THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

P.O. BOX 5000 - CLEVELAND, OHIO 44101 - TELEPHONE (216) 622-9800 - ILLUMINATING BLDG. — 55 PUBLIC SQUARE

Serving The Best Location in the Nation

MURRAY R. EDELMAN
VICE PRESIDENT
NUCLEAR

January 14, 1983

PY-CEI/NRC-0005 L

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Perry Nuclear Power Plant
Docket Nos. 50-440; 50-441
Additional Information on
SRV Hydrodynamic Loads

Dear Mr. Youngblood:

This letter and its attachments are provided to further address our position that the Kuosheng SRV test data confirms the conservatism of the SRV hydrodynamic load methodology used in the Perry Plant design and plant unique testing is not required at Perry. Previous submittals dated October 15, 1982 and November 17, 1982 provided documentation of this position.

In response to a request by the Structural Engineering Branch, we have performed further analysis, comparing Kuosheng and Perry response spectra in the pool region, using similar forcing functions. The attached discussion and response spectra (Attachments 1 and 2), together with our previous submittals, provide quantitative evidence that fluid/structure interaction effects on load definition will be very similar at Perry to those at Kuosheng and obviates the need for confirmatory SRV testing at Perry.

Finally, a revised discussion of the amplification factors used to compare Kuosheng test data to the Perry design values in our November 17, 1982 submittal is provided (Attachment 3) to clarify how these factors were developed.

B001

This submittal completes our analysis and evaluation that in-plant SRV testing is not required for Perry.

If you have any questions, please let me know.

Very truly yours,

Murray R. Edelman

Murray R. Edelman
Vice President
Nuclear Group

MRE:kh

cc: Jay Silberg, Esq.
John Stefano
Max Gildner
J. Kudrick
D. Jeng
L. Yang
N. Chokshi
F. Eltawila

Attachments

In the region of the suppression pocl there is virtually no difference in the horizontal structural characteristics of Perry and Kuosheng in that in this region they are both steel lined concrete containments. The plants are also similar in their vertical structural characteristics regarding fluid/structural interaction, but similarity of vertical structural response is not anticipated.

The similarities that are important to pressure definition consist of basemats (141' diameter and 10.75' thick for Kuosheng, and 136' and 12.0' for Perry), drywells that are different only in diameter (69' for Kuosheng and 75' for Perry), nearly identical containments in the pool region (114' I.D. and 8.5' thick for Kuosheng, and 120' I.D. and 8.0' thick for Perry), and construction materials. The most significant difference, affecting only vertical response, is in the shear wave velocities for the two plants, 2,300 fps for Kuosheng and 4,900 fps for Perry.

In accordance with Structural Engineering Branch's request on November 22, 1982, we have performed an analysis which compares Kuosheng response spectra with Perry response spectra in the pool region using similar forcing functions (SRV and SRVCO). The basis for this comparison was General Electric Company's load definition for SRV and SRVCO. Using this load definition as a forcing function for Perry's containment model, the Perry response spectra were generated. These response spectra were then plotted--together with Kuosheng's design response spectra in the pool region. The curves in Attachment 2 are the results of this analysis.

Also attached is Figure 3.8-', "Typical Section of Reactor Building Complex," which indicates the location of node points evaluated.

It should be noted that these curves are expected to reveal disparities since the two plants are similar, not identical. The specific differences can be categorized as physical and analytical. The significant physical differences are basemat thickness and sub-foundation shear wave velocity. The analytical differences consist of different values of A and B damping, computer model element types (shell elements throughout for Perry and a mixture of solid elements and shell for Kuosheng), material properties (some orthotropic for Kuosheng and all isotropic for Perry) and forcing functions (the Kuosheng envelope is the worst of 3 loading cases plus CO, i.e., it is not a single continuous event as is the Perry SRV and SRV CO). These differences affect vertical response to a greater degree than they affect horizontal response. The effects of these differences are as anticipated (e.g., the higher design vertical response for Kuosheng at lower frequencies is primarily due to the softer basemat and soil). Furthermore, although the Perry vertical spectra are generally less than the Kuosheng vertical spectra, vertical response is relatively unimportant in fluid/structure interaction considerations. That is, vertical response, even in the pool region, is influenced by the stiffness and mass of the entire building to a far greater extent than radial response is, whereas fluid/structure interaction is primarily a function of the fluid-retaining structure rigidity. Both Perry and Kuosheng, including

the differences in basemat thickness and soil shear wave velocity, are beyond the "threshold" limits for rigidity insofar as fluid/structure interaction is concerned. Thus, comparisons of vertical response are more indicative of different total building inertia or mass and equivalent soil springs than they are of fluid/structure interaction or pressure definition.

With regard to the radial response, the use of the SRV and SRV CO forcing function does not affect the conclusion that fluid/structure interaction effects are similar for the two plants. This is best illustrated by referring to the attached radial comparisons in the mid and upper pool regions where fluid/structure interaction affects are most pronounced. There are "exceedances" in the theoretical curves of Attachment 2 just as there were in the previously submitted comparisons based on Kuosheng test data. However, these exceedances generally occur at higher frequencies and are of little concern because of the following:

1. Kuosheng strain gages verified that there was no problem with high accelerations at high frequency.

2. Generic studies (NEDE-25250) show that exceedances beyond 60 Hz are of no concern.

3. Perry valves can withstand, typically, a doubling of the RRS.

4. For equipment qualified by test, the actual TRS is generally far above anticipated exceedances.

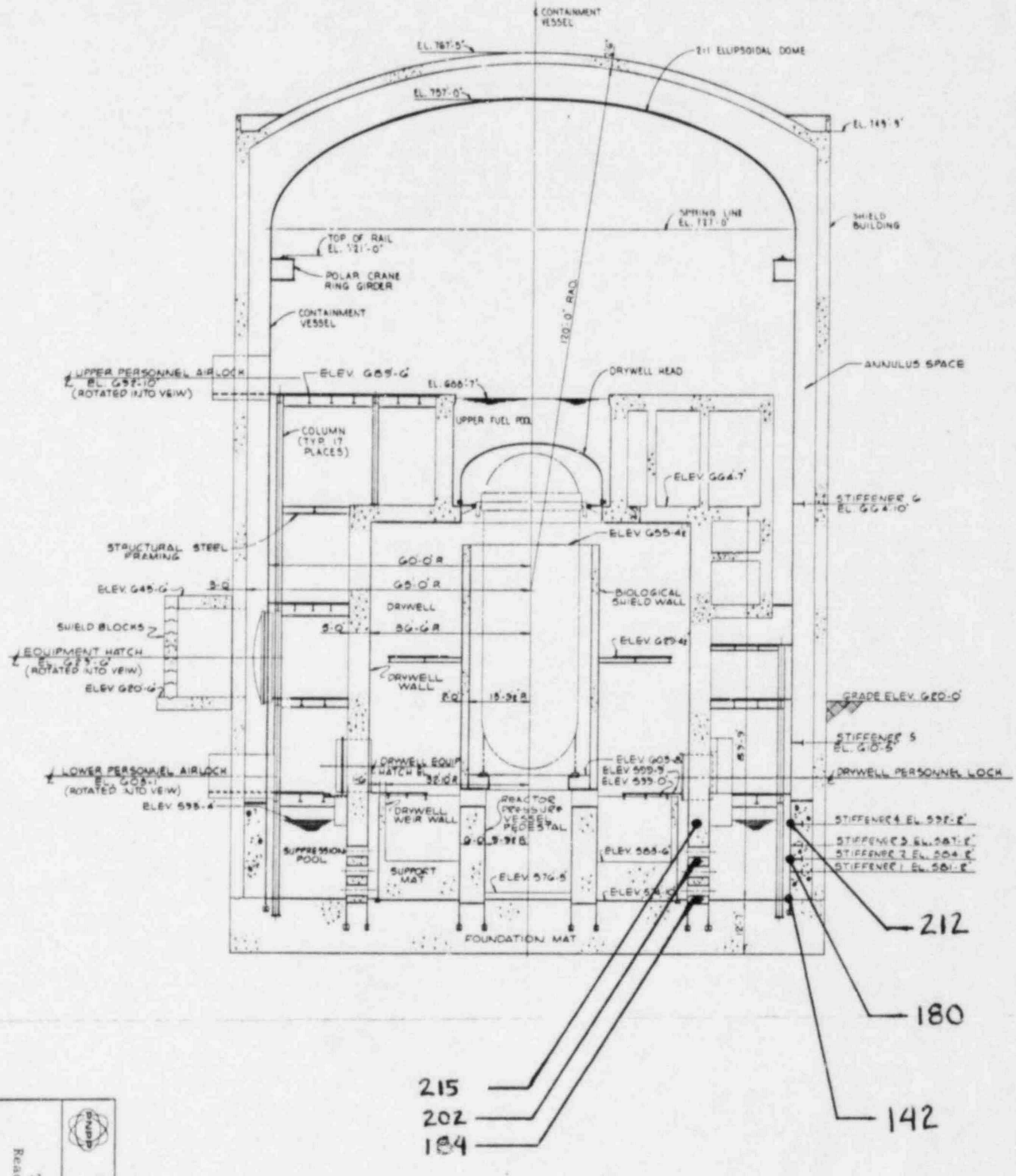
In conclusion, based on the attached data, Perry spectra generally bound Kuosheng spectra in the radial direction. Both of these spectra are theoretical, and there is good radial response correlation in the mid-pool region (nodes 202 and 180). The mid-pool region is more meaningful for this theoretical comparison because the affects of modeling differences are minimal in this region and fluid/structure interaction relative to load definition would be most pronounced in this area.

Although the attached Kuosheng spectra generally bound Perry spectra vertically, vertical response is relatively unimportant in fluid/structure interaction definition.

In addition, our November 17,1982, submittal of comparisons of Perry design spectra with spectra based on Perry model--Kuosheng pressure time history factored to Perry conditions generally indicate bounding in radial direction. Also, the pool region comparisons in the November 17 submittal of Perry model--Kuosheng pressure time history spectra with Kuosheng measured spectra exhibit good correlation. Where there are differences, they are either at extremely low response levels or at extremely high frequencies.

367/A/2/ba

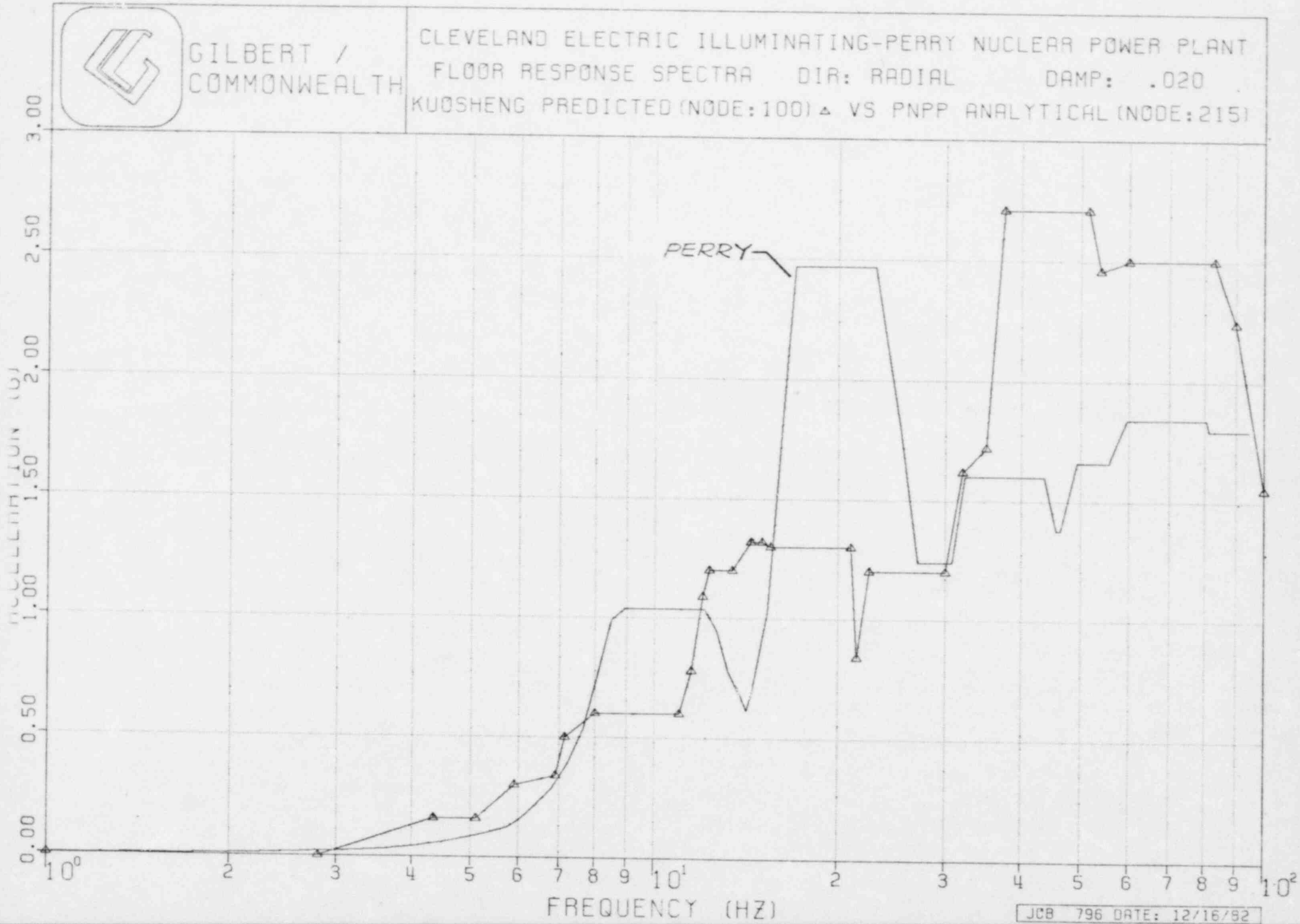
Attachment 2 to Letter Dated: January 14, 1983
PY-CEI/NRC-0005 L



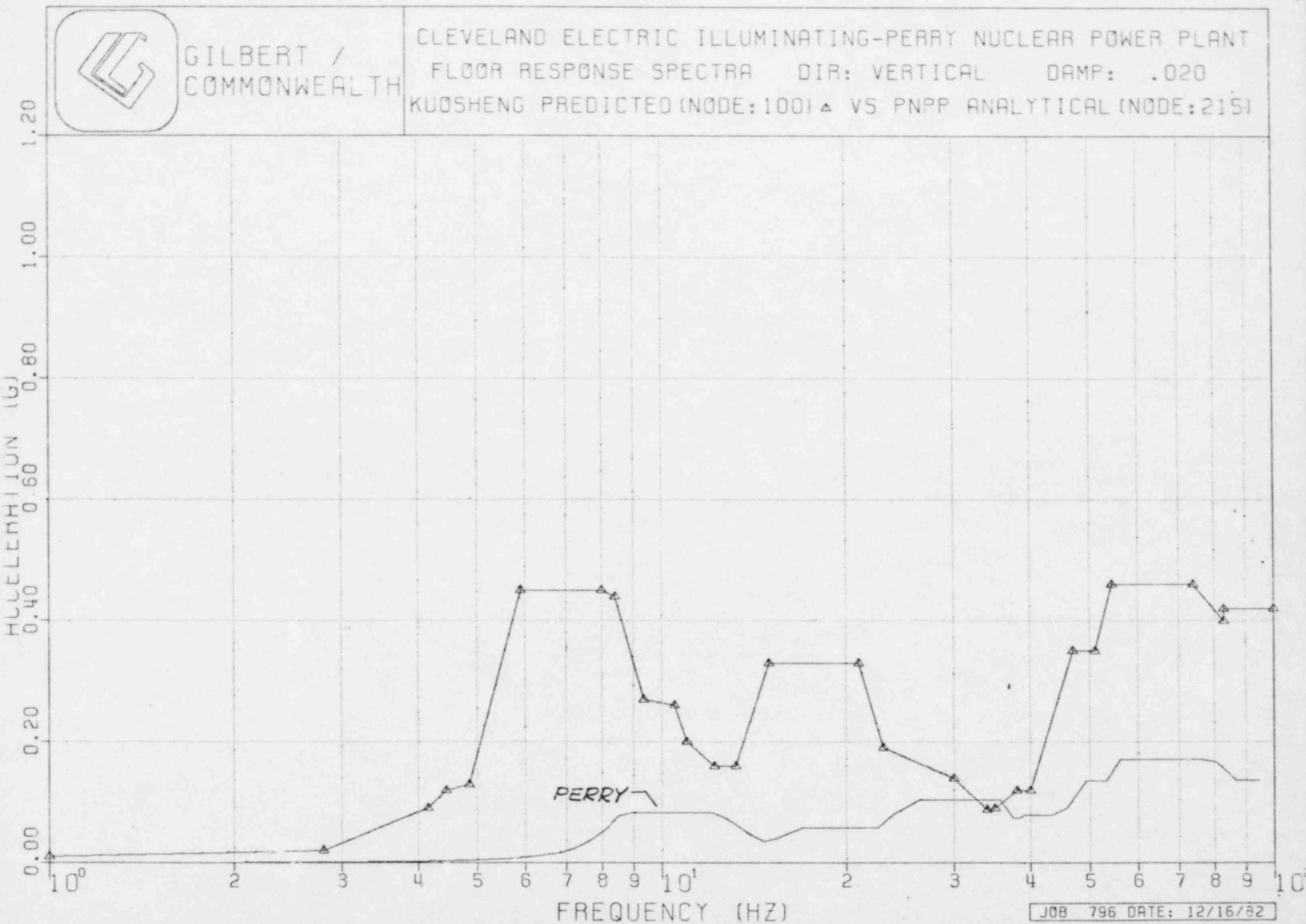
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

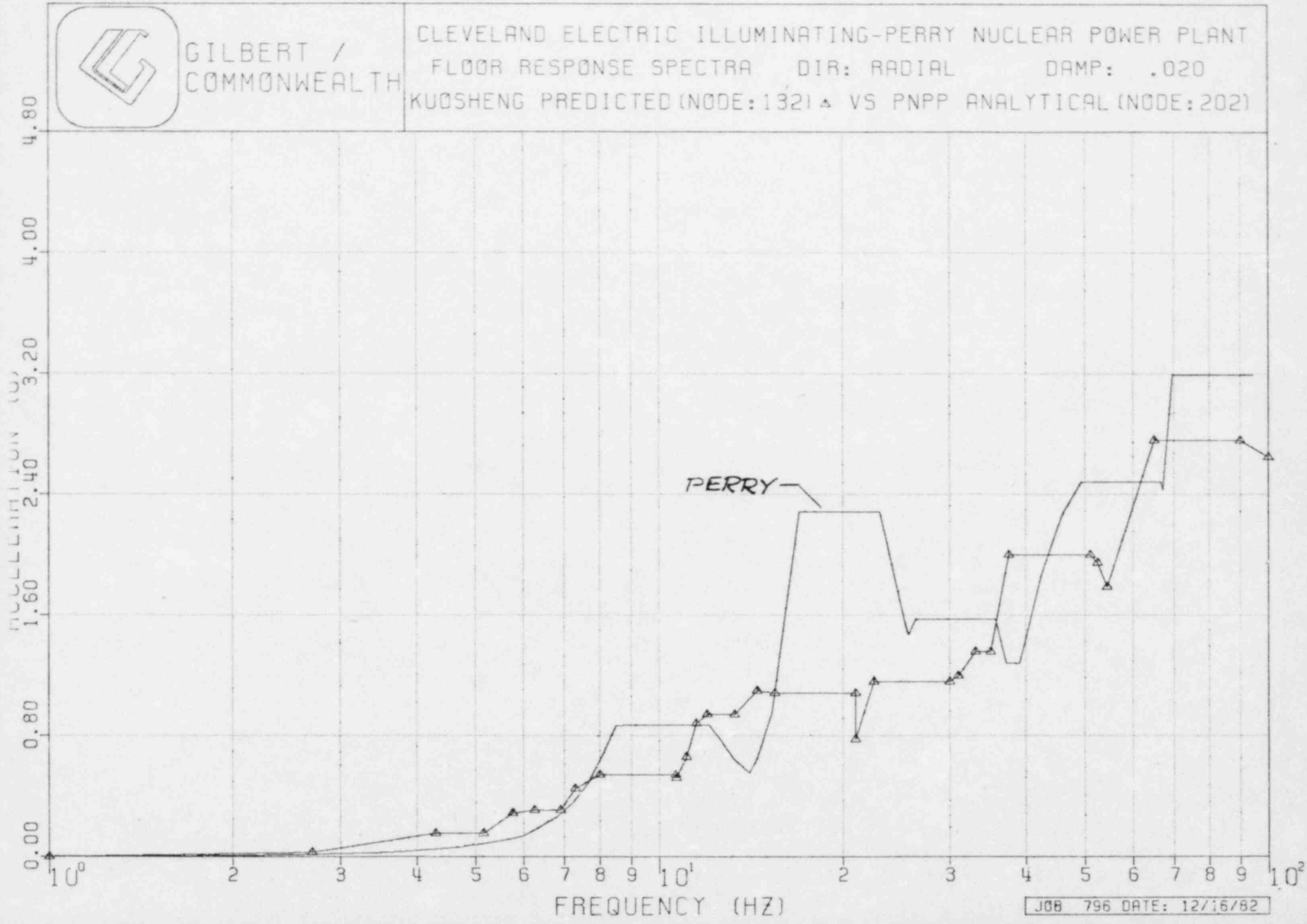
Typical Section of Reactor Building Complex

Figure 3.8-1



GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA DIR: RADIAL DAMP: .020
KUOSHENG PREDICTED (NODE:100) ▵ VS PNPP ANALYTICAL (NODE:215)
PERRY
0.00
0.50
1.00
1.50
2.00
2.50
3.00
10^0
2
3
4
5
6
7
8
9
10^1
2
3
4
5
6
7
8
9
10^2
FREQUENCY (HZ)
JCB 796 DATE: 12/16/82


GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA DIR: VERTICAL DAMP: .020
KUOSHENG PREDICTED (NODE:100) △ VS PNPP ANALYTICAL (NODE:215)
ACCELERATION (G)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
PERRY
FREQUENCY (HZ)
JOB 796 DATE: 12/16/82



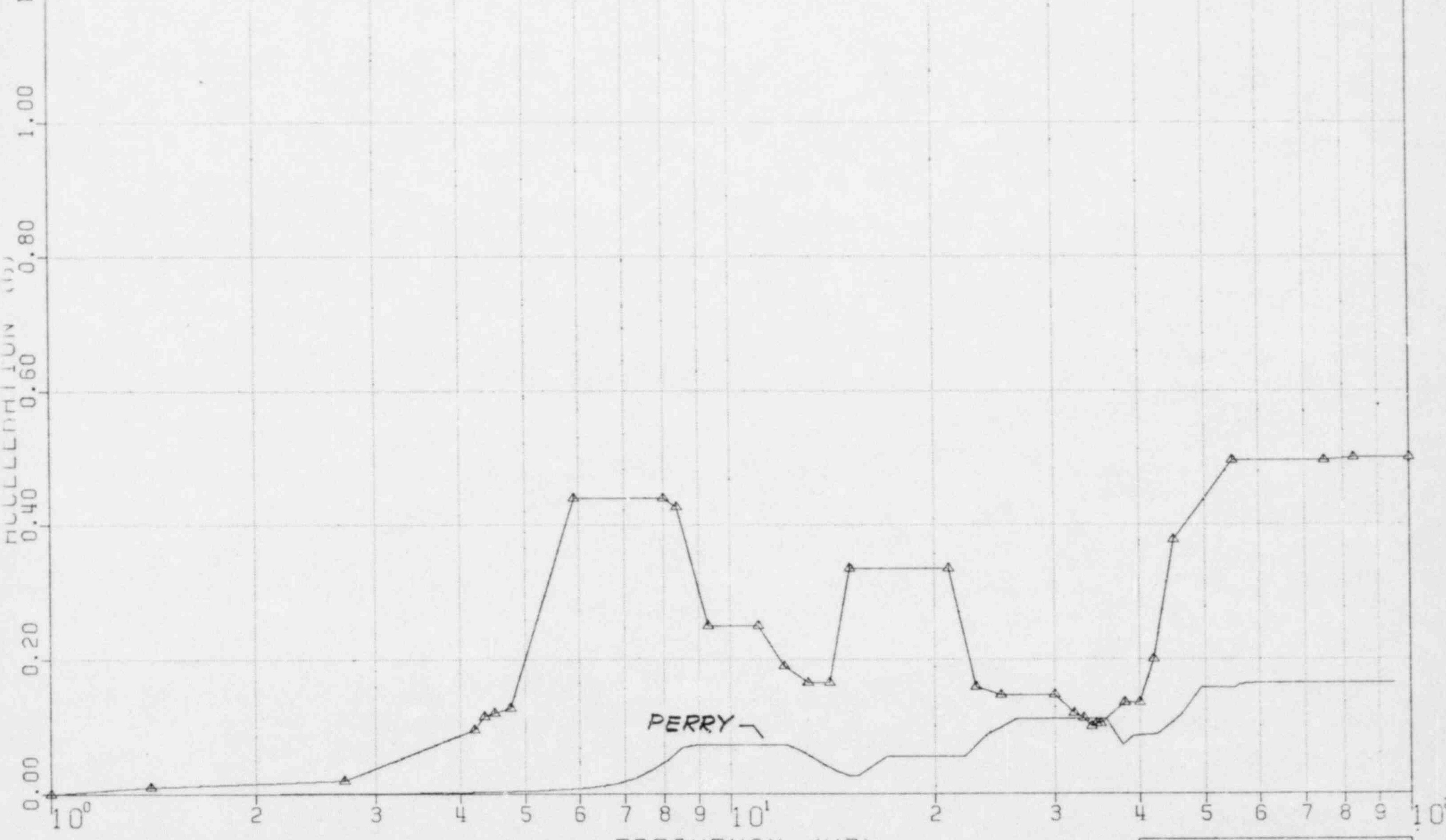
GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA DIR: RADIAL DAMP: .020
KUOSHENG PREDICTED (NODE:132) ▵ VS PNPP ANALYTICAL (NODE:202)
ACCELERATION (G)
0.00
0.80
1.60
2.40
3.20
4.00
4.80
PERRY
FREQUENCY (HZ)
JOB 796 DATE: 12/16/82

GILBERT / COMMONWEALTH

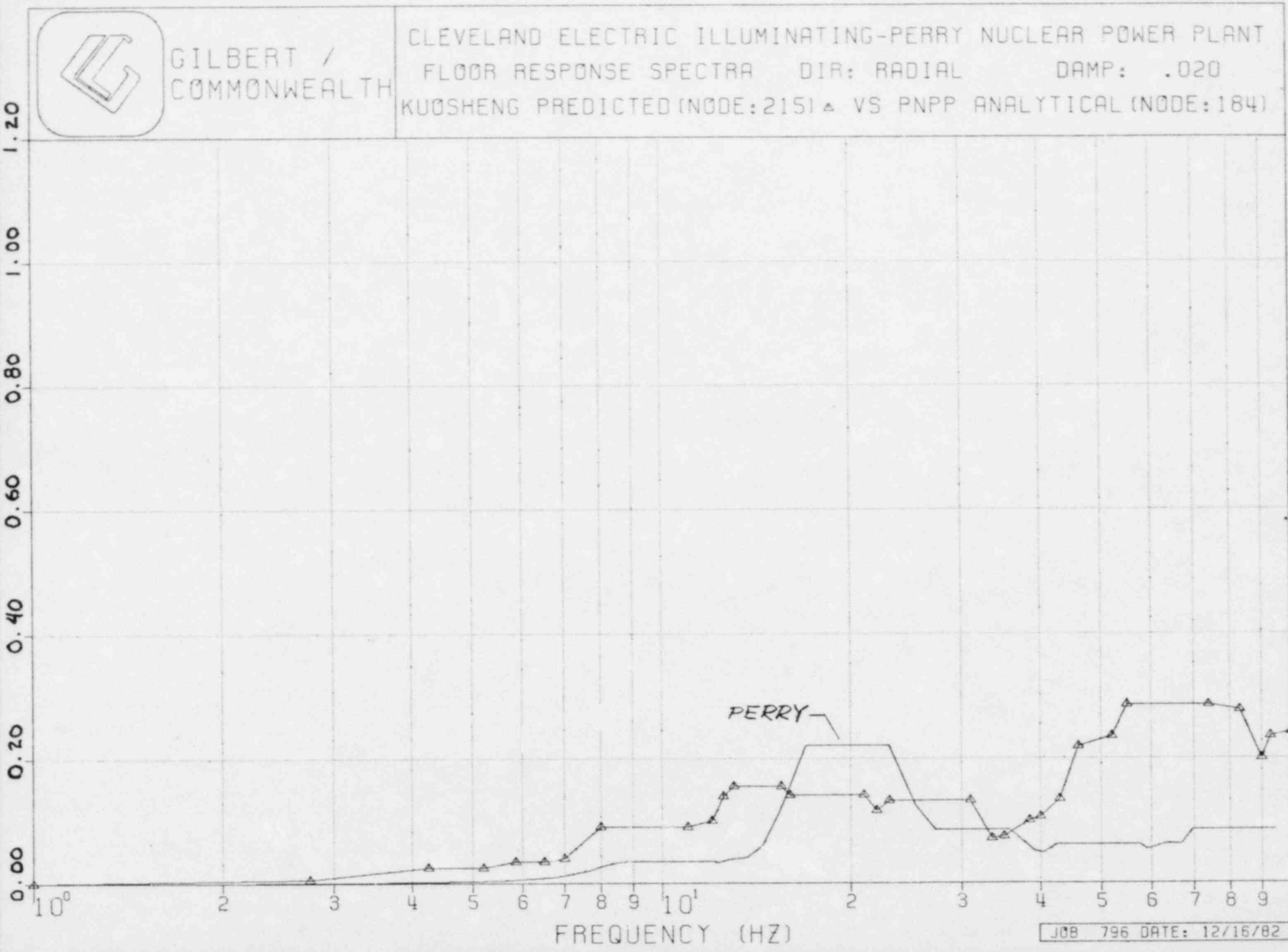
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT

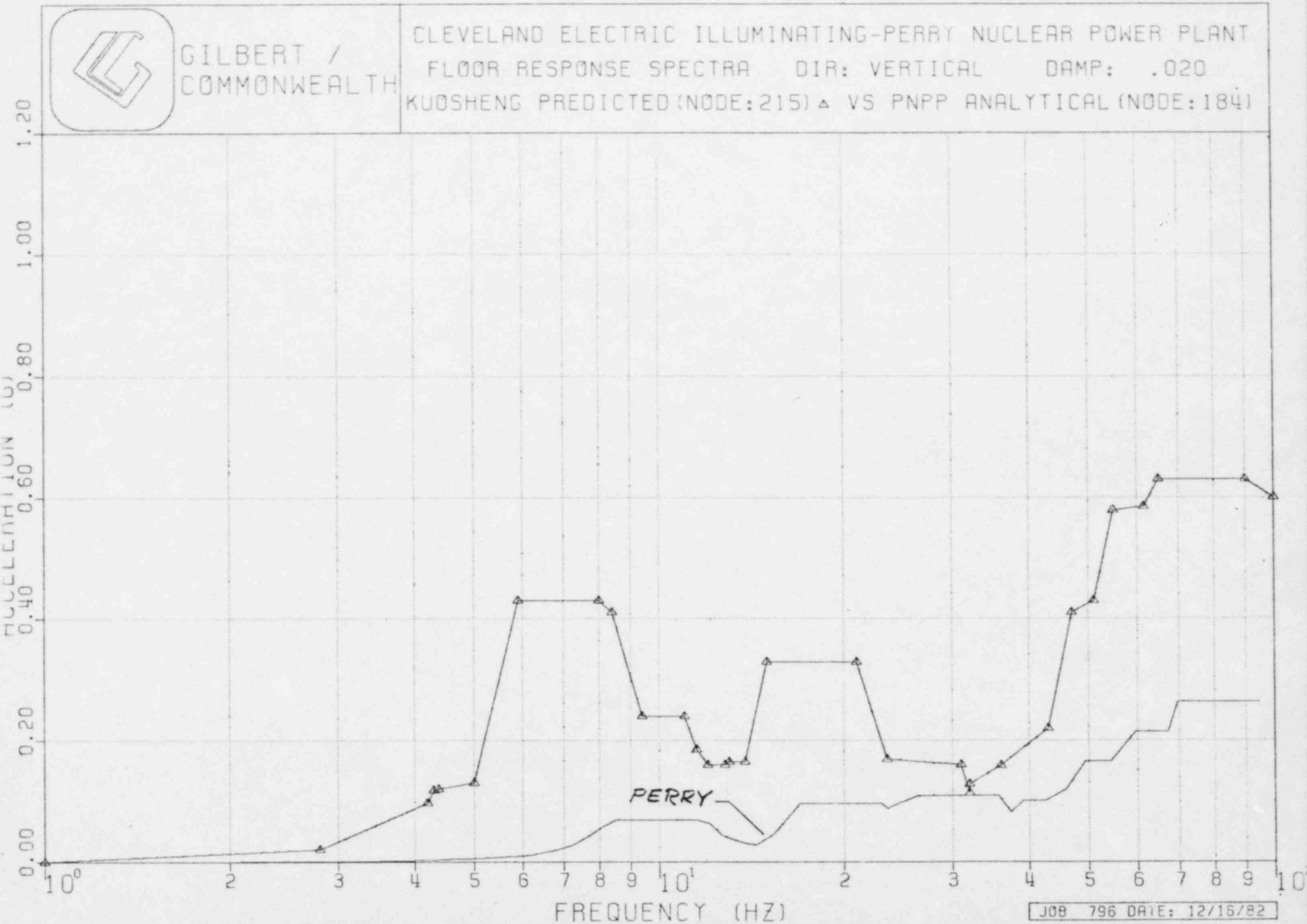
FLOOR RESPONSE SPECTRA DIR: VERTICAL DAMP: .020

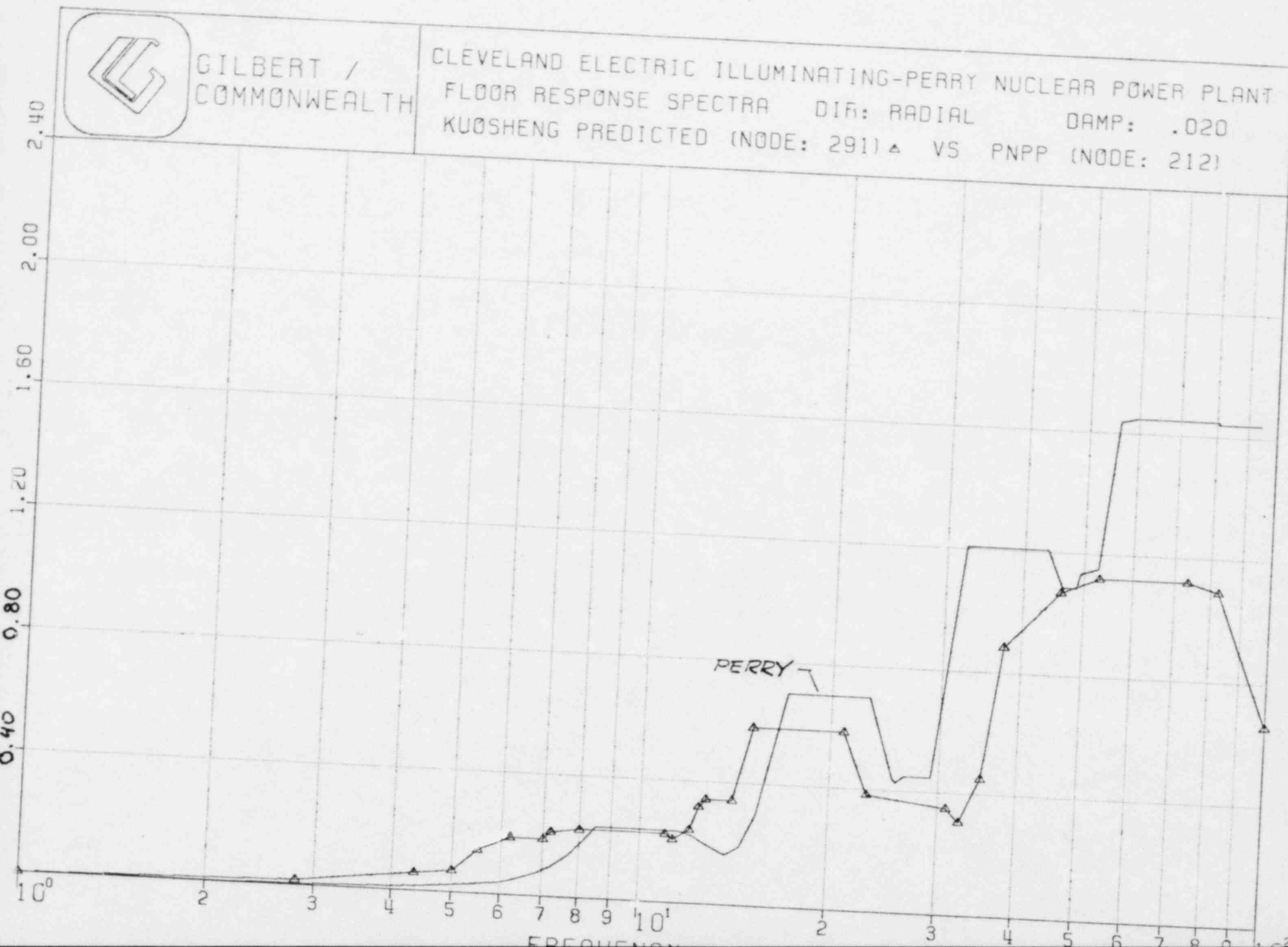
KUOSHENG PREDICTED (NODE: 132) △ VS PNPP ANALYTICAL (NODE: 202)



JOB 796 DATE: 12/16/82


GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA DIR: RADIAL DAMP: .020
KUOSHENG PREDICTED (NODE: 215) △ VS PNPP ANALYTICAL (NODE: 184)
PERRY
0.00
0.20
0.40
0.60
0.80
1.00
1.20
10⁰
2
3
4
5
6
7
8
9
10¹
2
3
4
5
6
7
8
9
10²
FREQUENCY (HZ)
JOB 796 DATE: 12/16/82


GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA DIR: VERTICAL DAMP: .020
KUOSHENG PREDICTED (NODE: 215) △ VS PNPP ANALYTICAL (NODE: 184)
ACCELERATION (G)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
PERRY
10^0
2
3
4
5
6
7
8
9
10^1
2
3
4
5
6
7
8
9
10^2
FREQUENCY (HZ)
JOB 796 DATE: 12/16/82

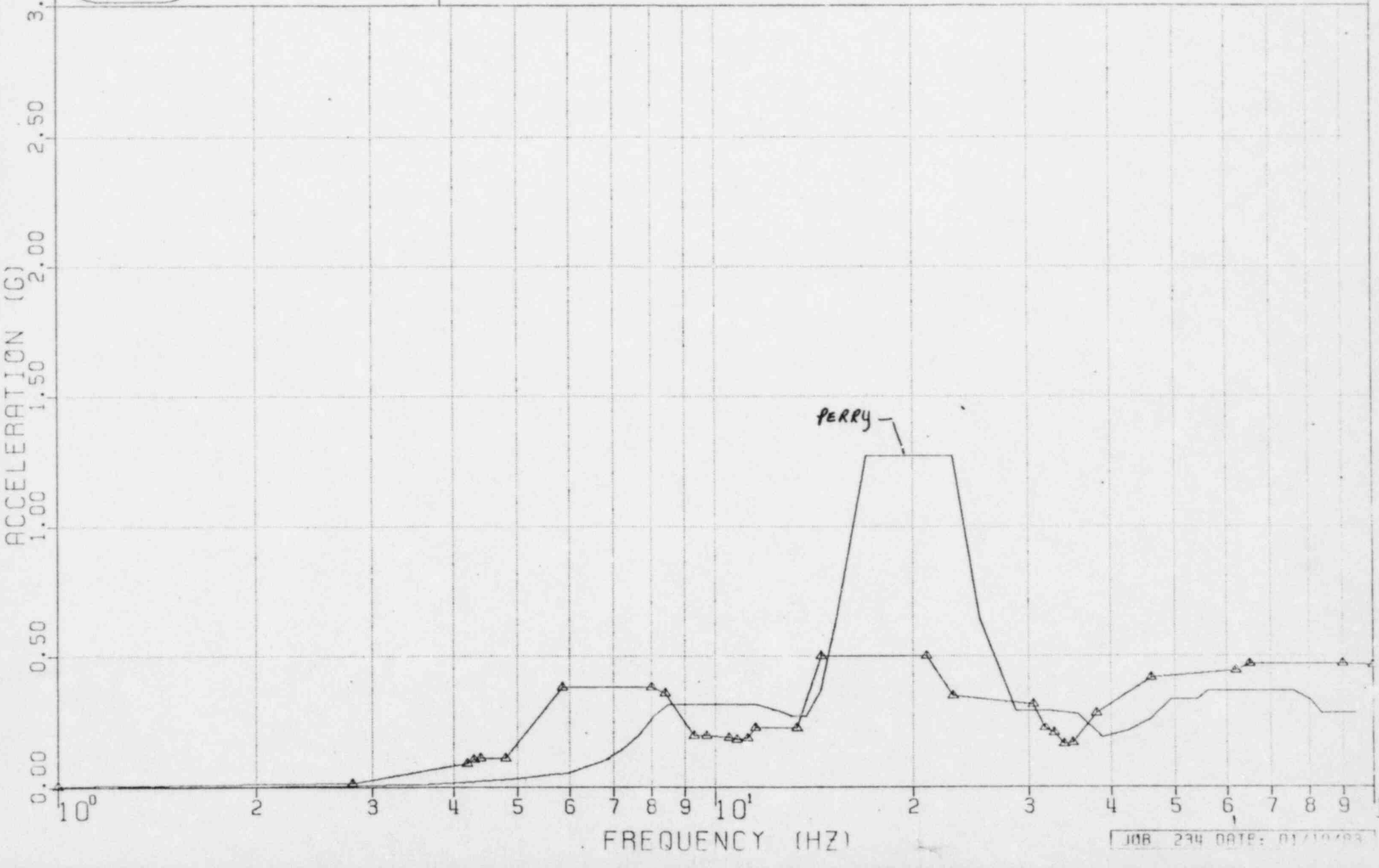

GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA DIR: RADIAL DAMP: .020
KUOSHENG PREDICTED (NODE: 291) △ VS PNPP (NODE: 212)
2.40
2.00
1.60
1.20
0.80
0.40
PERRY
10^0
2
3
4
5
6
7
8
9
10^1
2
3
4
5
6
7
8
9

GILBERT / COMMONWEALTH

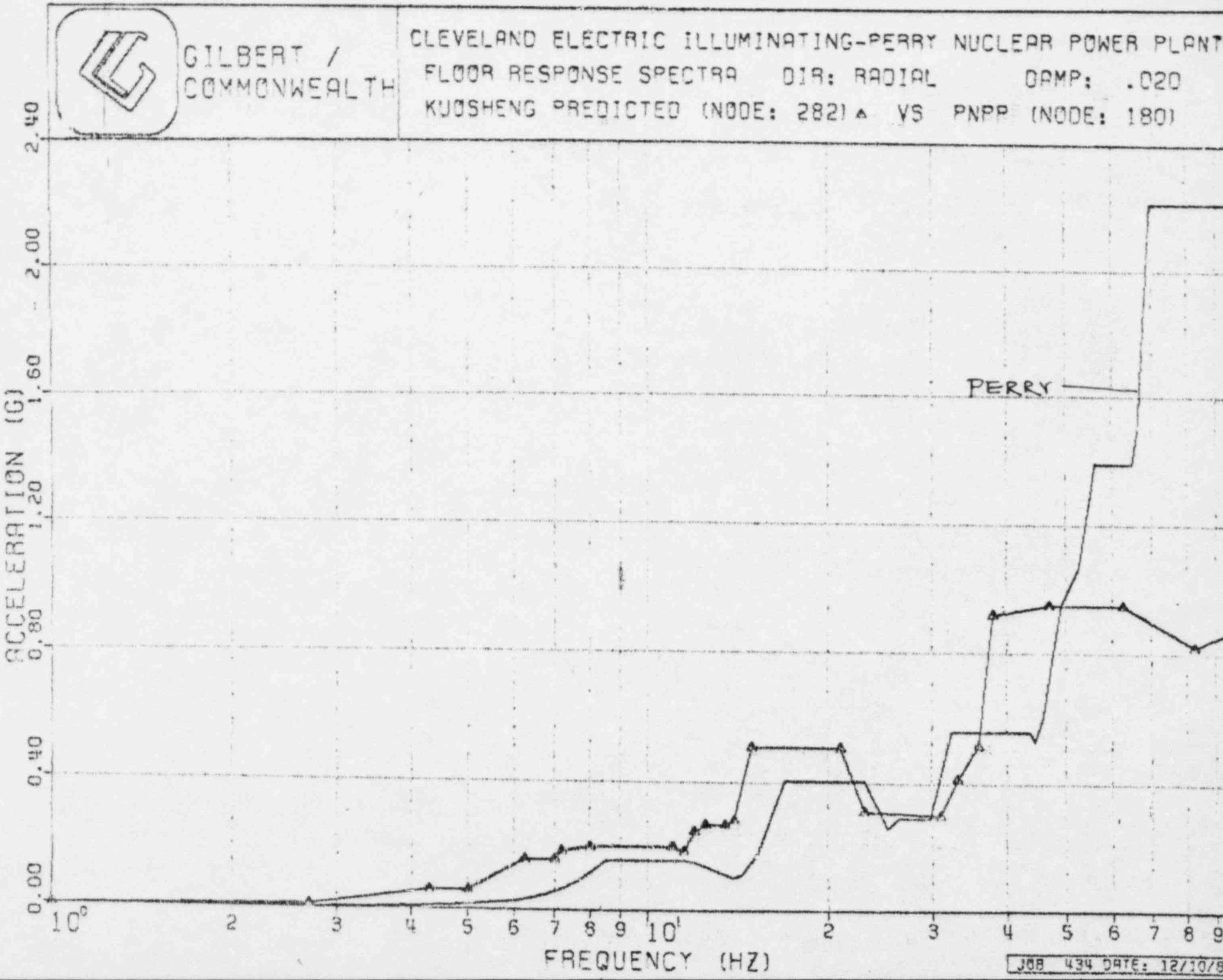
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT

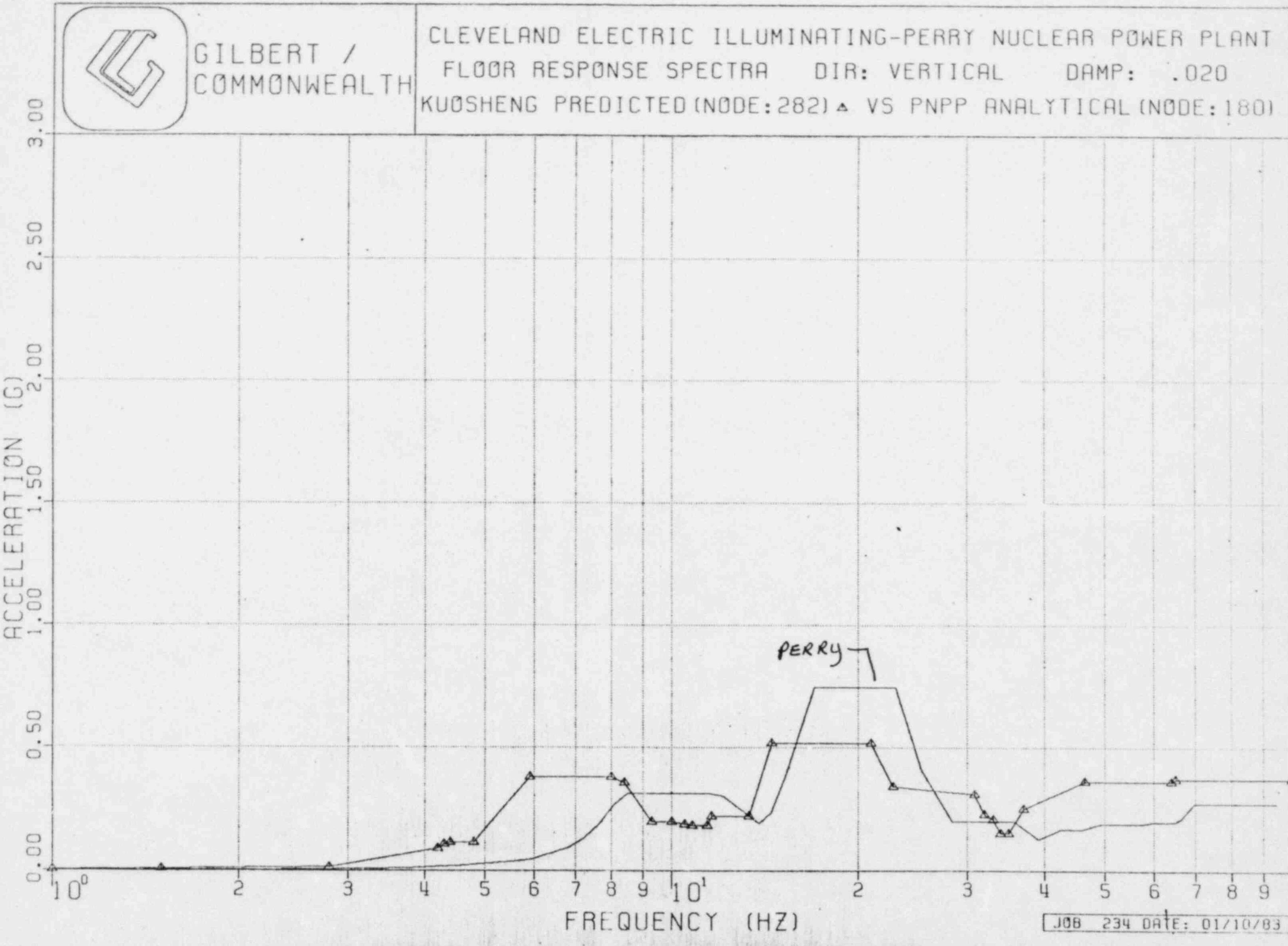
FLOOR RESPONSE SPECTRA DIR: VERTICAL DAMP: .020

KUOSHENG PREDICTED (NODE: 291) △ VS PNPP ANALYTICAL (NODE: 212)



JOB 234 DATE: 01/10/83

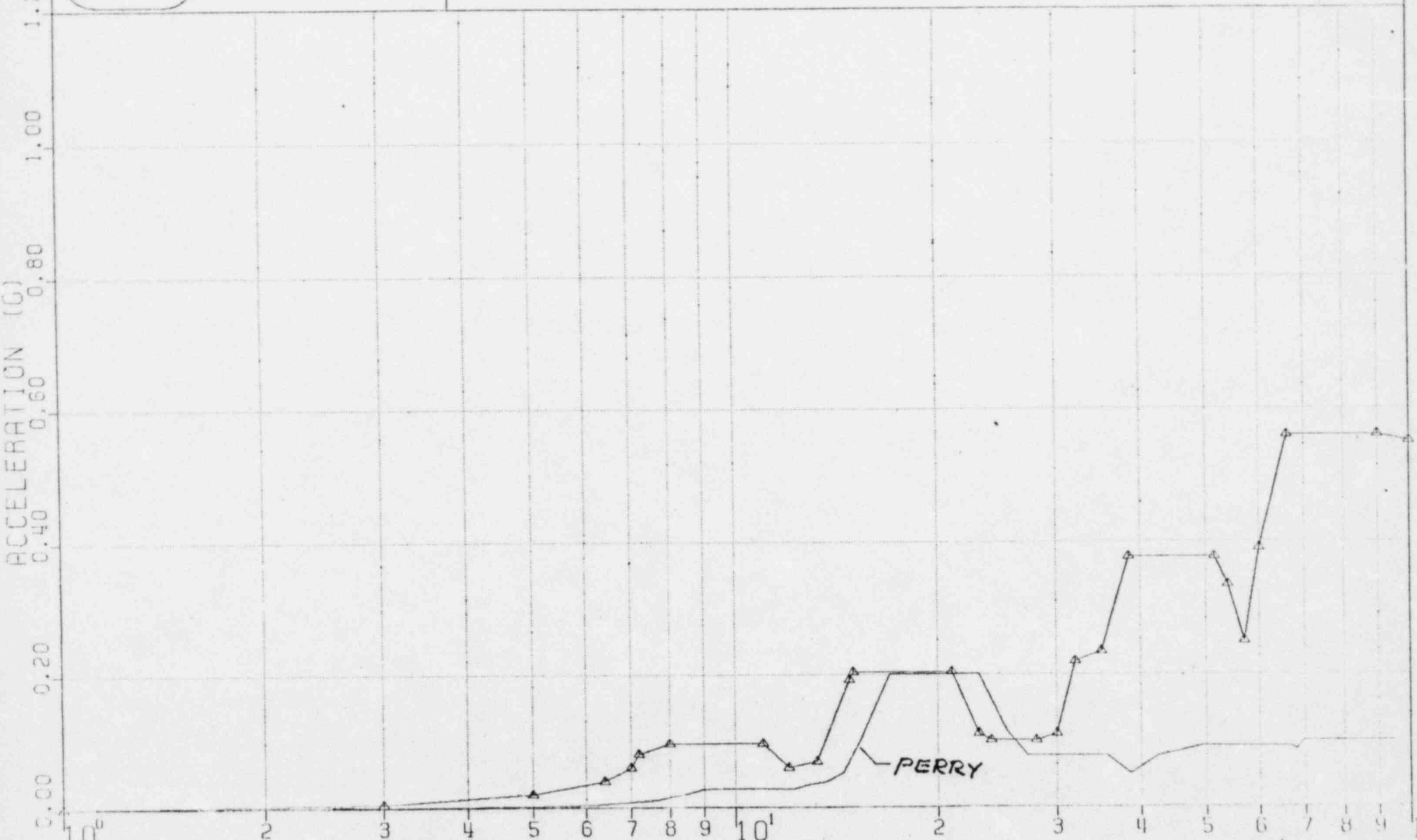

GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA DIR: RADIAL DAMP: .020
KUOSHENG PREDICTED (NODE: 282) ▲ VS PNPP (NODE: 180)
ACCELERATION (G)
0.00
0.40
0.80
1.20
1.60
2.00
2.40
PERRY
10^0
2
3
4
5
6
7
8
9
10^1
FREQUENCY (HZ)
JOB 434 DATE: 12/10/82



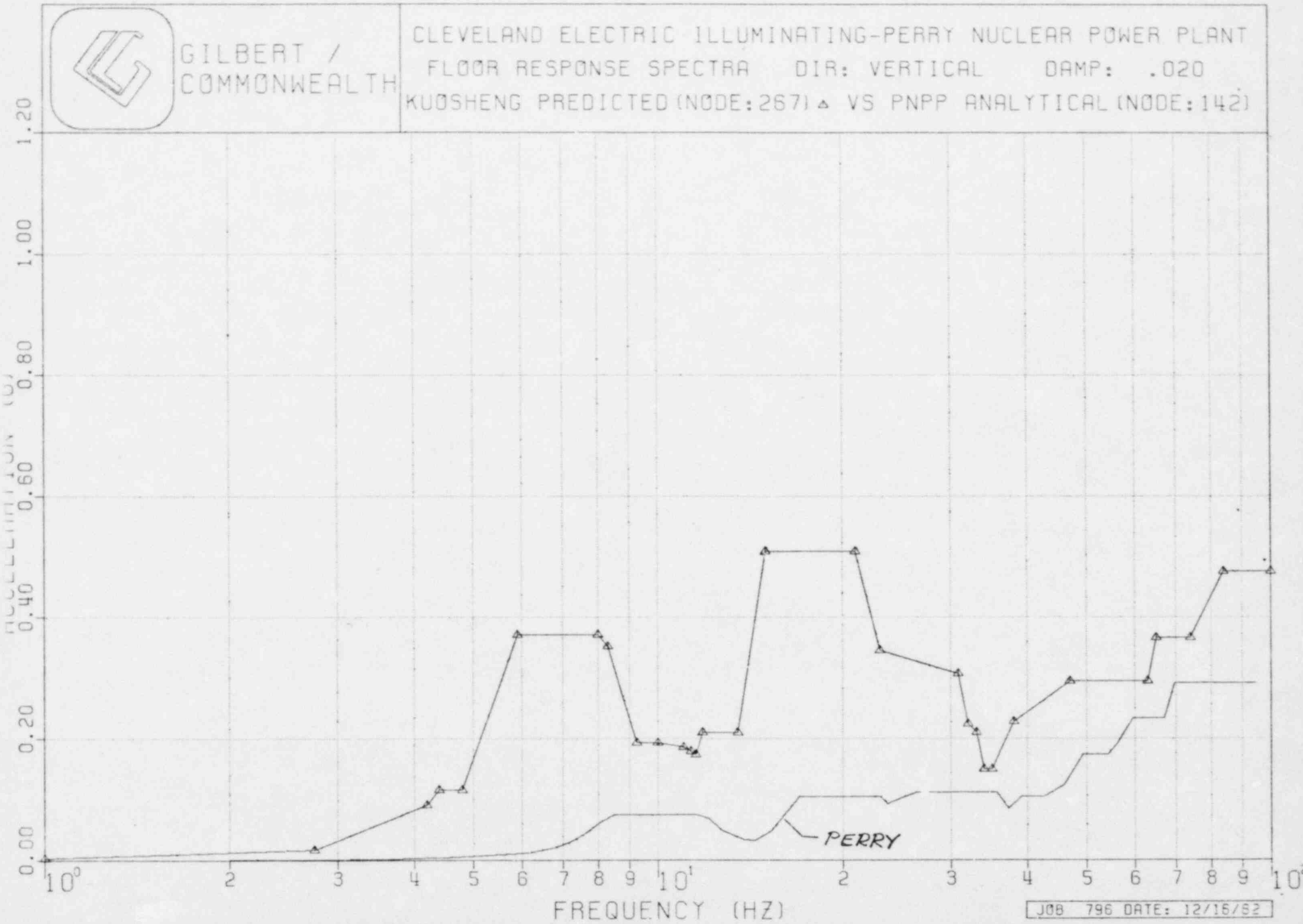
GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA DIR: VERTICAL DAMP: .020
KUOSHENG PREDICTED (NODE: 282) ▵ VS PNPP ANALYTICAL (NODE: 180)
ACCELERATION (G)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
PERRY
FREQUENCY (HZ)
JOB 234 DATE: 01/10/83

GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA DIR: RADIAL DAMP: .020
KUOSHENG PREDICTED (NODE:267) ▵ VS PNPP ANALYTICAL (NODE:142)



JOB 796 DATE: 12/16/82


GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUMINATING-PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA DIR: VERTICAL DAMP: .020
KUOSHENG PREDICTED (NODE: 267) △ VS PNPP ANALYTICAL (NODE: 142)
ACCELERATION (G)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
PERRY
FREQUENCY (HZ)
10^0
2
3
4
5
6
7
8
9
10^1
10^2
JOB 796 DATE: 12/16/82

This provides the calculations of predicted positive bubble pressures for both Kuosheng and Perry at plant conditons under which the Kuosheng SRV in-plant tests were conducted. In addition, predicted positive bubble pressures at design conditions for both plants are included. These calculations are provided herein to support the conservatism of the extrapolation factors presented in CEI's letter to the NRC dated 11/17/82. The methodology for predicting positive bubble pressures is contained in General Electric Company Document "Containment Loads Report (CLR) - Mark III Containment," 22A4365AB, Rev. 4, January, 1980.

Test conditions were established using data contained in the "Kuosheng Safety/Relief Valve In-Plant Test-Final Report" (NUTECH International Document No. ZTP-06-310, Revision 0).

Pertinent Test Conditions were as follows:

1) SRV Flowrate = 170 lb/sec = 278 MT/hr

2) Suppression Pool Temperature = 32°C

3) SRV Discharge Line Air Volume* = 45 ft^3 (Kuosheng)
50 ft^3 (Perry)

* These values are the approximate average air volume of the SRV discharge lines for the two plants, i.e., Kuosheng air volumes range from 40 to 50 ft^3, Perry air volumes range from 45 to 56 ft^3.

All other inputs to the methodology are the same as design.

Predicted positive bubble pressure, PRD1, can be calculated as follows:

$$
\begin{aligned}
PRD1 = {} & 0.253 \\
& +2.58\ (VAAQ-.1706) \\
& +0.1392\ (MNQ1-6.89) \\
& -0.0089\ (MNQ2-52.7) \\
& +0.01\ (MNQJ-6.89) \\
& +0.1377\ (LNTW-3.83) \\
& +0.206\ (WCL-4.0) \\
& -0.0176\ (WCL2-16.0) \\
& -0.000148\ (VOT-532.0) \\
& -0.0336\ (AWAQ-20.0) \\
& \underline{+0.000761\ (AWQ2-400.0)} \\
= {} & \underline{\hspace{3cm}}\ \text{BARS}
\end{aligned}
$$

Definitions for all terms are contained in GE's Containment Load Report. All pertinent geometric data are contained in Table 3 of CEI's letter to the NRC dated 10/15/82.

The Kuosheng variables at test conditions were as follows:

VAAQ = 45/74.66 = .603 ft = .184m

MNQ1 = 6.89

MNQ2 = 47.47

$$MNQJ = (278)^{.7} / 74.66 \times \frac{1}{.093 m^2/ft^2} = 7.40$$

LNTW = ln(32) = 3.466

WCL = 5.46

WCL2 = 29.77 m^2

VOT = 20msec

AWAQ = 20

AWQ2 = 400

The PRD1 equation for Kuosheng therefore becomes:

PRD1	=	0.253	0.253
		+2.58 (.184-.1706)	+0.0346
		+.1392 (6.89-6.89)	0
		-.0089 (47.47-52.7)	+0.0466
		+.01 (7.4-6.89)	+0.0051
		+.1377 (3.466-3.83)	-0.0501
		+.206 (5.46-4.0)	+0.3008
		-.0176 (29.77-16.0)	-0.2423
		-.000148 (20-532.0)	+0.0758
		-.0336 (20.0-20.0)	0
		+.000761 (400-400.0)	0
			0.4235 Bars

Perry variables at test conditons are the same as Kuosheng with the exception of the following:

VAAQ = 50/74.66 = .669ft = .204 m

WCL = 5.3

WCL2 = 28.1

The Perry PRD1 equation becomes:

$$
\begin{aligned}
PRD1 = (.253 + .0466 + .0051 + .0758) = \quad & .330 \\
+2.58\ (.204 - .1706) \quad & +.086 \\
+.206\ (5.3 - 4.0) \quad & +.2678 \\
-.0176\ (28.1 - 16.0) \quad & \underline{-.213} \\
& .471 \text{ Bars}
\end{aligned}
$$

The PRD1's at design conditions for Kuosheng and Perry are .537 and .595 Bars, respectively. These values are contained in Table 3 of CEI's letter to the NRC dated 10/15/82. Based on these PRD1's and the PRD1's calculated at test conditions, the extrapolation factor for test pressures to design pressures would be $\frac{.537}{.424} = 1.27$ for Kuosheng and $\frac{.595}{.471} = 1.26$ for Perry. In addition, the ratio between Perry PRD1's at either design or test conditions to Kuosheng PRD1's at either design or test conditions are essentially equal i.e., $\frac{.595}{.537} = 1.11$ or $\frac{.471}{.424} = 1.11$.

The use of these factors are more conservative than adding the absolute difference between Kuosheng test and design PRD1's (.113 bars = 1.64 psid) to the absolute difference between Kuosheng design and Perry design PRD1's (.058 bars - .84 psid). This is clearly represented below:

6.59 psid x 1.26 x 1.11 = 9.22 psid

6.59 psid + 1.64 psid + .84 psid = 9.07 psid

Using the extrapolation factors produces a slightly higher peak pool pressure than the alternate method when the measured pool pressure is greater than 6.0 psid.

Based on these calculations, the extrapolation factor for upgrading Kuosheng test data to Perry pressures at design conditions has been conservatively selected in CEI's letter to NRC dated 11/17/82 as 1.4, i.e., 1.26 x 1.11.