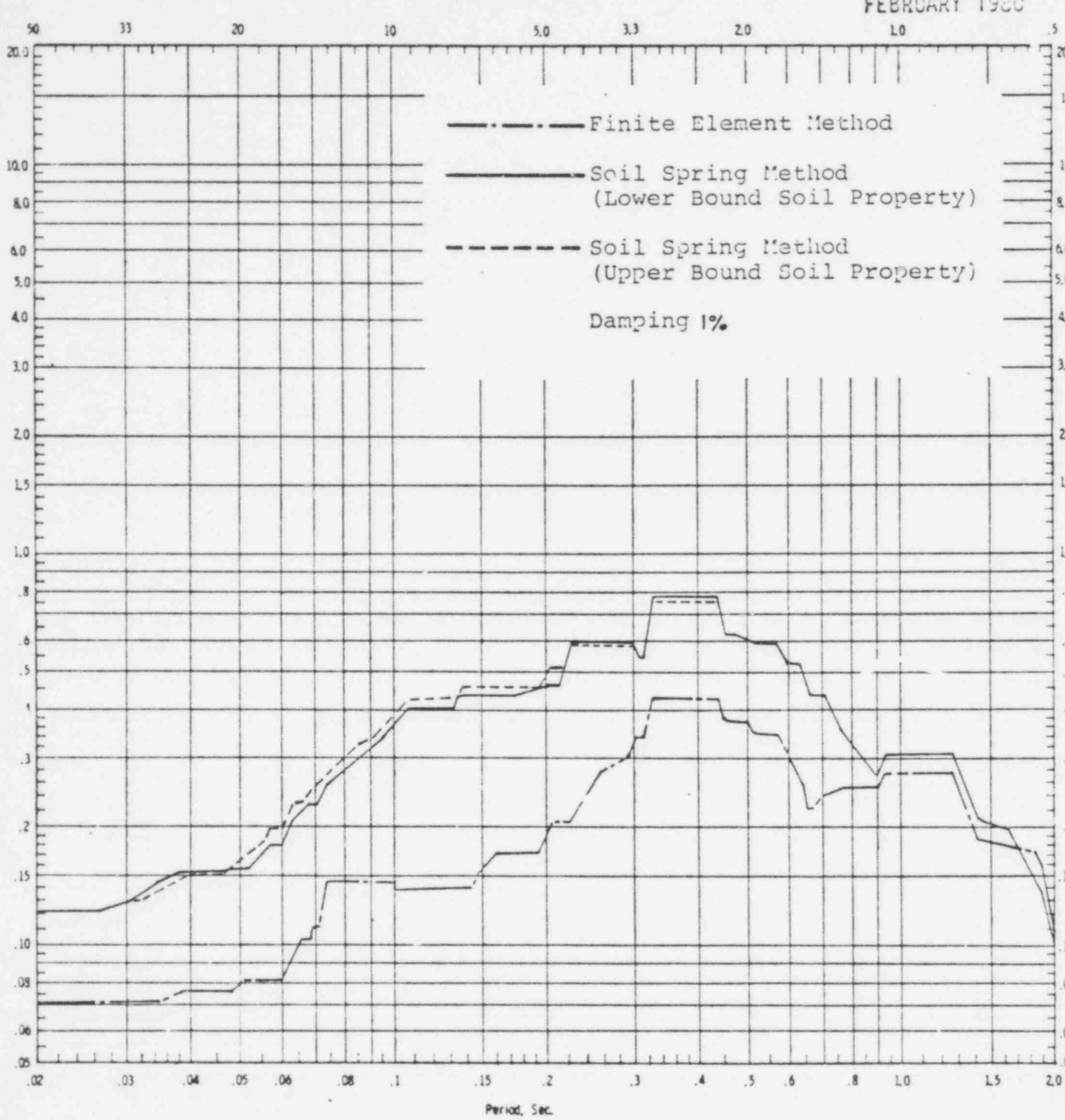

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FIGURE Q130.9-1

RIVER SCREEN HOUSE HORIZONTAL EW
OBE SPECTRA AT EL. 664'-0"

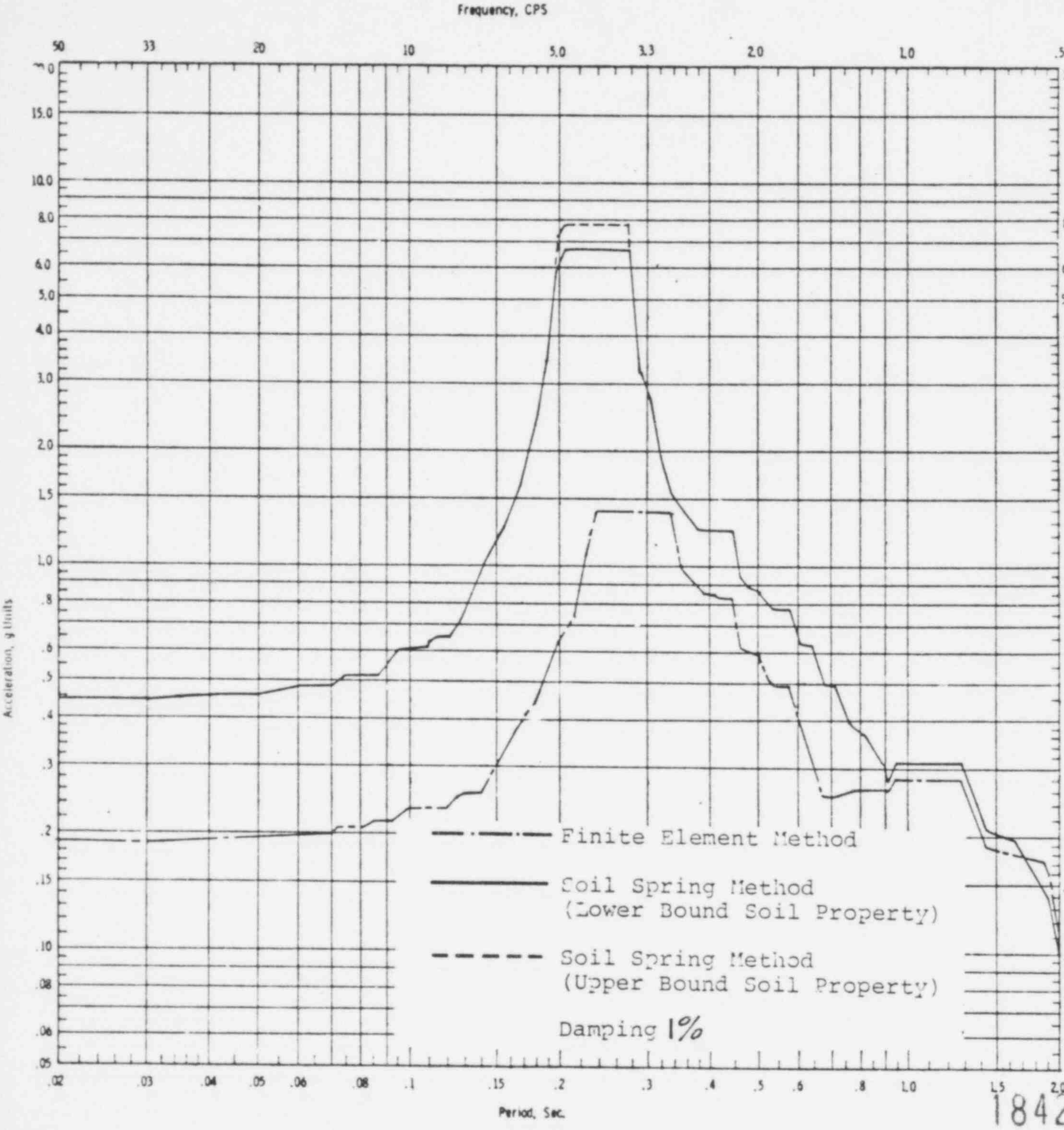

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FIGURE Q130.9-2

RIVER SCREEN HOUSE HORIZONTAL EW OBE SPECTRA AT EL. 702'-0"

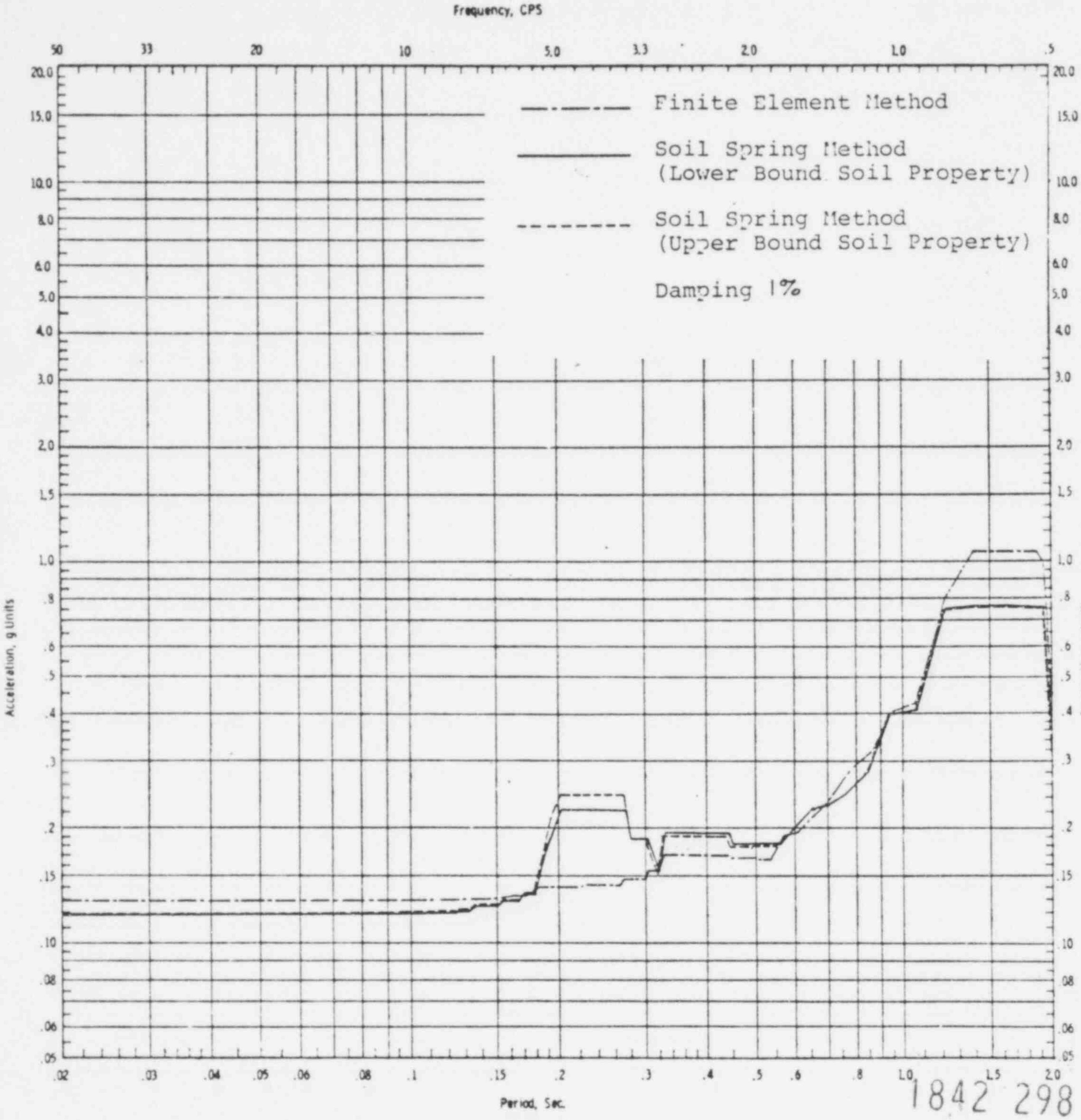

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FIGURE Q130.9-3

RIVER SCREEN HOUSE HORIZONTAL EW
OBE SPECTRA AT EL. 744'-0"

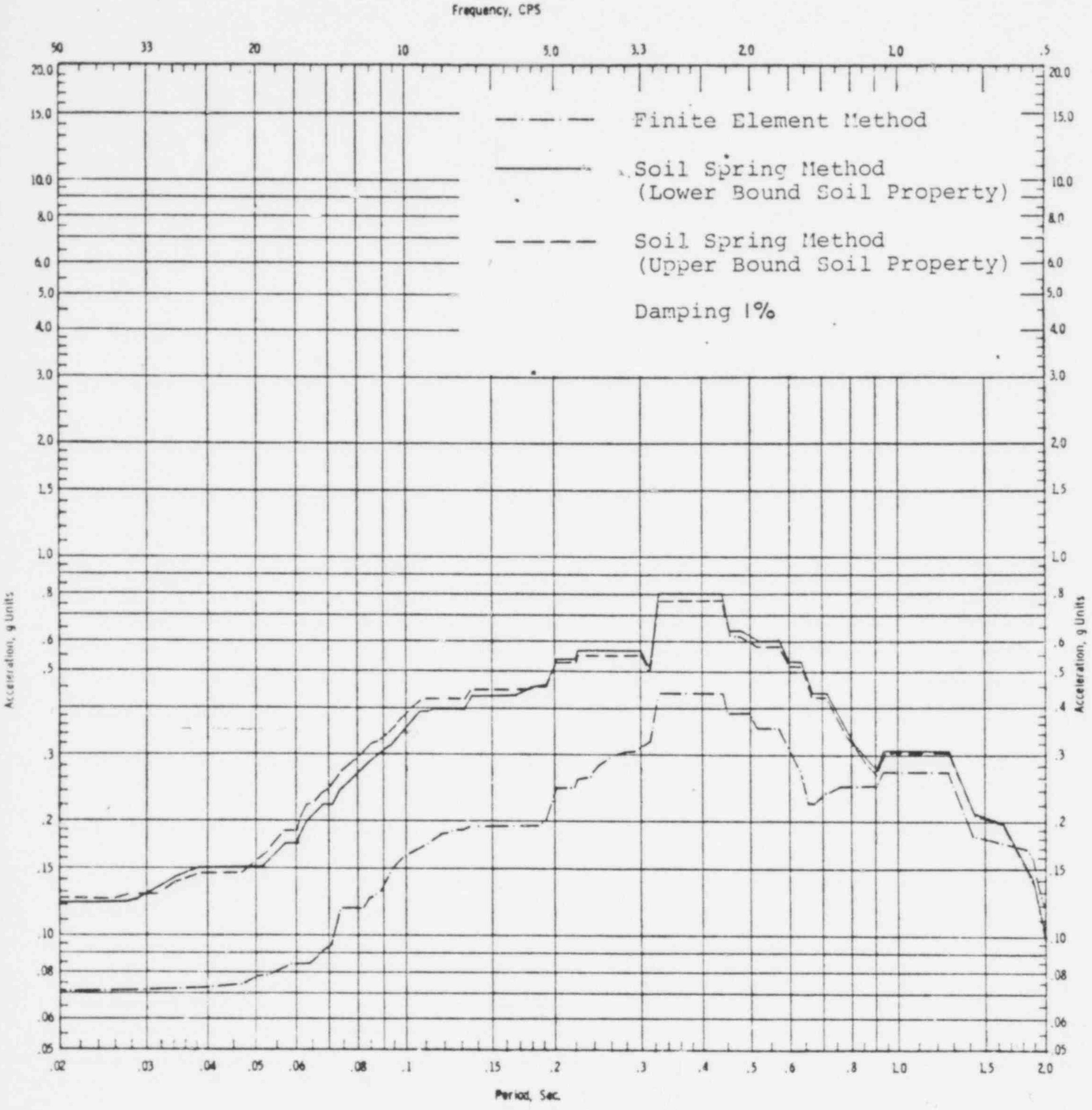

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FIGURE Q130.9-4

RIVER SCREEN HOUSE HORIZONTAL NS
OBE SPECTRA AT EL. 664'-0"

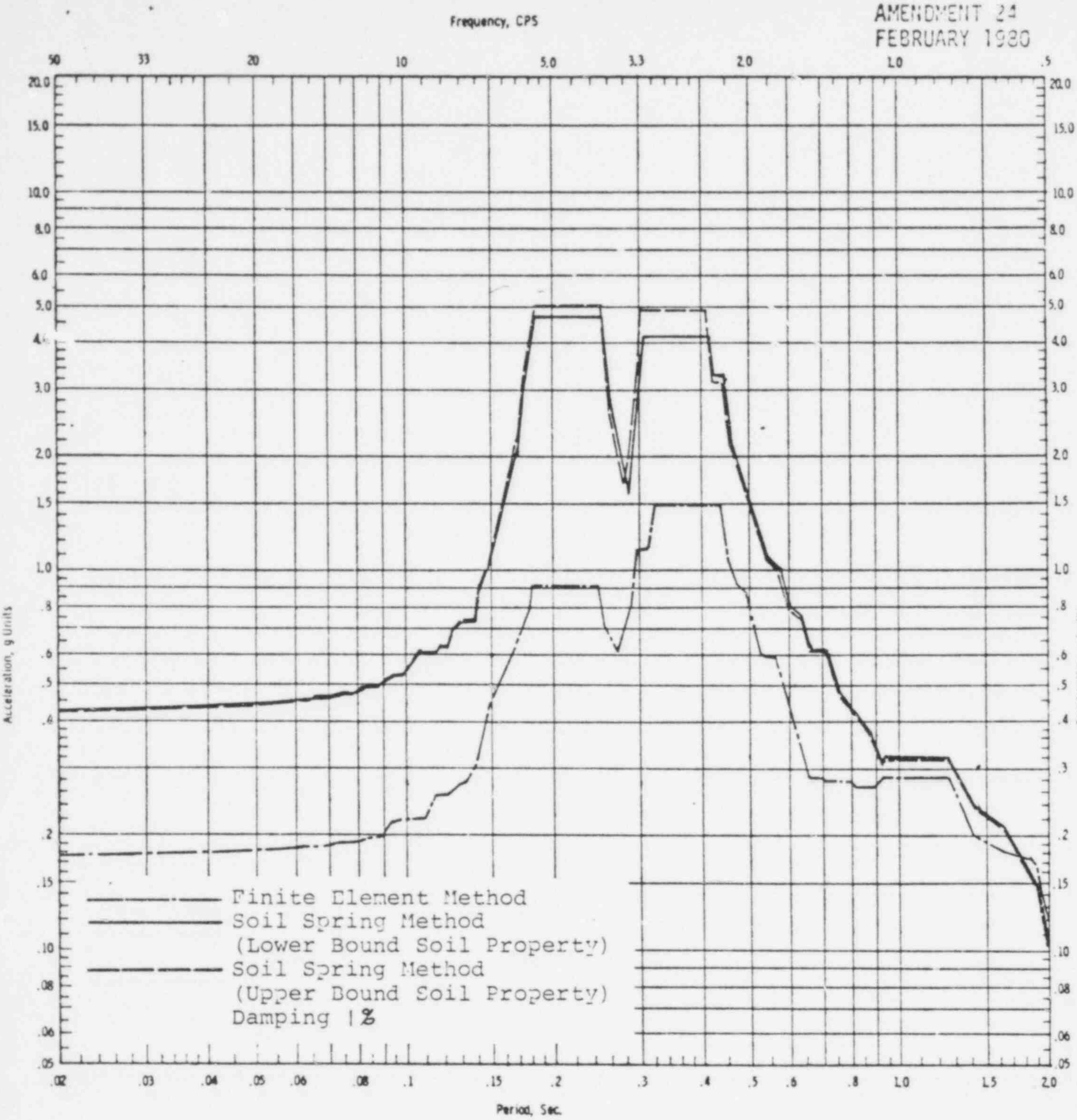

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FIGURE Q130.9-5

RIVER SCREEN HOUSE HORIZONTAL NS
OBE SPECTRA AT EL. 702'-0"

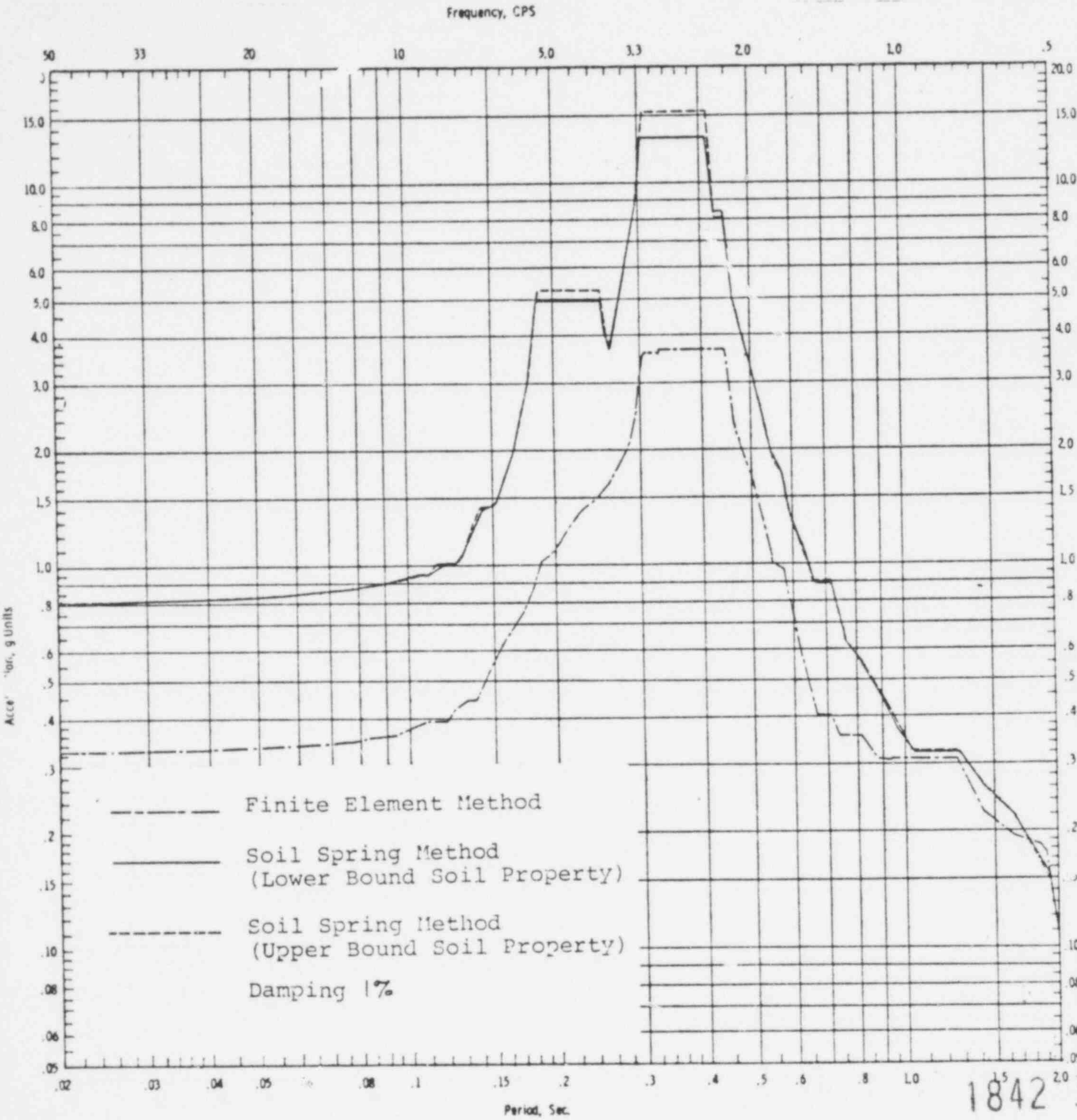

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FIGURE Q130.9-6

RIVER SCREEN HOUSE HORIZONTAL NS
OBE SPECTRA AT EL. 744'-0"

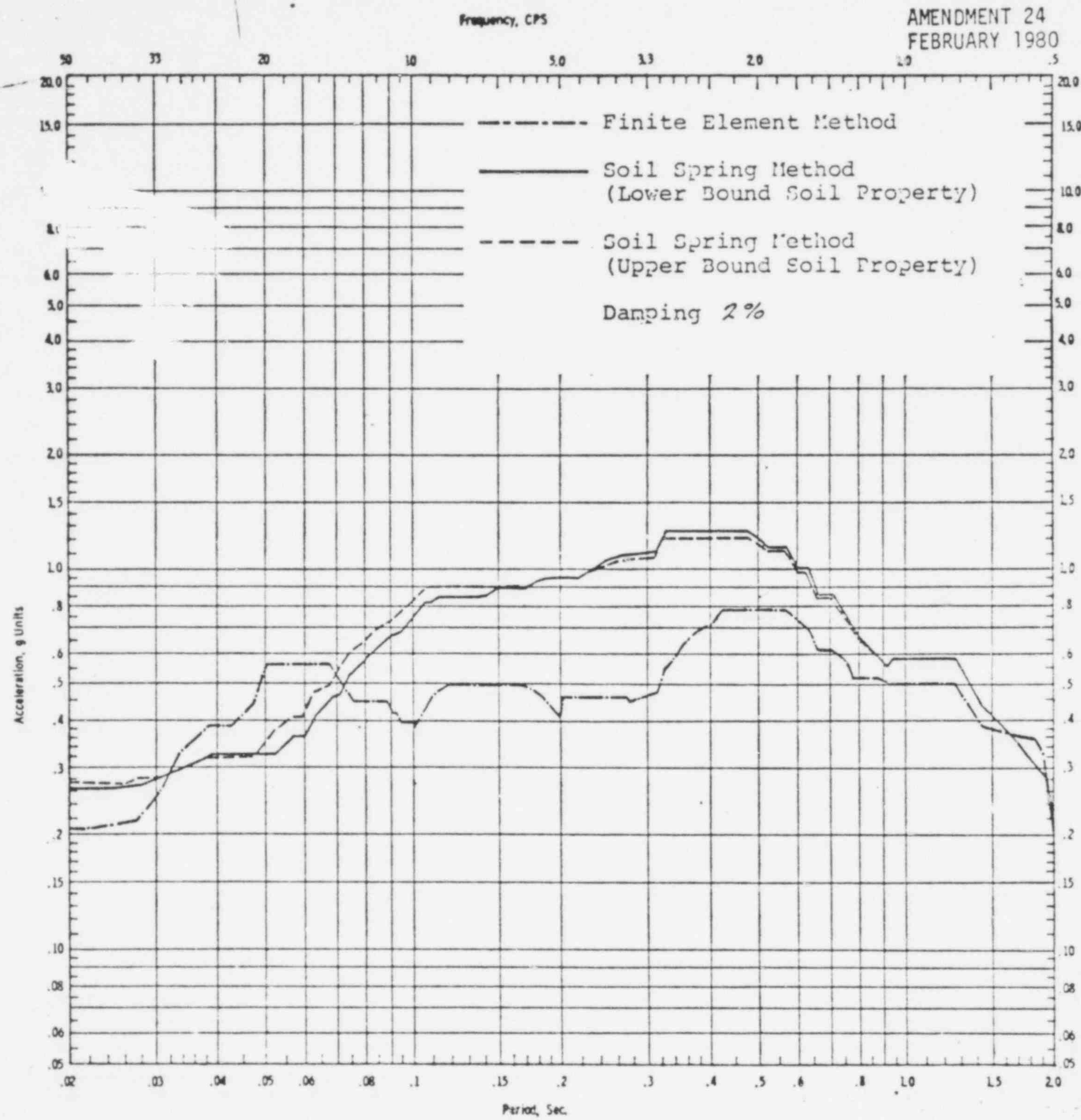

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FIGURE Q130.9-7

RIVER SCREEN HOUSE HORIZONTAL EW
SSE SPECTRA AT EL. 664'-0"

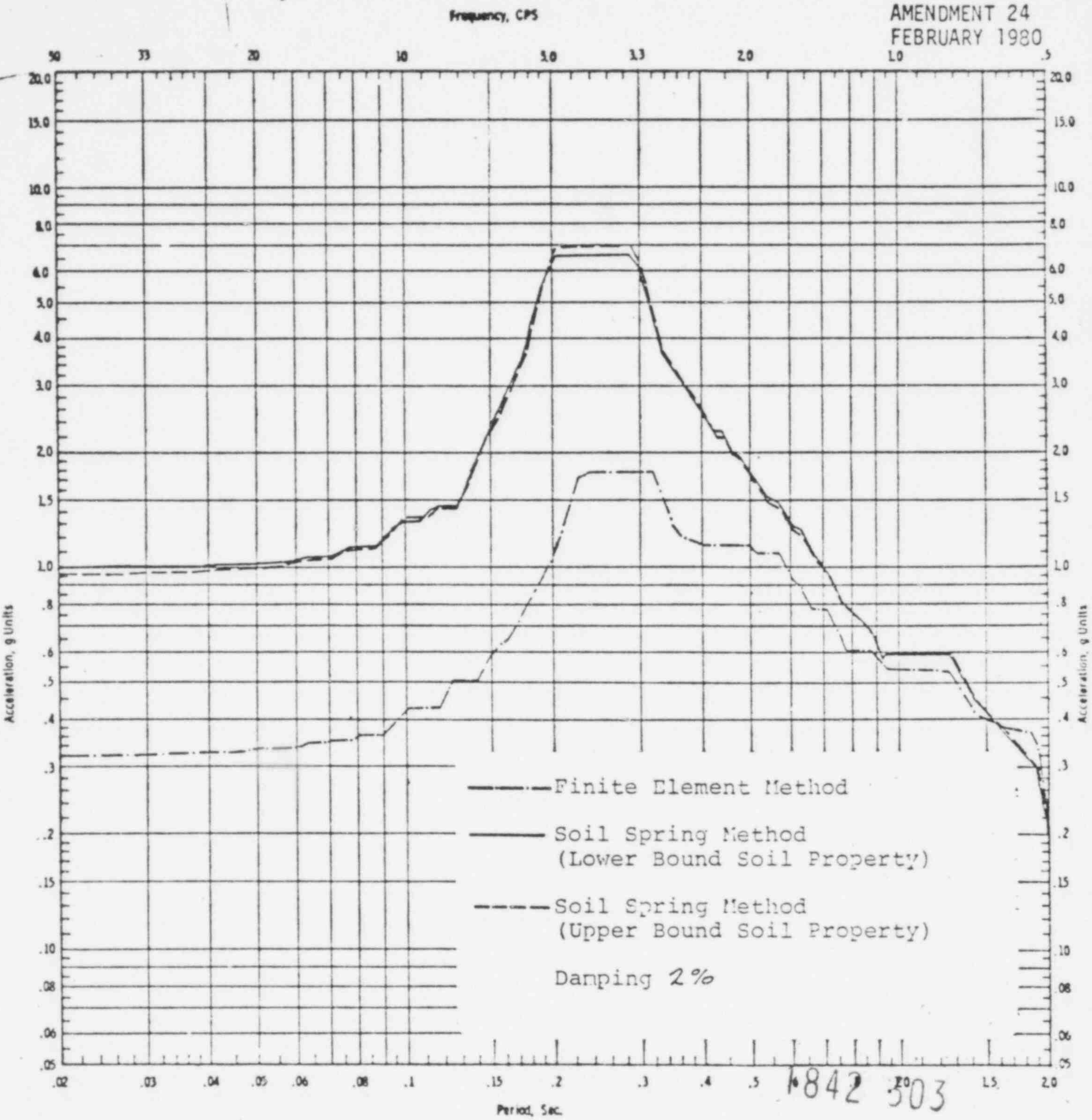

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FIGURE Q130.9-8

RIVER SCREEN HOUSE HORIZONTAL EW
SSE SPECTRA AT EL. 702'-0"

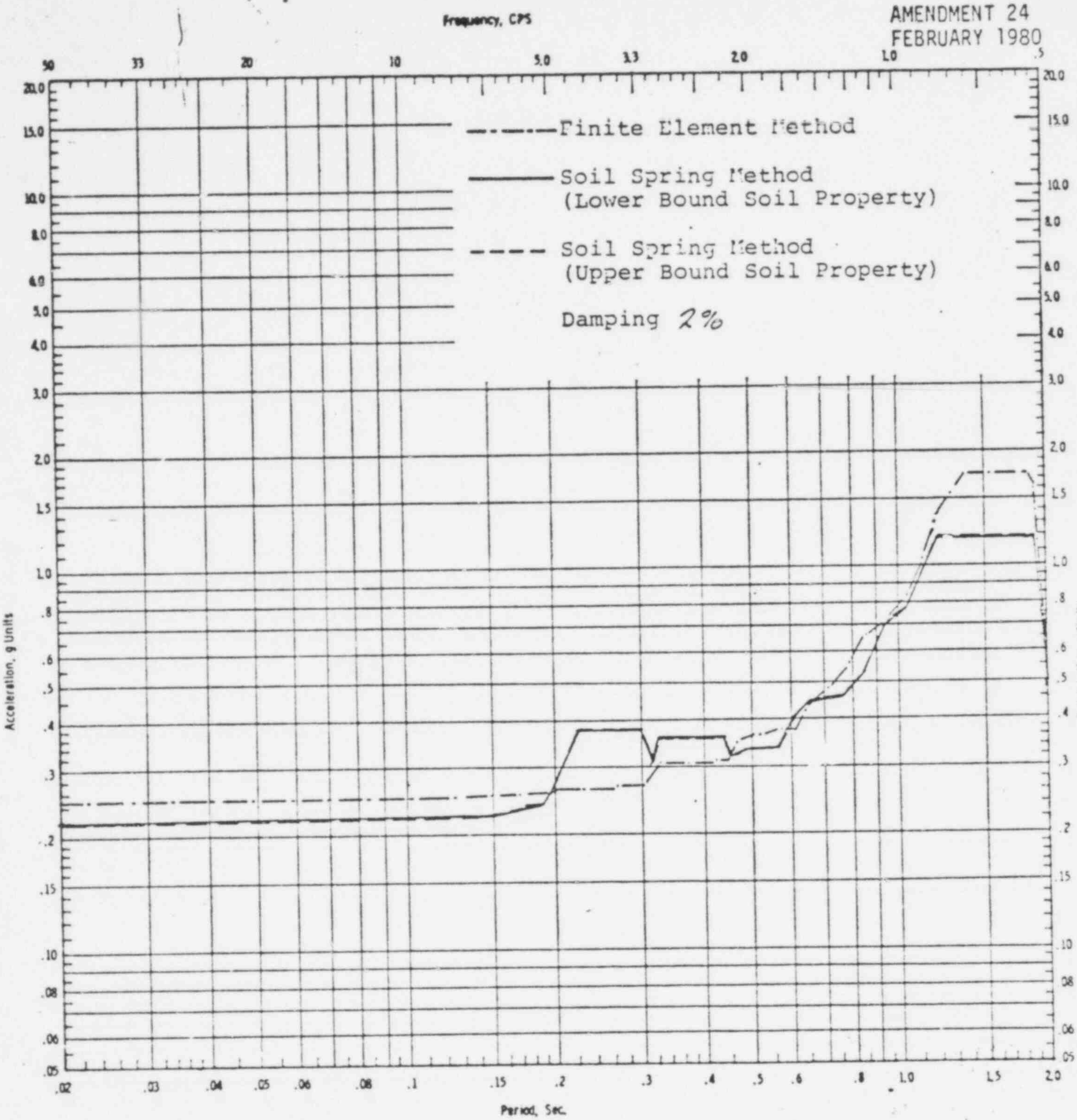

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FIGURE Q130.9-9

RIVER SCREEN HOUSE HORIZONTAL EW
SSE SPECTRA AT EL. 744'-0"

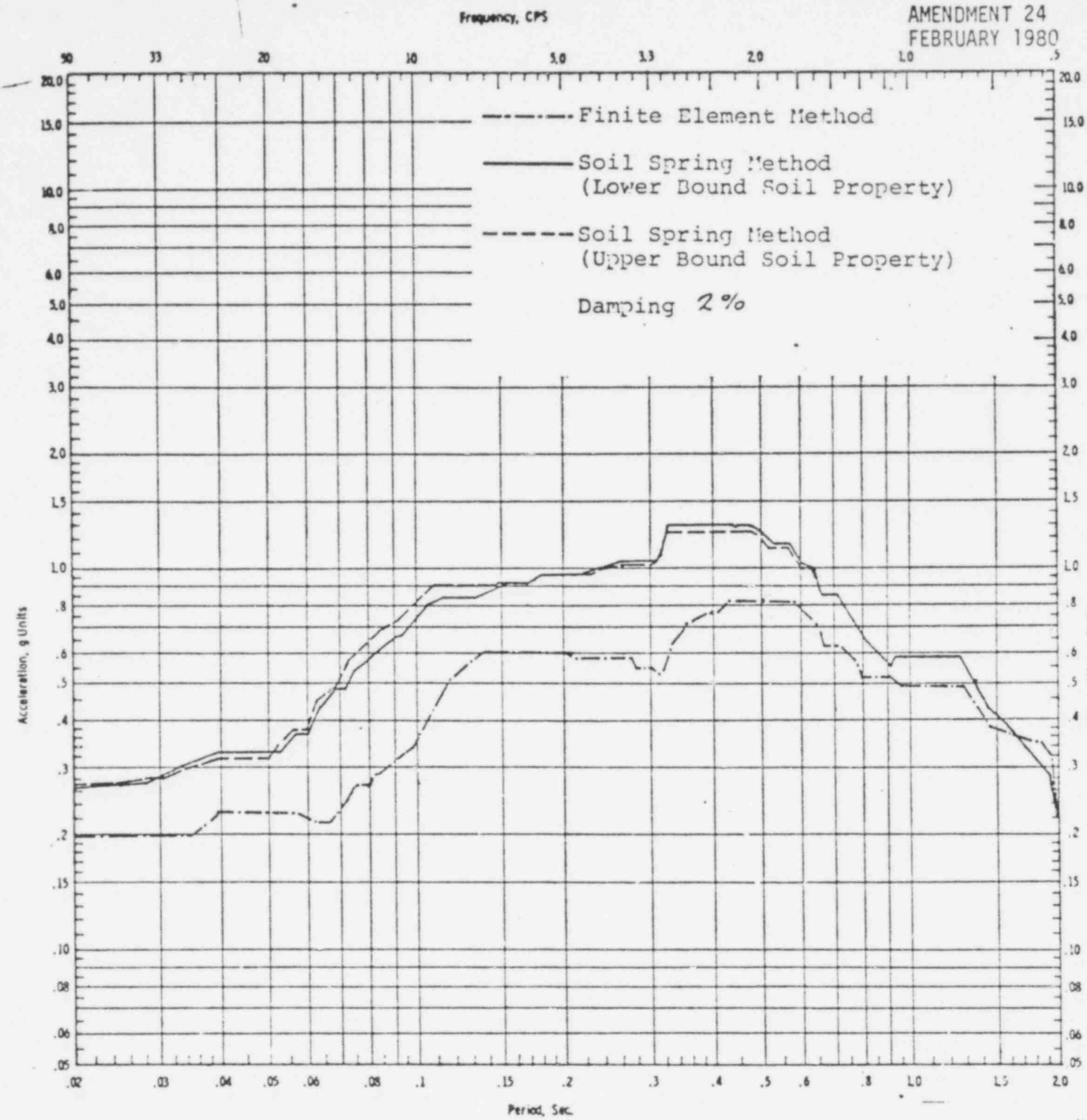

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FIGURE Q130.9-10

RIVER SCREEN HOUSE HORIZONTAL NS
SSE SPECTRA AT EL. 664'-0"

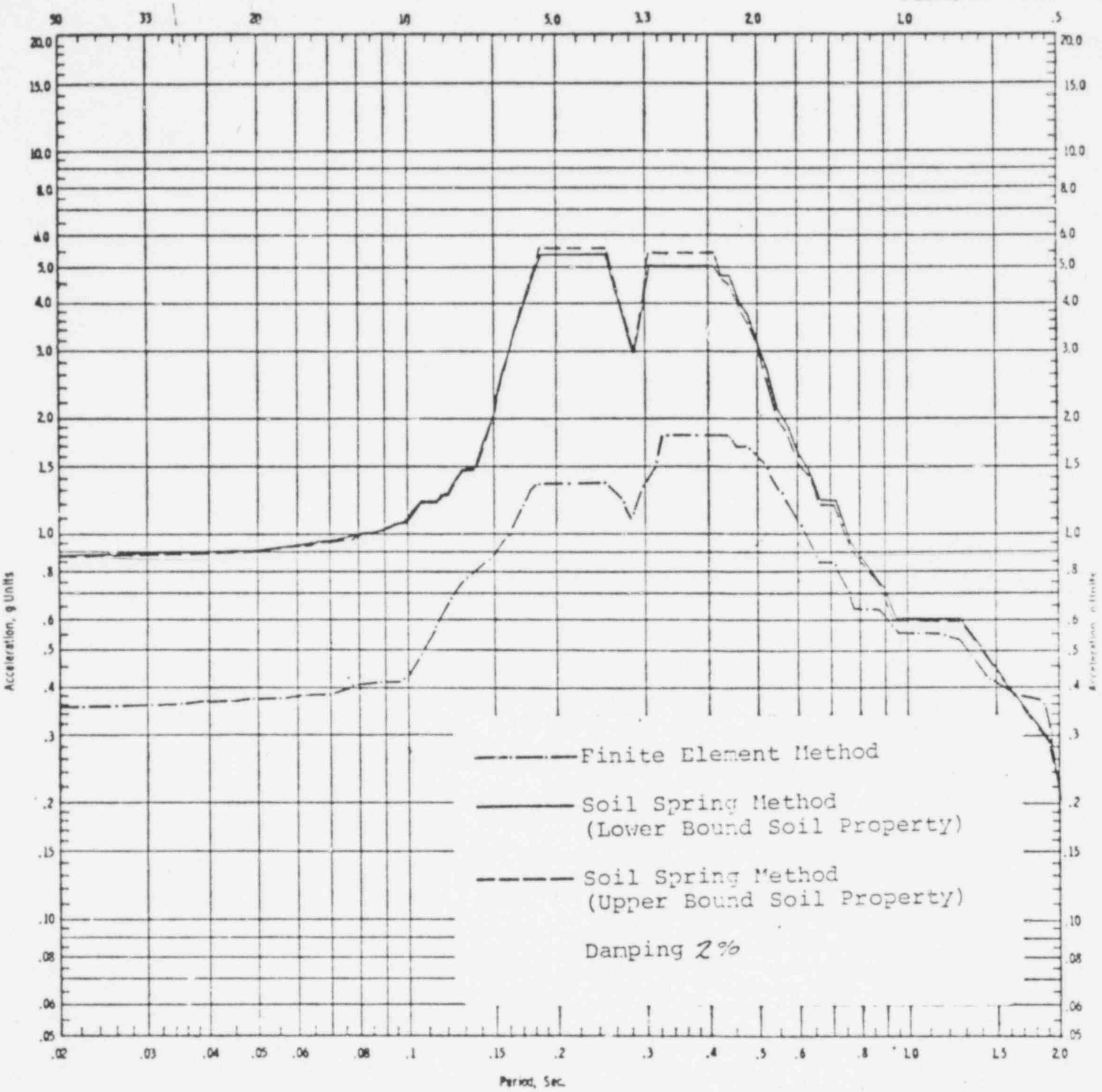

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FIGURE Q130.9-11

RIVER SCREEN HOUSE HORIZONTAL NS
SSE SPECTRA AT EL. 702'-0"

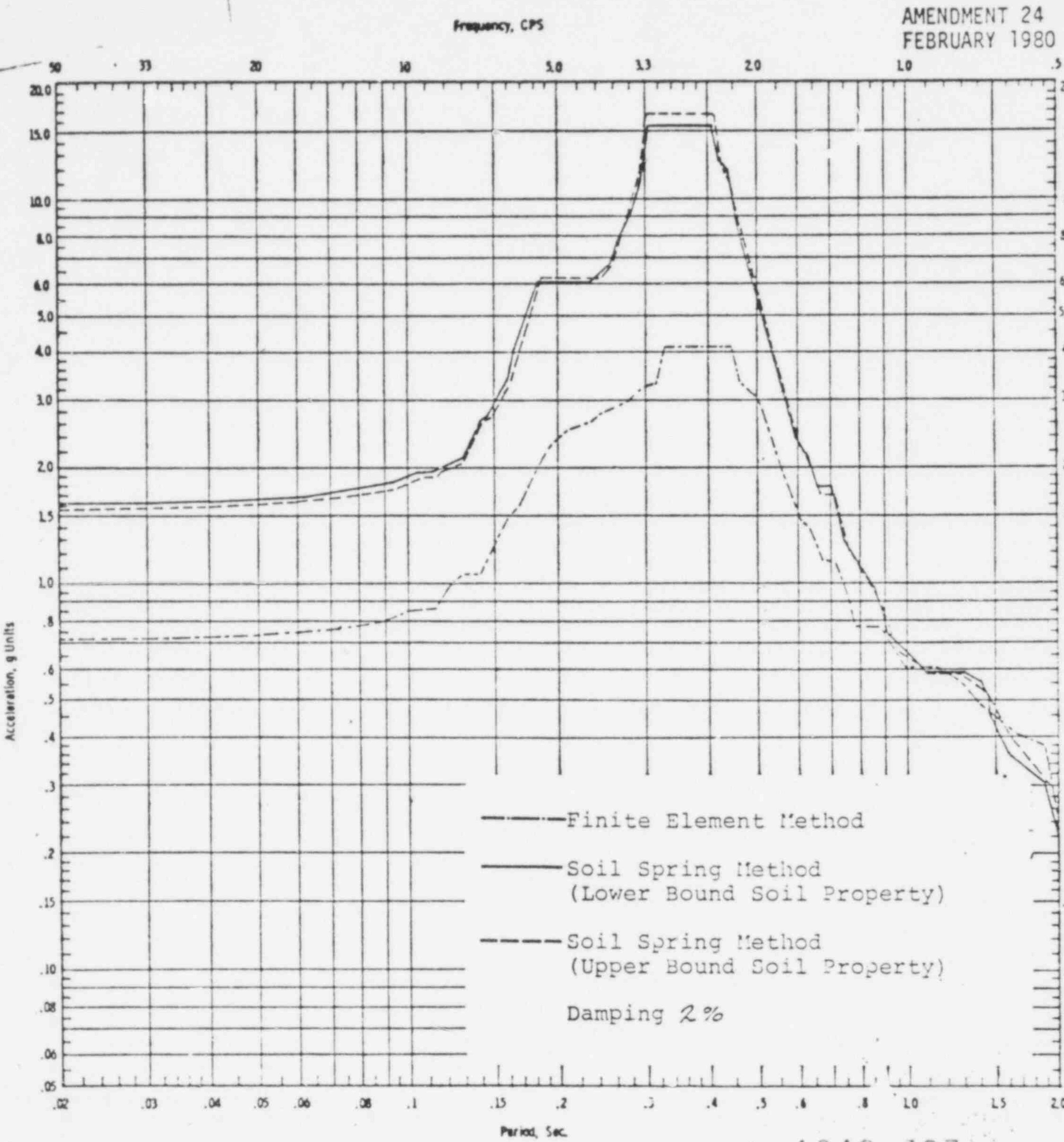

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FIGURE Q130.9-12

RIVER SCREEN HOUSE HORIZONTAL NS
SSE SPECTRA AT EL. 744'-0"

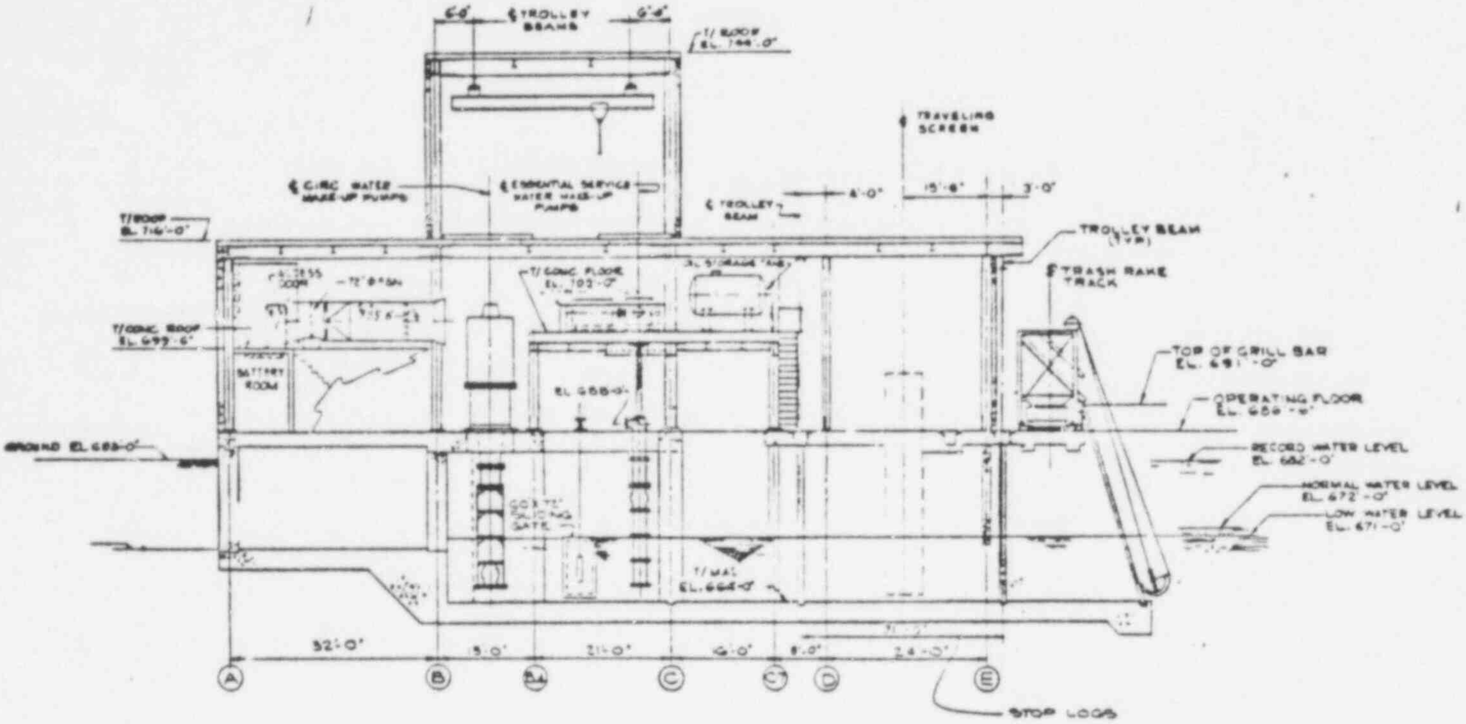

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FIGURE Q130.9-13

CROSS SECTION OF RIVER SCREEN HOUSE

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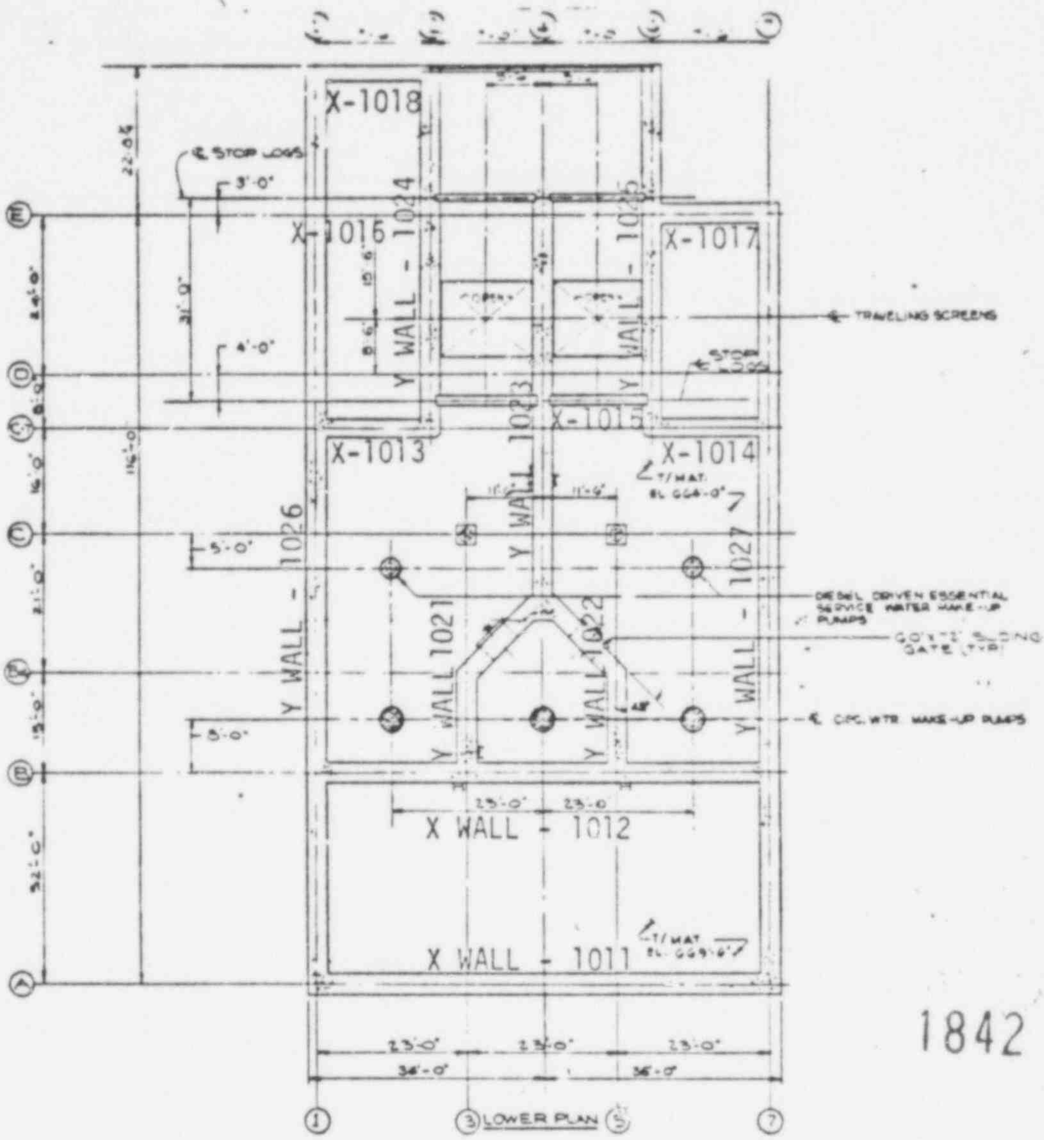

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FIGURE Q130.9-14

SHEAR WALL ARRANGEMENT
AT ELEVATION 664'-0"

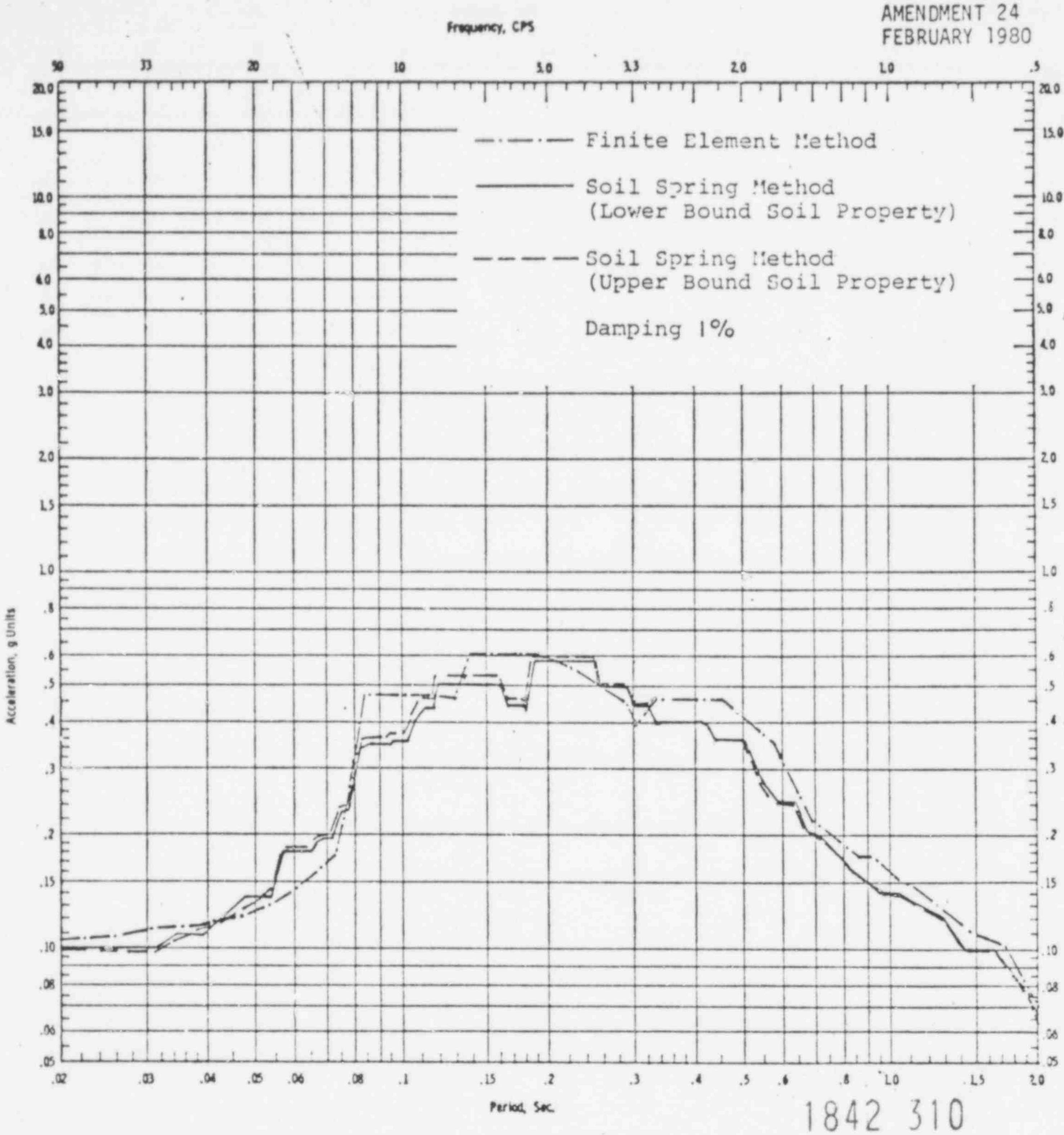

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FIGURE Q130.9-15

RIVER SCREEN HOUSE VERTICAL
OBE SPECTRA AT EL. 664'-0"

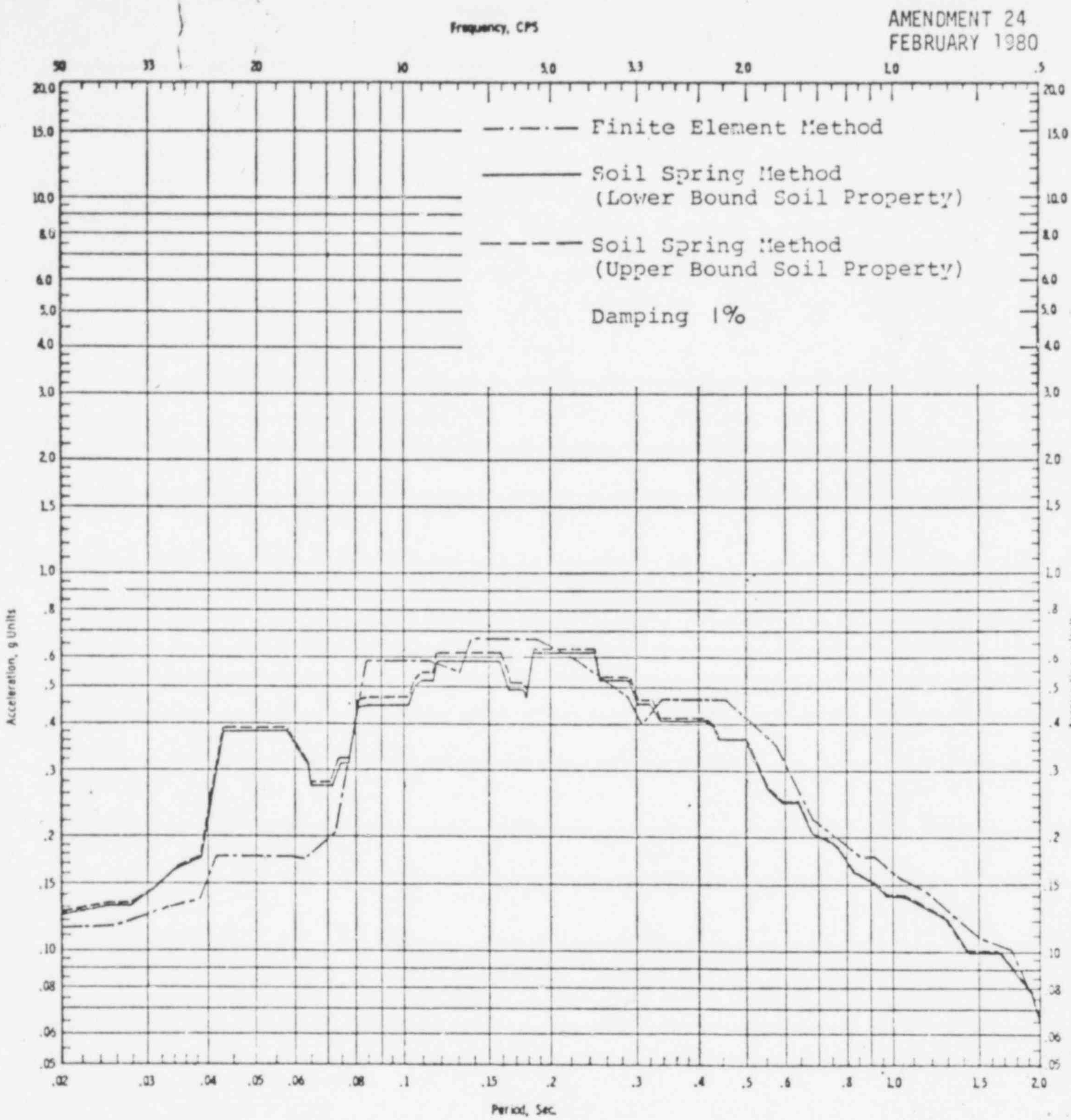

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FIGURE Q130.9-16

RIVER SCREEN HOUSE VERTICAL
OBE SPECTRA AT EL. 702'-0"

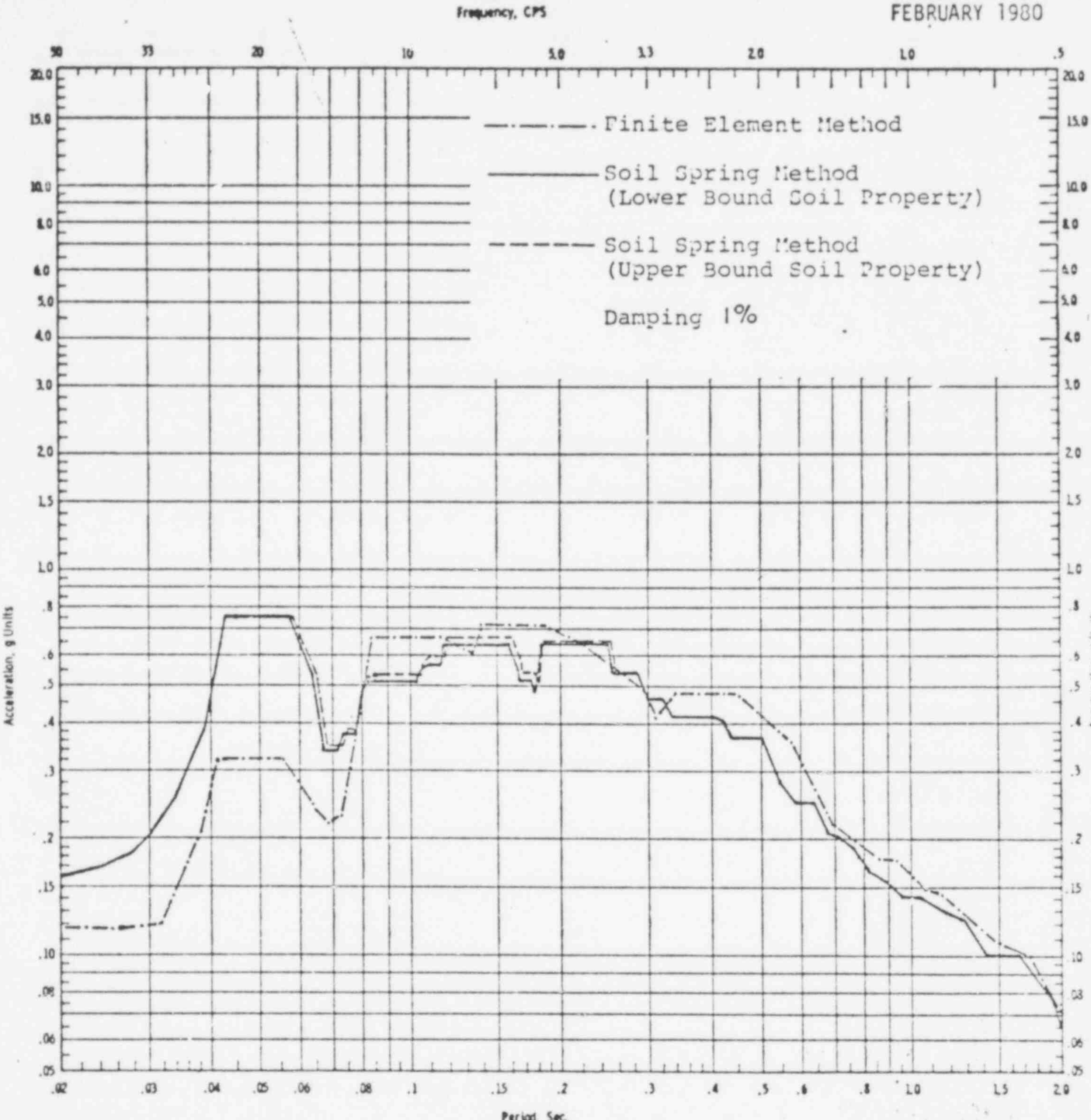

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FIGURE Q130.9-17

RIVER SCREEN HOUSE VERTICAL
OBE SPECTRA AT EL. 744'-0"

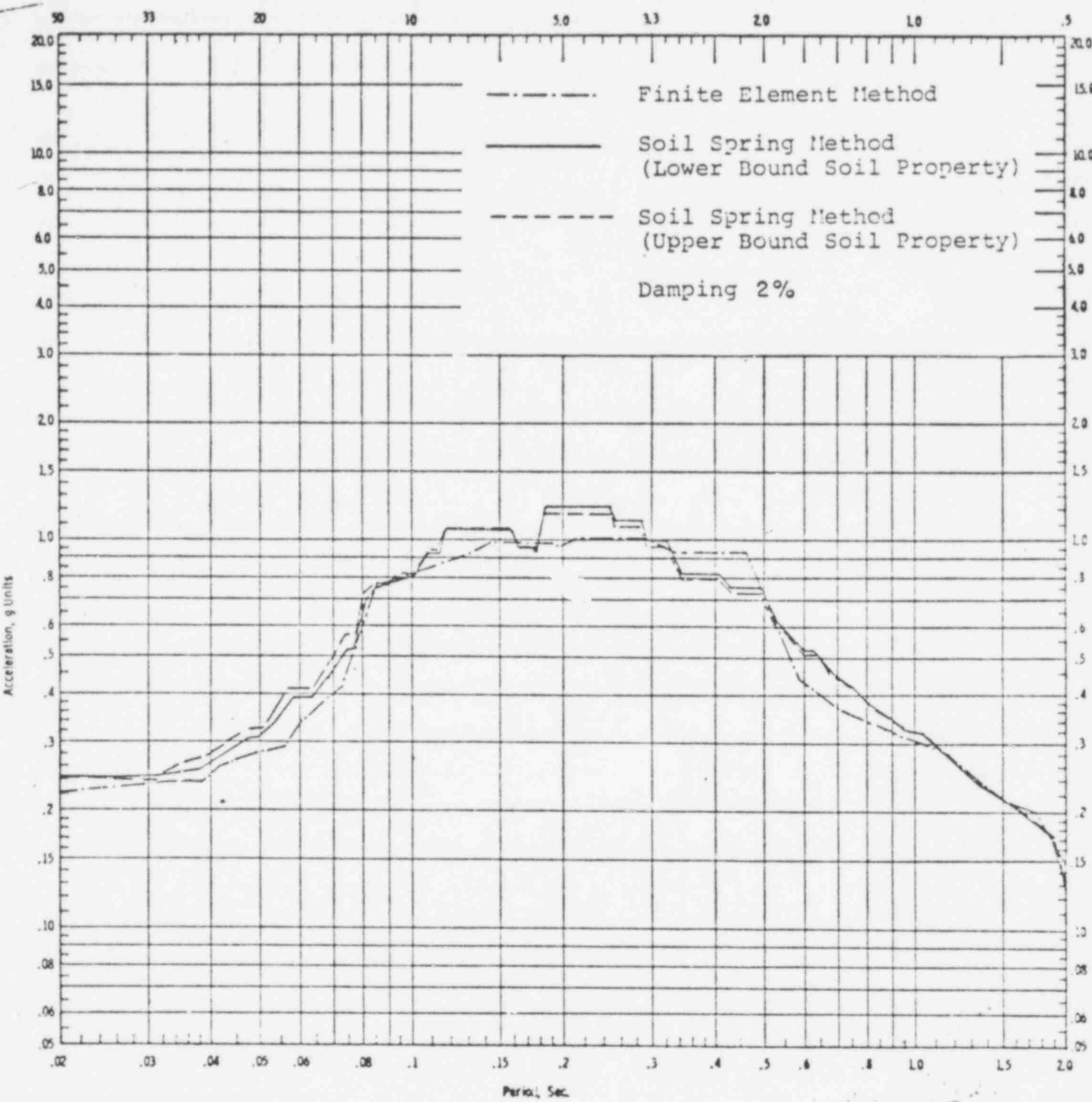

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FIGURE Q130.9-18

RIVER SCREEN HOUSE VERTICAL
SSE SPECTRA AT EL. 664'-0"

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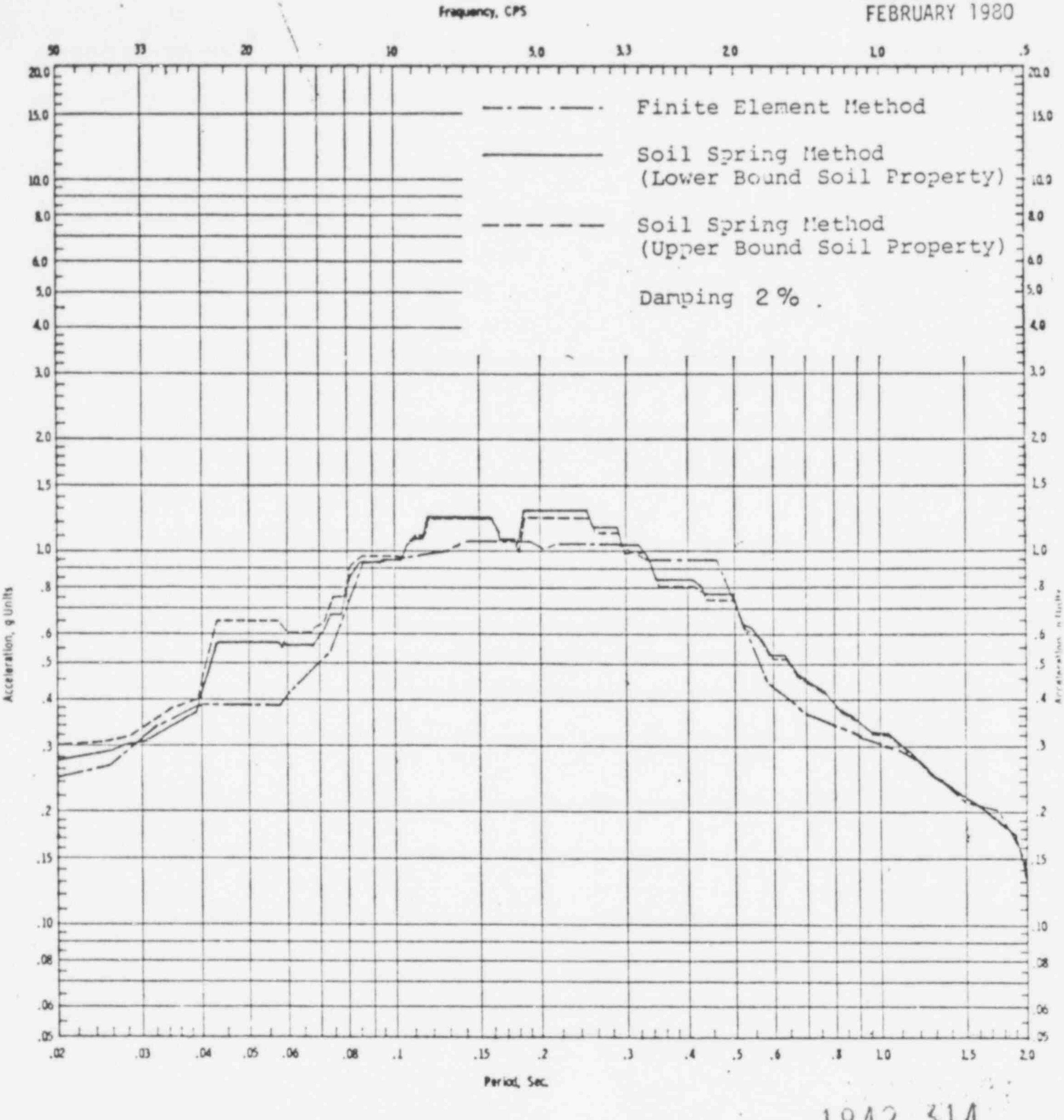

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FIGURE Q130.9-19

RIVER SCREEN HOUSE VERTICAL
SSE SPECTRA AT EL. 702'-0"

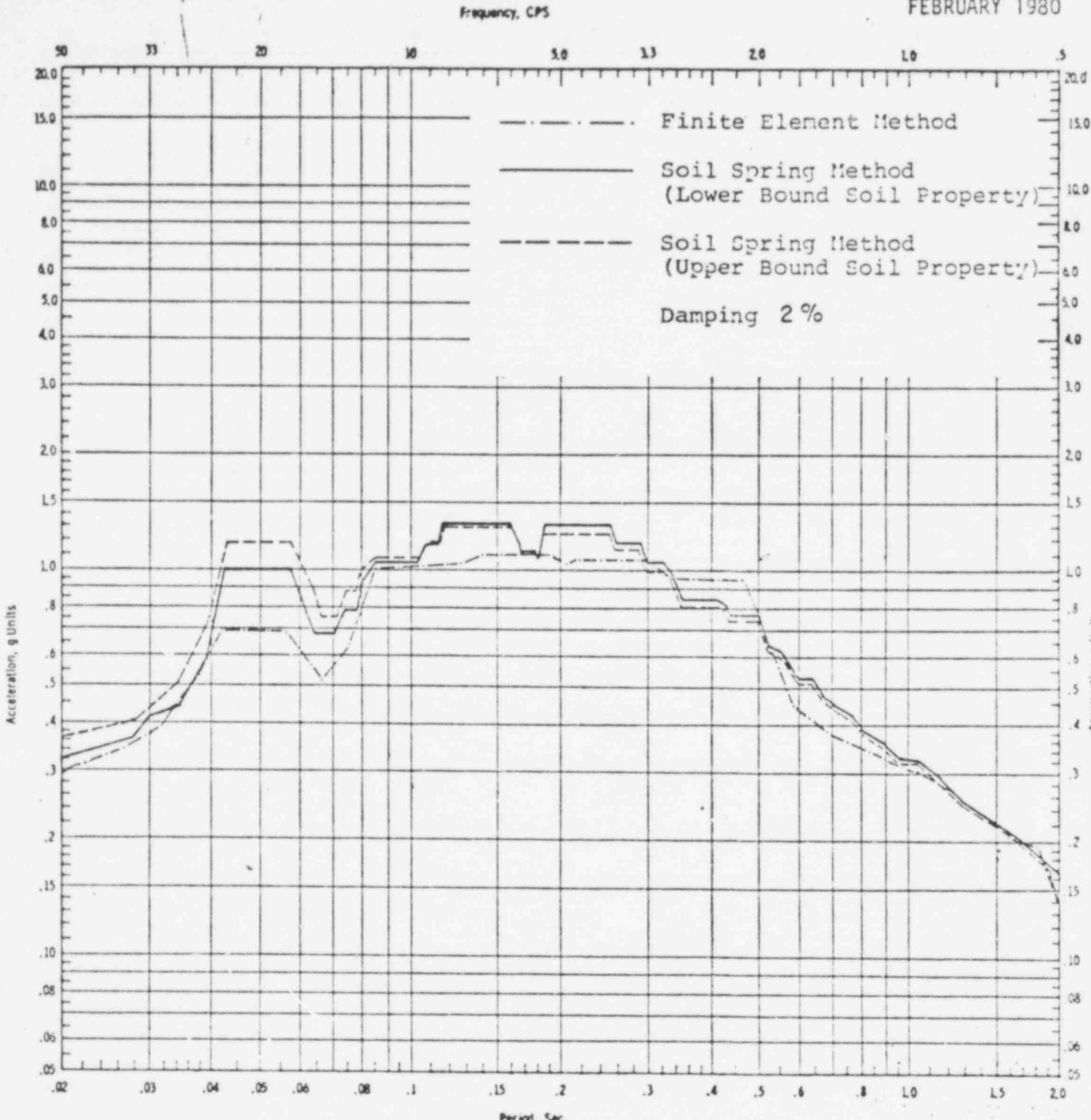

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FIGURE Q130.9-20

RIVER SCREEN HOUSE VERTICAL
SSE SPECTRA AT EL. 744'-0"