STONE & WEBSTER ENGINEERING CORPORATION

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January 3, 1980

Mr. Harold Denton
Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

During the process of collecting pipe support loads for use in the IE Bulletin 79-02 Baseplate Evaluations, it came to our attention that some of the pipe supports on 2 1/2 to 6 inch piping on the Beaver Valley 1 Power Station are designed for loads that were derived from Shock 2 Computer calculations.

It had previously been thought that the calculations of record for these supports were simplified manual calculations.

In response to the telephone request by your Messrs. Wigginton and Wychman, we have obtained the following information with respect to the other projects that were affected by the March 13, 1979 Order to Show Cause:

Surry 1 and 2 - No Shock 2 computer runs were identified in connection with 6 inch and under piping.

Maine Yankee - There were a number of Shock 2 runs identified in connection with 6 inch and under piping and all were reanalyzed as a part of the Show Cause reanalysis.

J. A. FitzPatrick- There were no Shock 2 runs identified in connection with 6 inch and under piping.

We do not believe that there are any safety implications from this finding since previous reanalysis of Shock 2 calculations did not result in any significant changes.

Very truly yours,

W. J. L. Kennedy
Director of Engineering

1-3-80

Tovell
Beckman
Casey

DW, Wichman
Jack Severa

Tagyen
King
Frank Torabi

Rejections:

9 problems w/ Shark 2
Were in B-2 Table on Shark 2 check-cables

9 problem – 63 suggests
43 were designed w/ Hard color
15 were " w/ Shark 2 Loads
5 " " will work less than simplified method

Systems involved:
6" Fuel Pool line to inside Containment
3" Charging Line to Reg. Hot Leg inside containment & outside.
3" Safety Injection Line from BIT outside containment.
4" RHR discharge line to pressurizer relief tank.
6" CCW line to RC Pumps.

S+W given OK to use Norge.
S+W are using as billets.
" have begun on CCW.

S+W proceed to update previous Report and add Plan w/g mistake.

EG&G Idaho, Inc.

P. O. Box 1625
Idaho Falls, Idaho 83401

July 13, 1979

Mr. R. E. Tiller, Director
Reactor Operations & Program Division
Idaho Operations Office - DOE
Idaho Falls, ID 83401

SEISMIC REEVALUATION OF PIPING ASSOCIATED WITH THE NRC SHOW CAUSE ORDER OF MARCH 13, 1979, BEAVER VALLEY POWER PLANT (A6156) - JAD-146-79

Dear Mr. Tiller:

Attachment 1 documents the technical assistance EG&G Idaho, Inc. provided to NRC-NRR in their re-review of certain Beaver Valley Power Plant piping systems. Attachment 2 is the input provided by the NRC to perform the audit calculation described in Attachment 1 and is returned by this transmittal to R. G. LaGrange, NRC-DOR. This transmittal completes Node PA-16 page 21 of the A6156 PERT chart dated June 8, 1979.

Very truly yours,

J. A. Dearien, Manager
Code Assessment and
Applications Program

BFS:srw

Attachments:
As Stated

cc: R. G. LaGrange, NRC-DOR
R. W. Kiehn, EG&G Idaho w/o attachments

Attachment 1

BEAVER VALLEY POWER STATION UNIT 1
PIPING REEVALUATION

D. K. Morton
G. L. Thinnes
R. W. Macek

INTRODUCTION

EG&G Idaho personnel are, at the request of NRC-DOR Engineering Branch, participating in the seismic review of safety related piping systems at the five plants affected by the NRC Show Cause Order of March 13, 1979. The scope of this effort includes participating in meetings of the plant specific NRC review teams, performing audit calculations, and performing miscellaneous technical assistance.

In response to a March 21, 1979 request from the Nuclear Regulatory Commission's Division of Operating Reactors, a visit was made by EG&G Idaho and NRC personnel to the Beaver Valley Power Station (BVPS) Unit 1 on March 23, 1979. The purpose of the visit was to acquaint the personnel with BVPS and prepare for the review. Three meetings were held in Boston, Massachusetts (March 29 & 30, April 11 & 12, and June 5, 6, & 7,) at Stone & Webster to initiate the review of the various piping system analyses.

Five safety related systems (Stone and Webster Problems 203C, 783A, 204, 255A, and 1200B) were chosen for independent audit review. Figures 1 through 7 are computer model plots of these piping systems. EG&G Idaho received the final data necessary to perform the review on April 23. Preliminary results were supplied over the telephone to the NRC on May 4 and selected EG&G Idaho results, compared to Stone and Webster results, were transmitted to the NRC on May 8.

ANALYSIS

This audit review entailed performing response spectrum seismic analyses using independently formulated finite element models. Several parameters were varied in the audit review to assess areas of concern. The Stone and Webster results are believed to be based on rigid ($\approx 10^{16}$ lb/in.) rather than an estimate support stiffness value ($\approx 10^{6}$-10^{7} lb/in.) and not to have considered the current requirements for closely spaced modes as outlined in Regulatory Guide 1.92. Some uncertainty existed as to what change in magnitude would occur when using SRSS instead of algebraic summation methods of intramodal spatial combination. Table I defines the parameters varied for performing case by case comparisons. No valve eccentricities were supplied and, therefore, were not reflected in the audit calculations.

Two sets of earthquake spectra were used in each analysis. The first was for an operational basis earthquake (OBE) and the second was for a design basis earthquake (DBE). Figures 8 through 19 are the response spectrum used in the audit calculations. Table II lists which types of seismic displacements were supplied with each problem. Seismic displacements were applied exactly as Stone and Webster data indicated. No attempt was made to obtain a worst case combination.

The EG&G Idaho audit calculations were performed using the Nuclear Services Corporation (Campbell, California) computer code NUPIPE-II. This version of NUPIPE-II uses normal SRSS techniques for

TABLE I

CASES COMPLETED

	OBE	DBE
Best Estimate Restraints	Yes	Yes
Rigid Restraints	Yes	Yes
Without Closely Spaced Modes	Yes	Yes
Algebraic Sum	Yes	Yes
SRSS	Yes	Yes

TABLE II

SEISMIC DISPLACEMENTS

S&W Problem	OBE Anchor	DBE Anchor	OBE Intermediate Constraint	DBE Intermediate Constraint
203C	No	Yes	No	No
204	No	No	No	No
1200B	No	Yes	No	No
255A	Yes	Yes	Yes	Yes
783A	Yes	Yes	Yes	Yes

combining seismic response. The "algebraic sum" cases were performed using a version of the NUPIPE-II computer code modified specifically for this effort.

RESULTS

A direct comparison between EG&G Idaho results and Stone and Webster SHOCK II results was made (Tables III-VIII). The selected results compared reasonably well except for Problems 783A and 1200B. Problem 1200B indicates a significant difference (factor of 3.5) in results using algebraic sum versus SRSS on the seismic response combination. Problem 783A also indicates a significant difference in results (factor of 2.3) due to the seismic response combination method used. In addition, Problem 783A highlights how stress results can change by using an estimated support stiffness rather than assuming rigid supports. In this one case, stresses due only to seismic response increased by a factor of 2.2.

CONCLUSION

The results of the BVPS audit calculations indicate that seismic stresses may be significantly altered depending on support stiffnesses used and which method of seismic response combination (algebraic sum vs SRSS) is employed. However, all calculated stress levels were below code allowables.

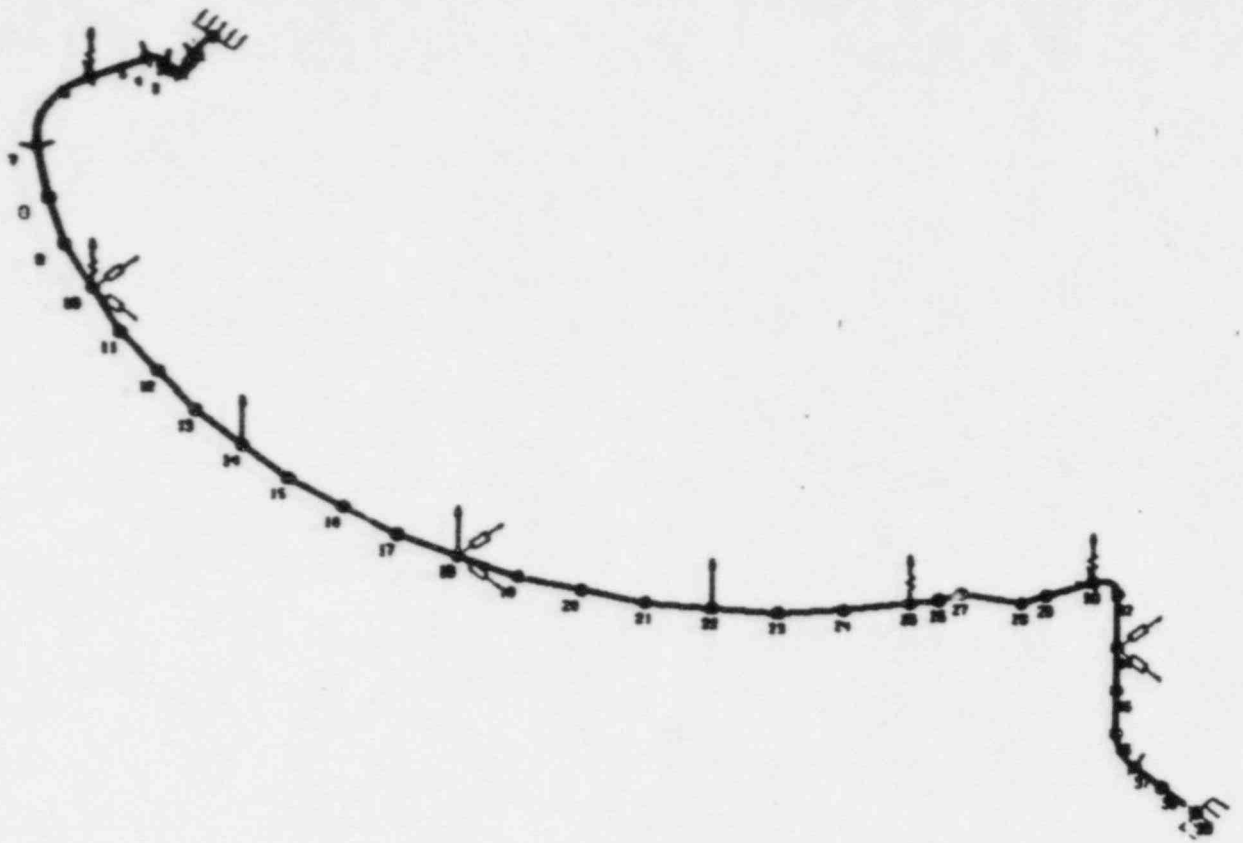


Figure 1. Problem No. 783A NUPIPE-II Model

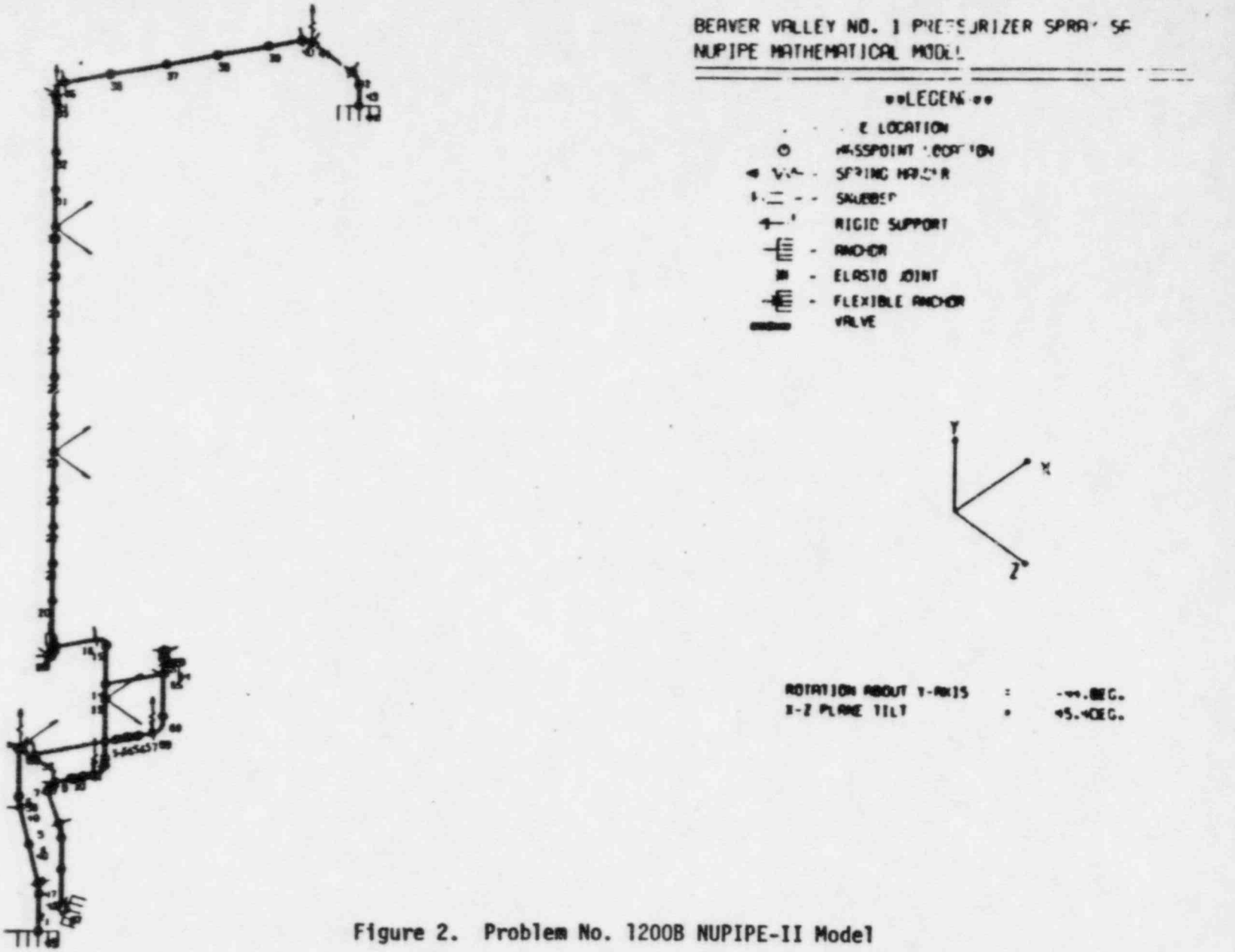
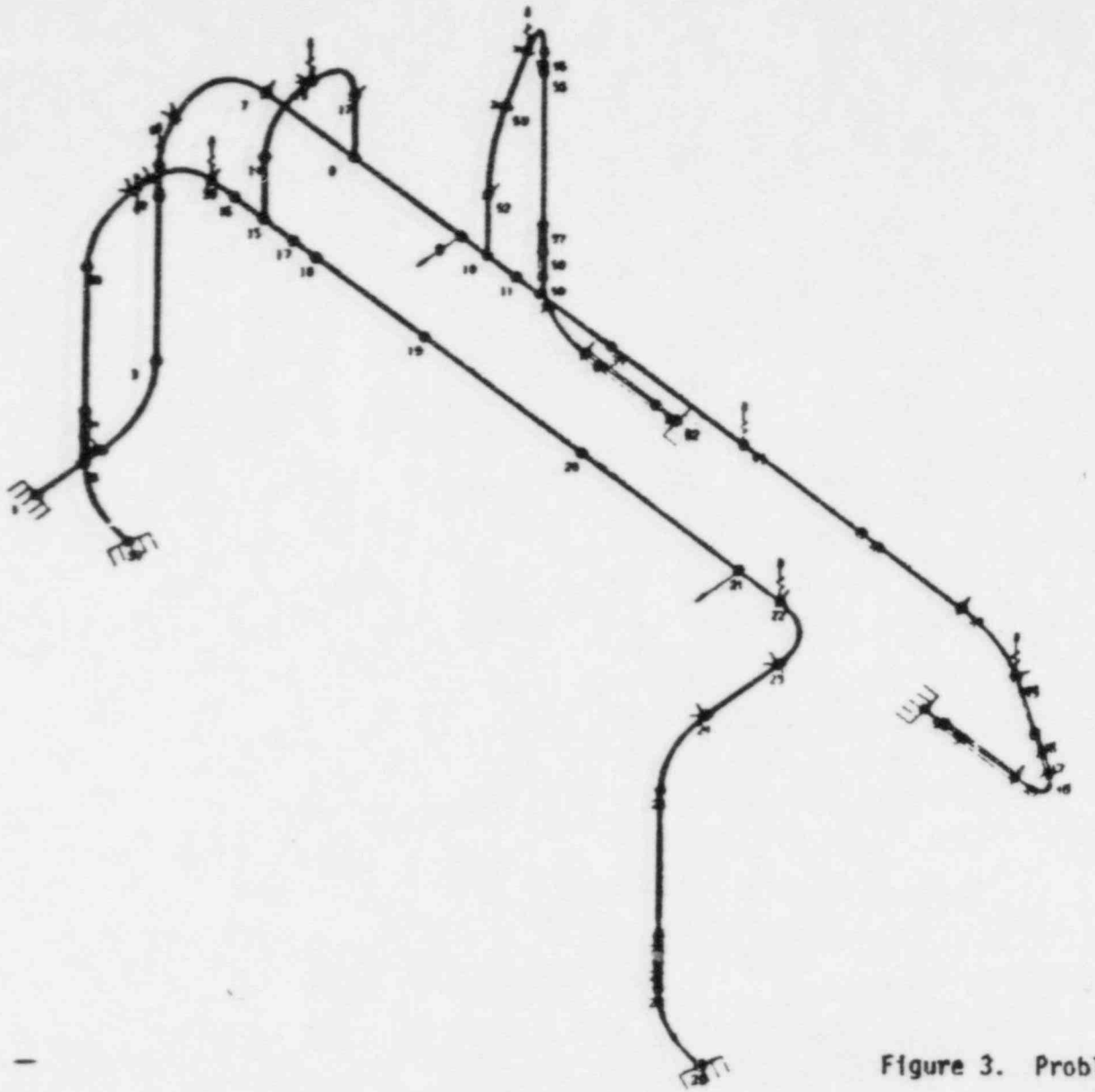


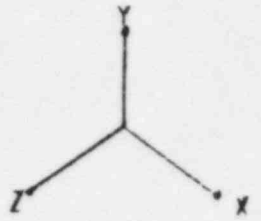
Figure 2. Problem No. 1200B NUPIPE-II Model



BEAVER VALLEY NO. 1 RHR SYSTEM PROB. NO.
NUPIPE MATHEMATICAL MODEL

LEGEND

- / - NODE LOCATION
- ⊙ - MASSPOINT LOCATION
- SPRING, HANGER
- SNUBBER
- RIGID SUPPORT
- ANCHOR
- ELASTO JOINT
- FLEXIBLE ANCHOR
- VALVE



ROTATION ABOUT Y-AXIS = 45.0000.
X-Z PLANE TILT = 45.0000.

Figure 3. Problem No. 255A NUPIPE-II Model (Part 1,

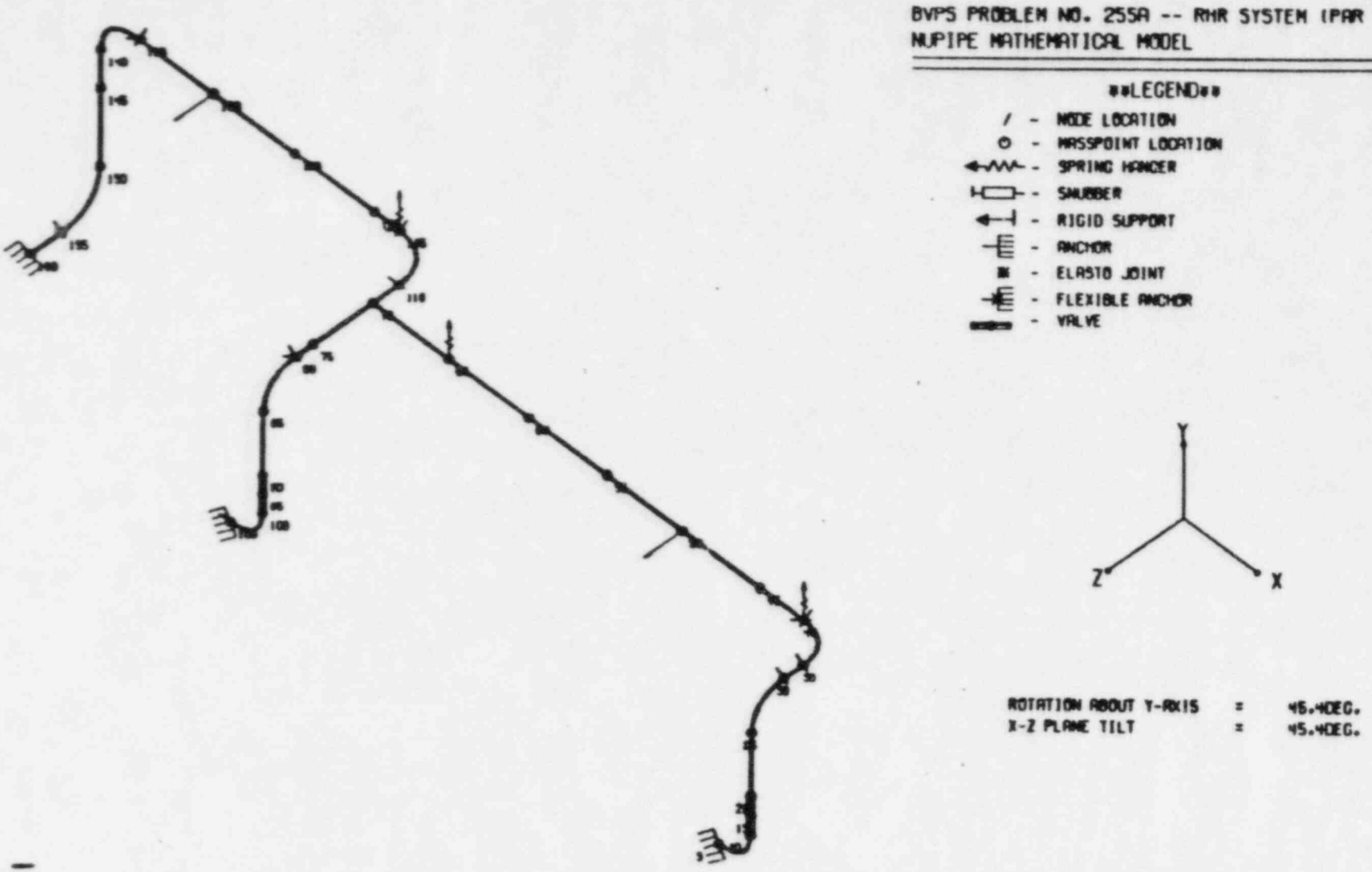


Figure 4. Problem No. 255A NUPIPE-II Model (Part 2)

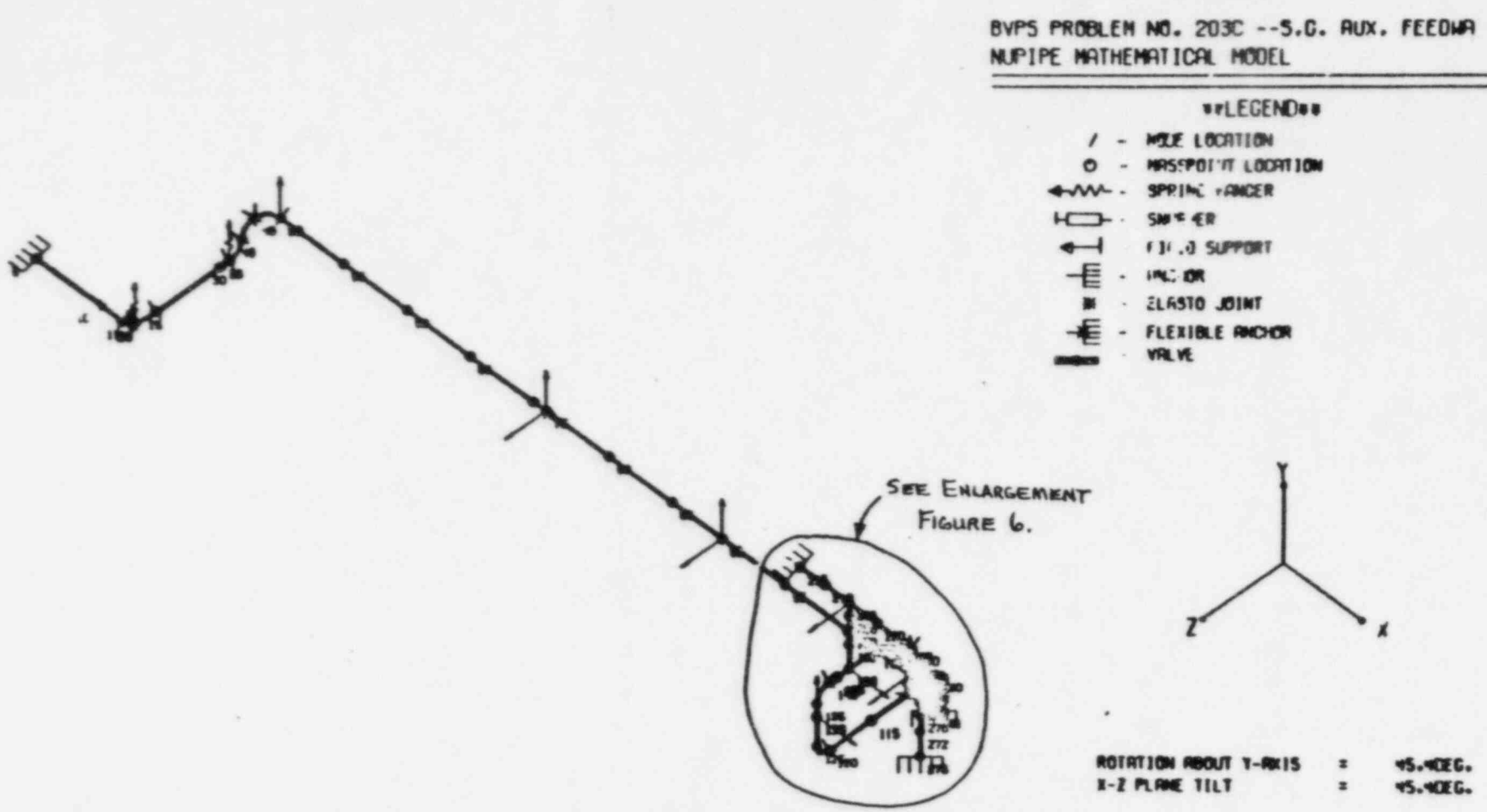


Figure 5. Problem No. 203C NUPIPE-II Model

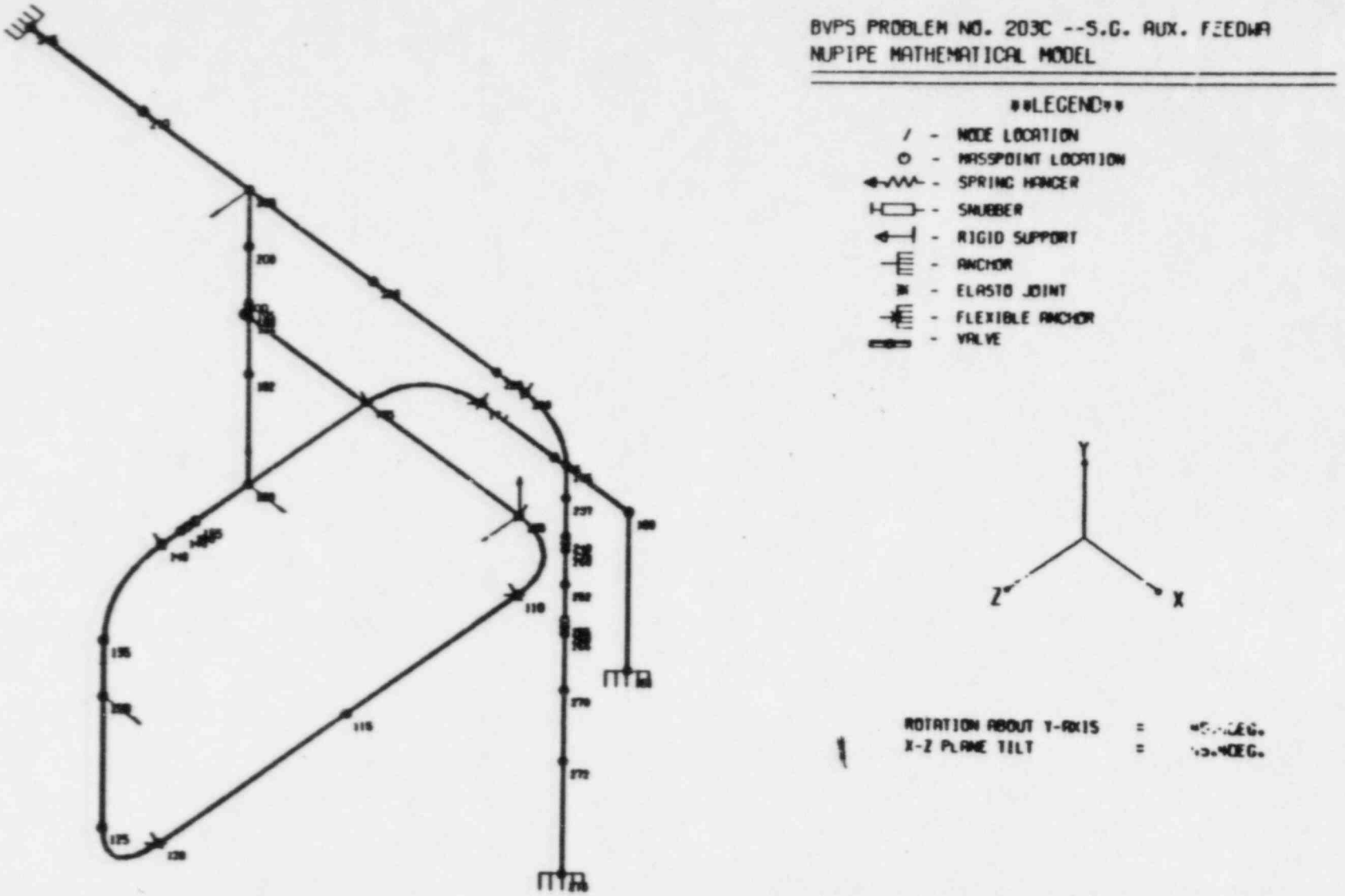


Figure 6. Enlargement of Portion of Problem No. 203C

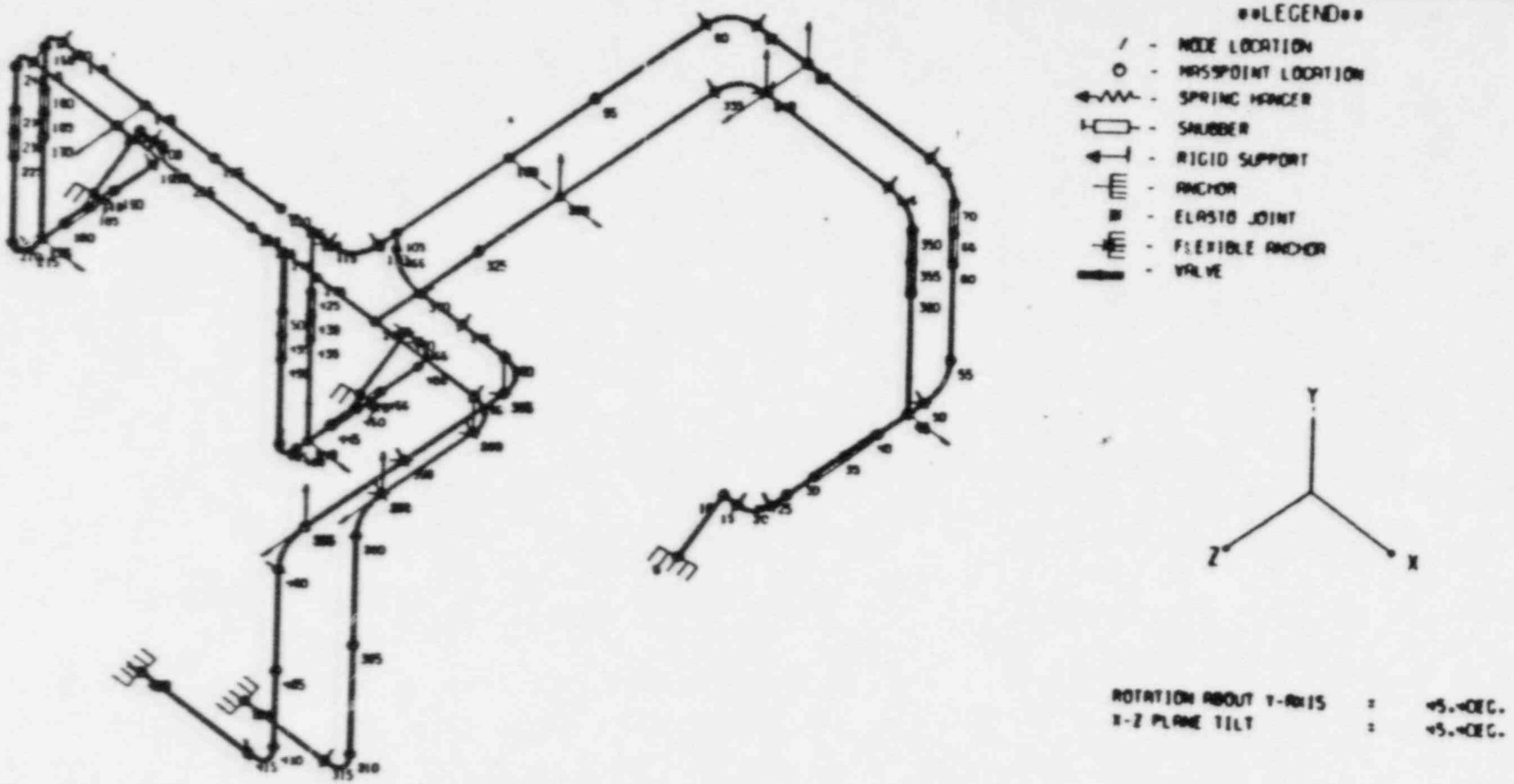


Figure 7. Problem No. 204 NUPIPE-II Model

TABLE III

PLANT: BEAVER VALLEY LINE: 16"-WFPD-22-601 PROB NO.: 783A

Load Case	Snubber & Hanger Support Stiffness Estimate		Snubber & Hanger Support Stiffness Rigid		S&W	Allowable	Ratio	
	SRSS ①	Algb Sum ②	SRSS ③	Algb Sum ④			①/②	③/④
Dead Load + P	6022	X	X	6035	7299	15,000	X	X
Dead Load + P + OBE	12,172	X	X	8854	15,677	18,000	X	X
Dead Load + P + DBE	13,054	X	X	9824	22,313	27,000	X	X
OBE	7617	3265	4091	3399	X	X	2.33	1.20
DBE	8517	4267	3794	4369	X	X	2.00	.87

No anchor movements included in audit results.

No closely spaced modes.

Stress summary data are maximum values irregardless of location.

Anchor movement loads calculated consist of all constraint displacements supplied. It is believed that S&W included their anchor displacements in their primary stress calculations. Due to the fact that they used only the end anchor displacements, this contribution was small. If the intermediate constraint displacements are also included, the OBE combined stress for Case I would be about 25% over allowable while the DBE stress would be about 10% over. If the seismic anchor stresses are included in the secondary stress calculations instead of the primary, as permitted in current code criteria, all stresses would be under allowable.

Hanger H-6 which was not shown on the work sketch was modeled at the location shown on the hanger drawings.

Modes 1 and 2 were the primary contributors to the seismic stress.

The effect of changing dynamic support stiffnesses from magnitudes in the 10^{16} range to 10^{6} range shifted the first two modal frequencies as from 3.836 hz and 6.594 hz for 10^{16} to 3.807 hz and 5.463 hz for 10^{6}. This shifts the second mode into a part of the spectrum.

TABLE IV

PLANT: BEAVER VALLEY UNIT NO. 1 LINE: Pressurizer Spray, Safety & Relief System PROB NO.: 1200B

Load Case	Snubber & Hanger Support Stiffness Estimate		Snubber & Hanger Support Stiffness Rigid		S&W	Allowable	Ratio	
	SRSS ①	Algb Sum ②	SRSS ③	Algb Sum ④			①/②	③/④
Dead Load + P	5846 psi	X	X	5046 psi	7976	16000 psi	X	X
Dead Load + P + OBE	13 084 psi	X	X	7422 psi	16873	19200 psi	X	X
Dead Load + P + DBE	13728 psi	X	X	7584 psi	15930	28800 psi	X	X
OBE	8051 psi	2349 psi	8050 psi	2347 psi	X	X	3.43	3.43
DBE	8695 psi	2509 psi	8695 psi	2507 psi	X	X	3.47	3.47

No anchor movements included in tabulated audit results.

No closely spaced modes.

Stress summary data are maximum values irregardless of location.

Anchor movement loads calculated consist of all constraint displacements supplied using only the direction indicated by S&W. No OBE anchor movements were supplied. No intermediate earthquake constraint movements were supplied. It appears that S&W included earthquake anchor movements in their primary stress calculation. Our results indicate as S&W's do that the primary stresses with anchor movements included are within allowable for the DBE.

Modes 1 and 2 are the primary contributors to the seismic stress.

The effect of changing constraint and dynamic support stiffnesses from 10^5 to 10^{16} on the first two modal frequencies are small for this problem.

No valve eccentricities were given, therefore, our model does not reflect this effect.

TABLE V

PLANT: BEAVER VALLEY UNIT 1 LINE: RHR System PROB NO.: 255A 1 of 2

Load Case	Snubber & Hanger Support Stiffness Estimate		Snubber & Hanger Support Stiffness Rigid		S&W	Allowable	Ratio	
	SRSS ①	Algb Sum ②	SRSS ③	Algb Sum ④			①/②	③/④
Dead Load + P	5885 psi	X	X	5885 psi	6111	16300 psi	X	X
Dead Load + P + OBE	6444 psi	X	X	6378 psi	7719	19560 psi	X	X
Dead Load + P + DBE	6791 psi	X	X	6663 psi	8898	29340 psi	X	X
OBE	959 psi	1241 psi	956 psi	1241 psi	X	X	.77	.77
DBE	1382 psi	1793 psi	1377 psi	1792 psi	X	X	.77	.77

No anchor movements included in tabulated audit results.

No closely spaced modes.

Stress summary data are maximum values irregardless of location.

Anchor movement calculated loads consist of all constraint displacements supplied. OBE & DBE anchor movements and intermediate constraint movements were given.

All modes were at the zero period acceleration level. Three to four modes provided the primary contribution to the response.

The effect of changing constraint stiffnesses on system frequency was small.

S&W may have included earthquake anchor movements in their primary stress calculation. Since the earthquake anchor movement stresses are low (3000 psi) it doesn't make much difference where they are included.

TABLE VI

PLANT: BEAVER VALLEY LINE: RHR System PROB NO.: 255A 2 of 2

Load Case	Snubber & Hanger Support Stiffness Estimate		Snubber & Hanger Support Stiffness Rigid		S&W	Allowable	Ratio	
	SRSS ①	Algb Sum ②	SRSS ③	Algb Sum ④			①/②	③/④
Dead Load + P	6649	X	X	6630	---	16300	X	X
Dead Load + P + OBE	8257	X	X	8125	---	19560	X	X
Dead Load + P + DBE	8497	X	X	8382	---	29340	X	X
OBE	721	745	581	639	X	X	.97	.91
DBE	993	1034	862	909	X	X	.96	.95

No anchor movements included in tabulated audit results.

No closely spaced modes.

Stress summary data are maximum values irregardless of location.

TABLE VII

PLANT: BEAVER VALLEY LINE: S.G. Aux. Feedwater PROB NO.: 203C

Load Case	Snubber & Hanger Support Stiffness Estimate		Snubber & Hanger Support Stiffness Rigid		S&W	Allowable	Ratio	
	SRSS ①	Algb Sum ②	SRSS ③	Algb Sum ④			①/②	③/④
Dead Load + P	3110	X	X	3106	3634	15000	X	X
Dead Load + P + OBE	4719	X	X	4202	5909	18000	X	X
Dead Load + P + DBE	5029	X	X	5170	6751	27000	X	X
OBE	3498	3550	3500	3536	X	X	1.00	.99
DBE	4360	4424	4459	4505	X	X	1.00	.99

No anchor movements.

No closely spaced modes.

Stress summary data are maximum values irregardless of location.

The first three modes are:

Best Estimate Stiffness	Rigid Stiffness
1. 12.509 cps	1. 12.559
2. 13.618	2. 13.684
3. 15.039	3. 15.053

Three modes, to [illegible] primary contribution to the response.

TABLE VIII

PLANT: BEAVER VALLEY LINE: S.G. Aux. Feedwater (Discharge) PROB NO.: 204

Load Case	Snubber & Hanger Support Stiffness Estimate		Snubber & Hanger Support Stiffness Rigid		S&W	Allowable	Ratio	
	SRSS ①	Algb Sum ②	SRSS ③	Algb Sum ④			①/②	③/④
Dead Load + P	5371	X	X	5440	5138	15000	X	X
Dead Load + P + OBE	8225	X	X	8380	7323	18000	λ	X
Dead Load + P + DBE	8860	X	X	8931	10842	27000	X	X
OBE	4098	4762	3697	4263	X	X	.86	.87
DBE	4734	5347	4318	4814	X	X	.89	.90

No anchor movements included in tabulated audit results.

No closely spaced modes.

Stress summary data are maximum values irregardless of lecation.

No seismic anchor movements specified.

For the EG&G Idaho analysis, rod hangers were input in dynamic support configuration. S&W apparently did not include them in their seismic analysis.

The first two modes provided the primary contribution to the response.

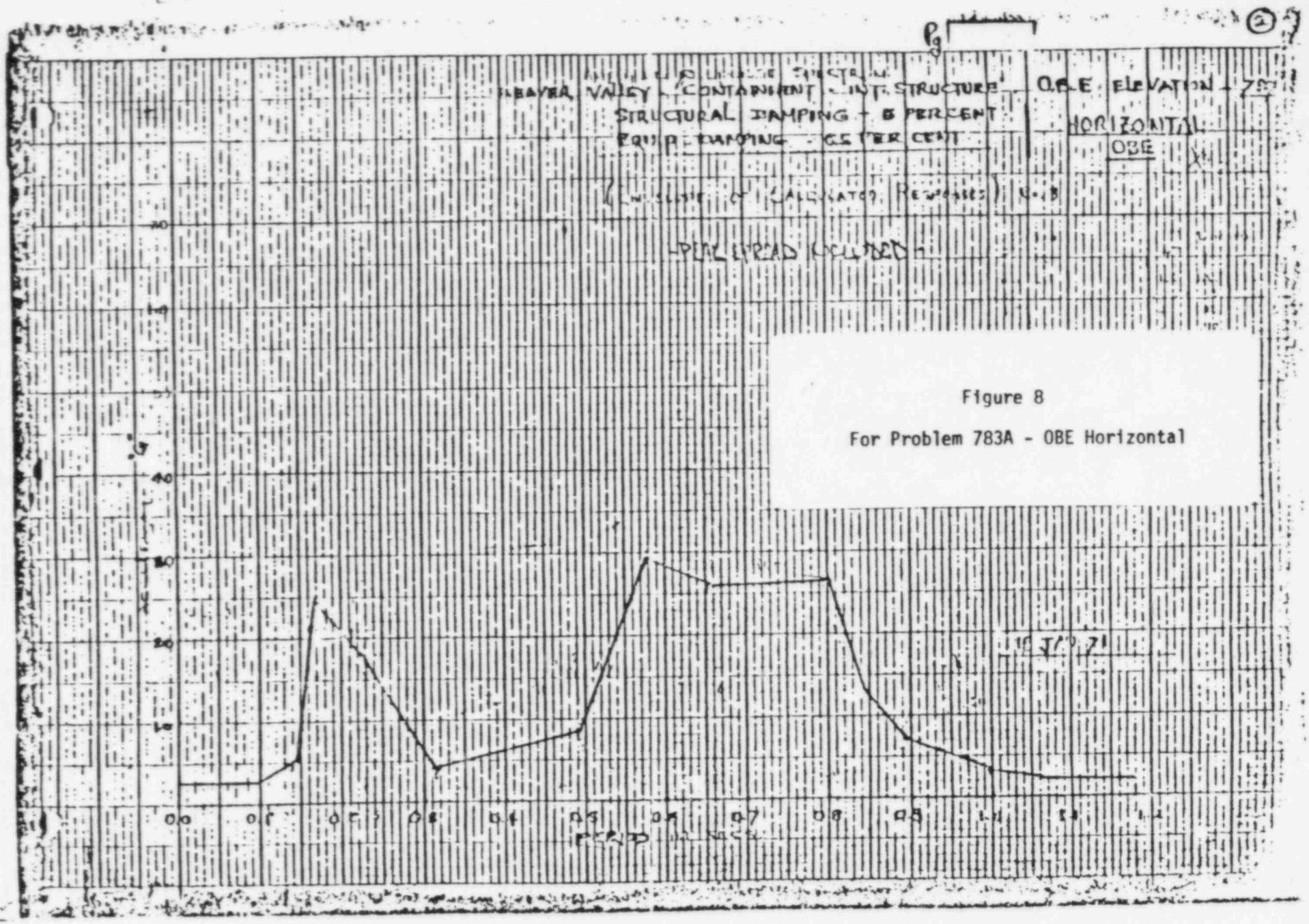


Figure 8

For Problem 783A - OBE Horizontal

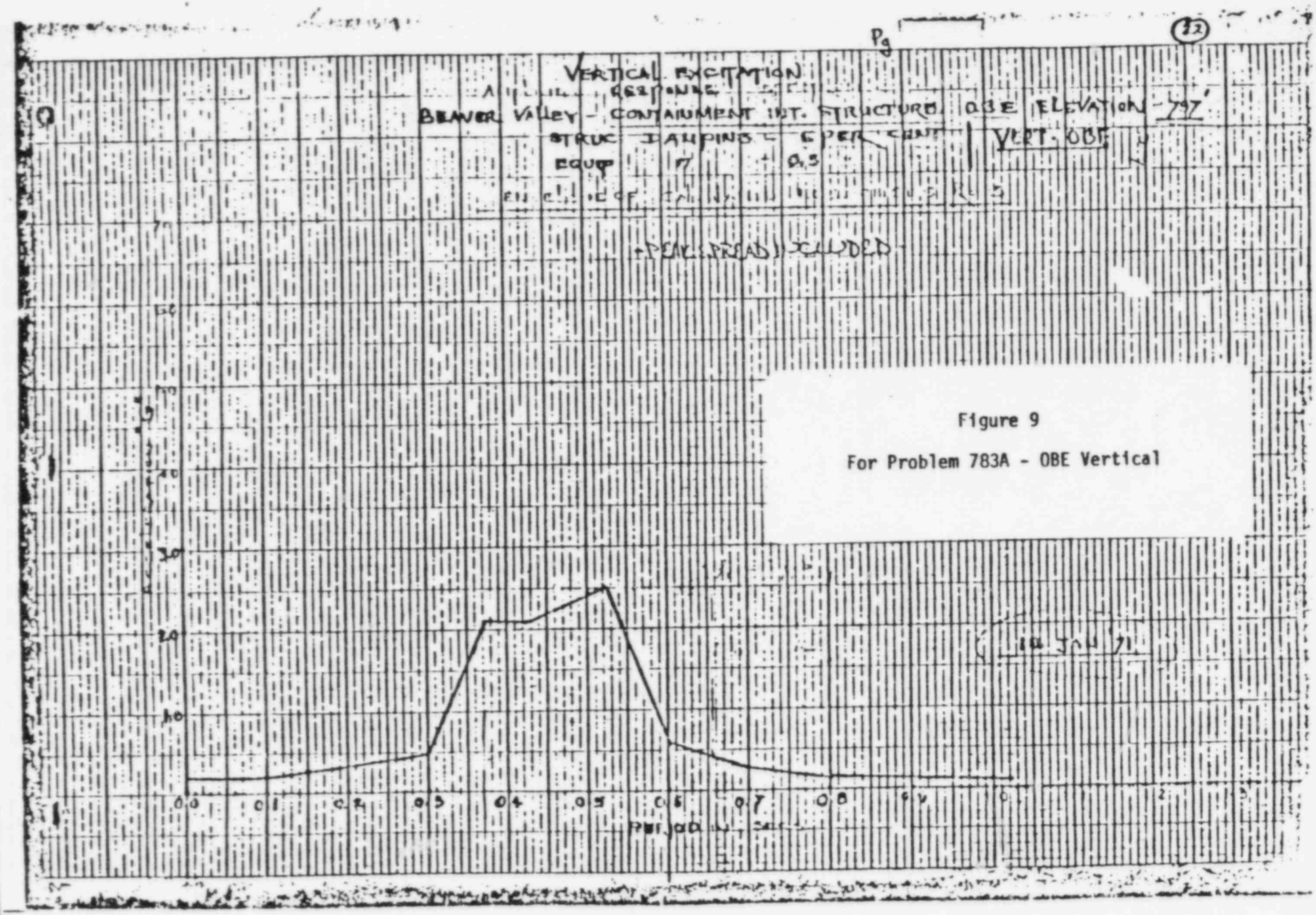


Figure 9

For Problem 783A - OBE Vertical

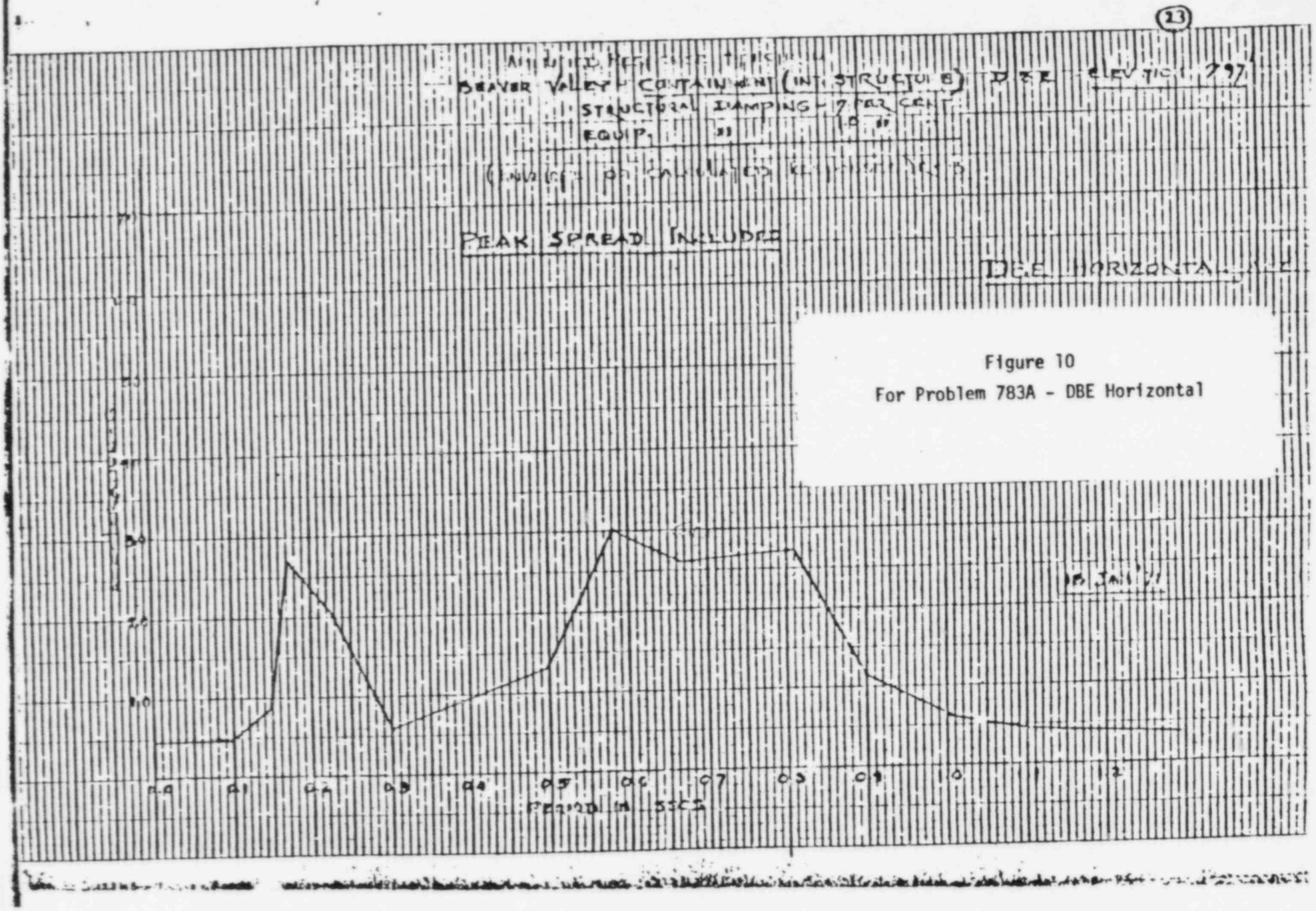


Figure 10
For Problem 783A - DBE Horizontal

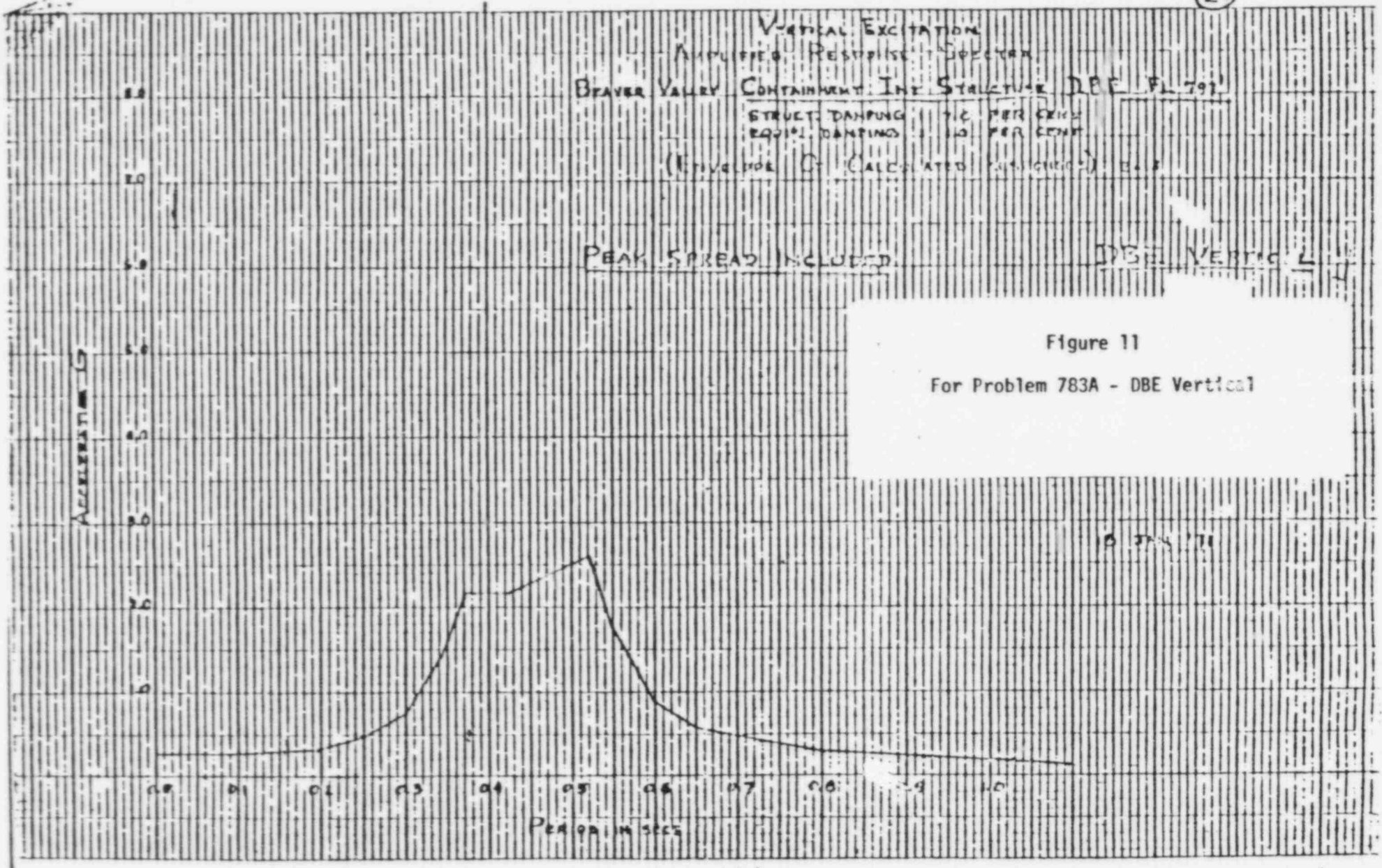


Figure 11

For Problem 783A - DBE Vertical

LISTING IS O.K. CURVE 520

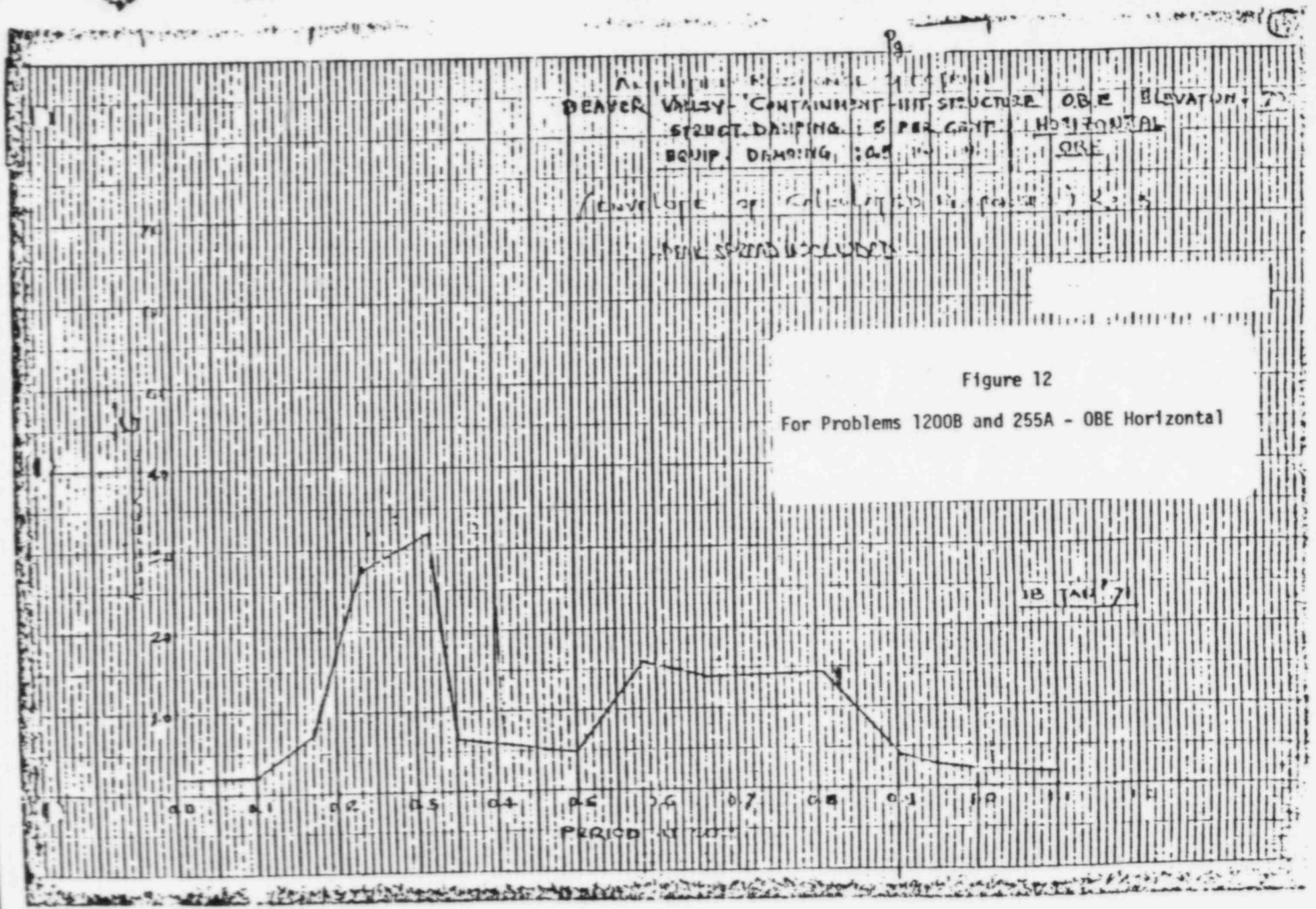


Figure 12

For Problems 1200B and 255A - OBE Horizontal

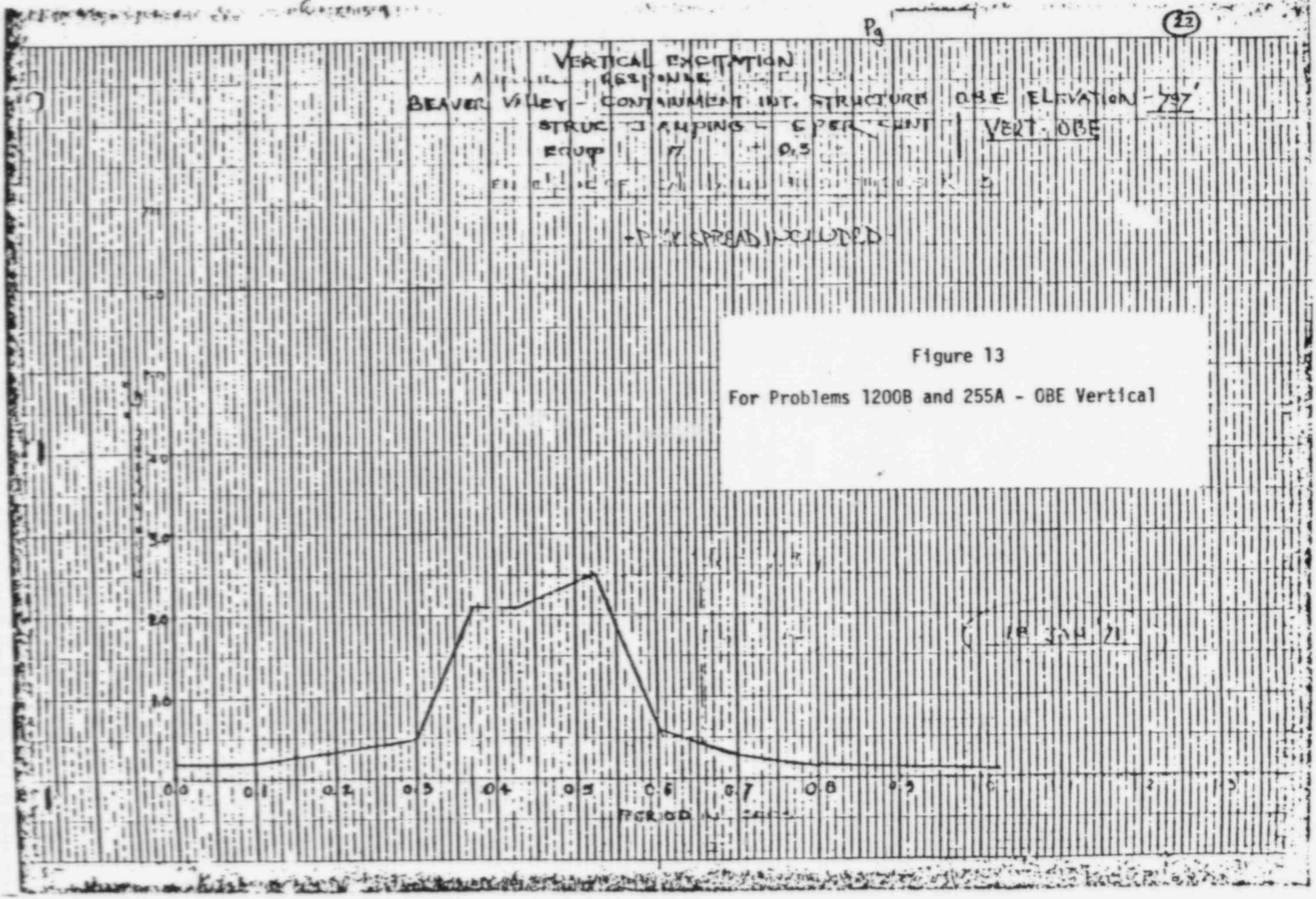


Figure 13

For Problems 1200B and 255A - OBE Vertical

LISTING IS O.K.

CURVE 520

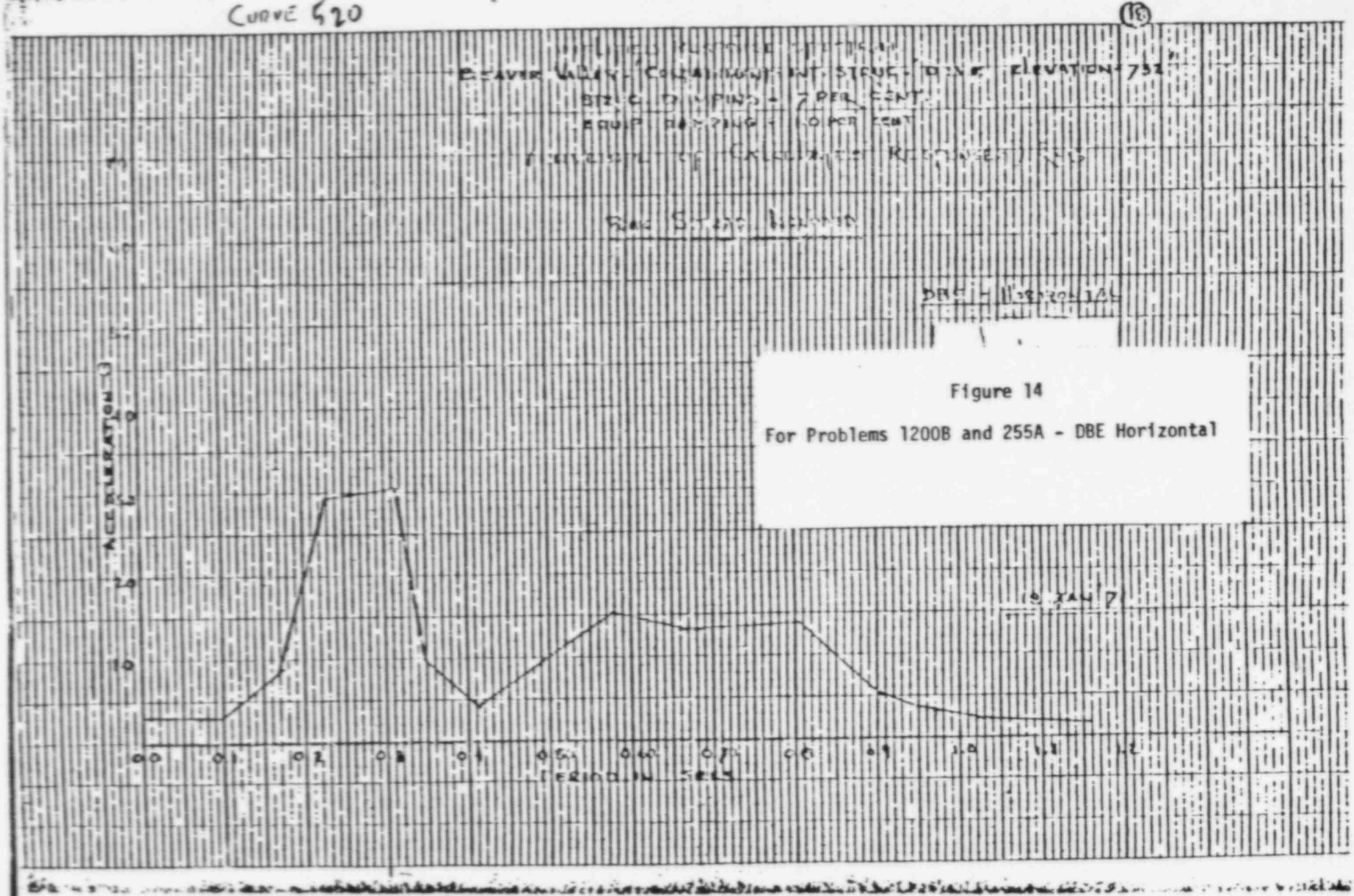


Figure 14

For Problems 1200B and 255A - DBE Horizontal

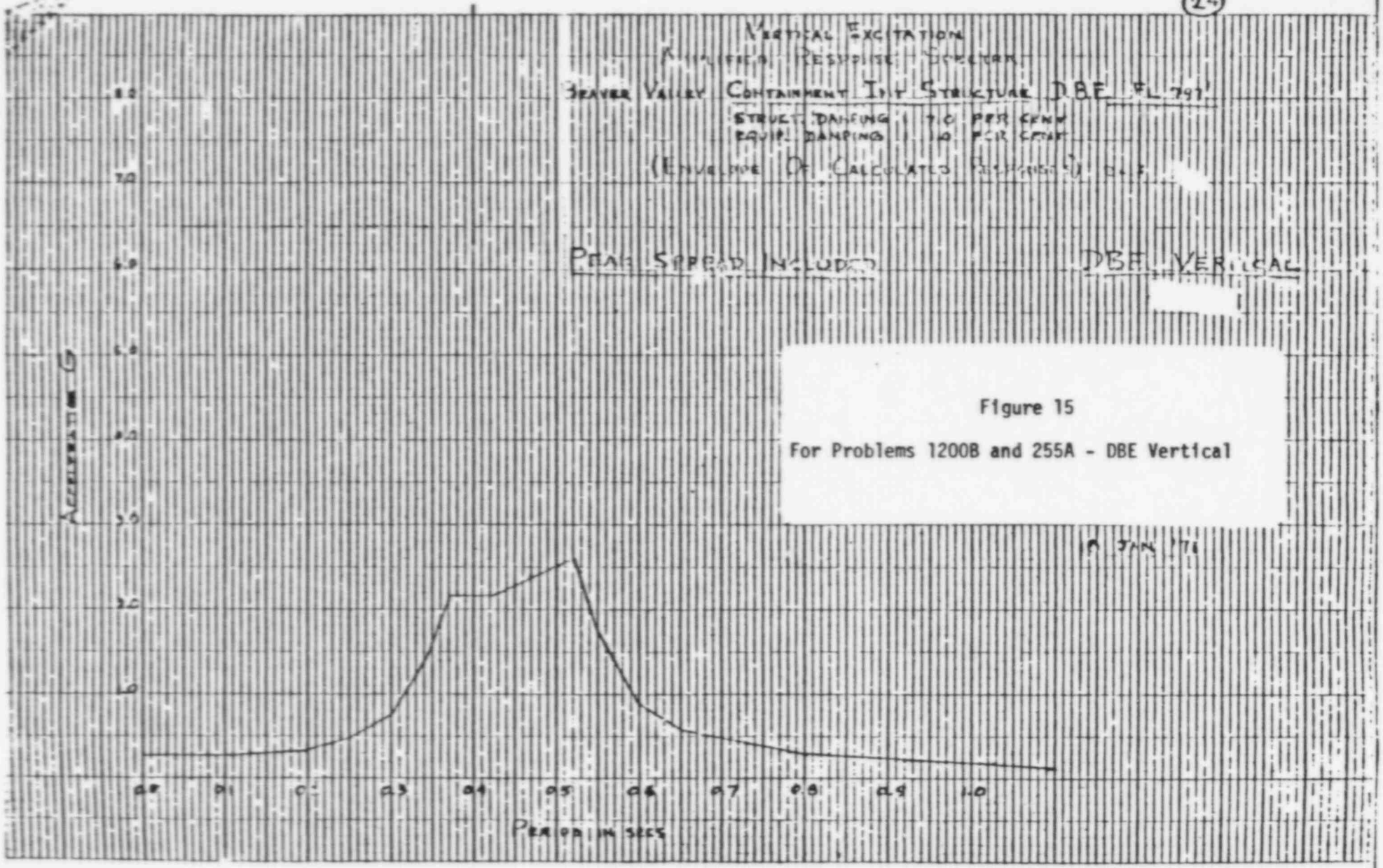


Figure 15

For Problems 1200B and 255A - DBE Vertical

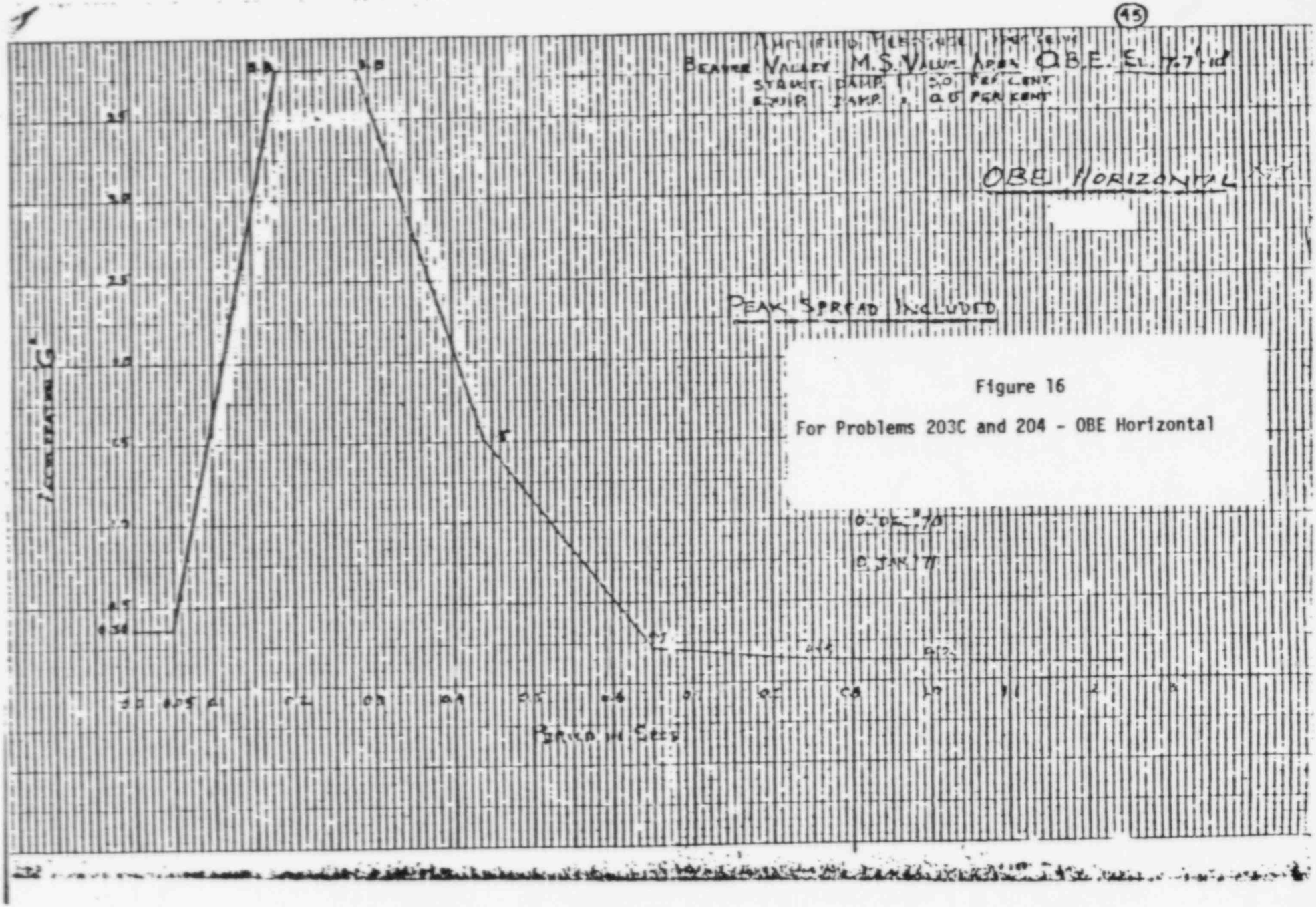


Figure 16

For Problems 203C and 204 - OBE Horizontal

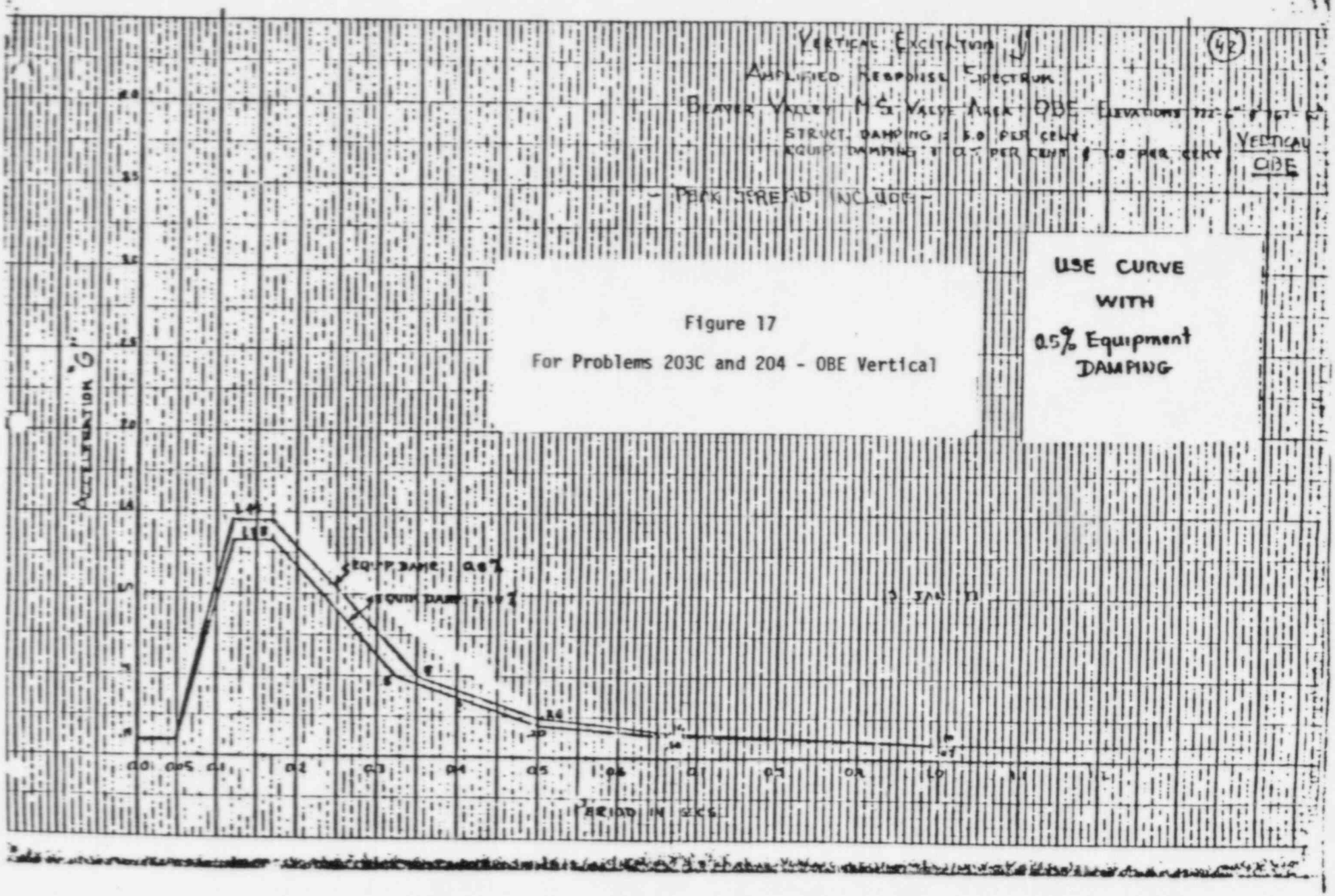


Figure 17

For Problems 203C and 204 - OBE Vertical

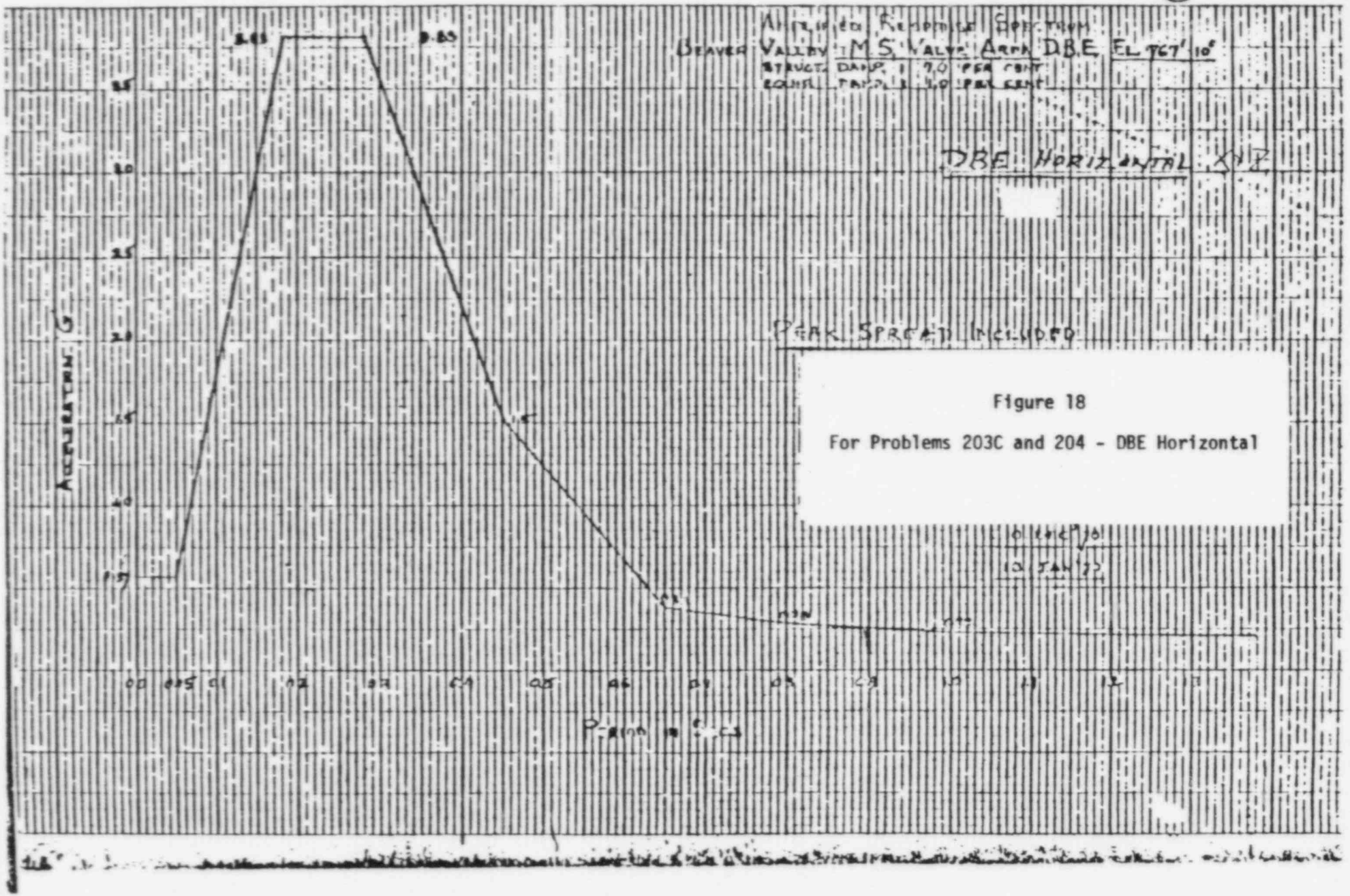
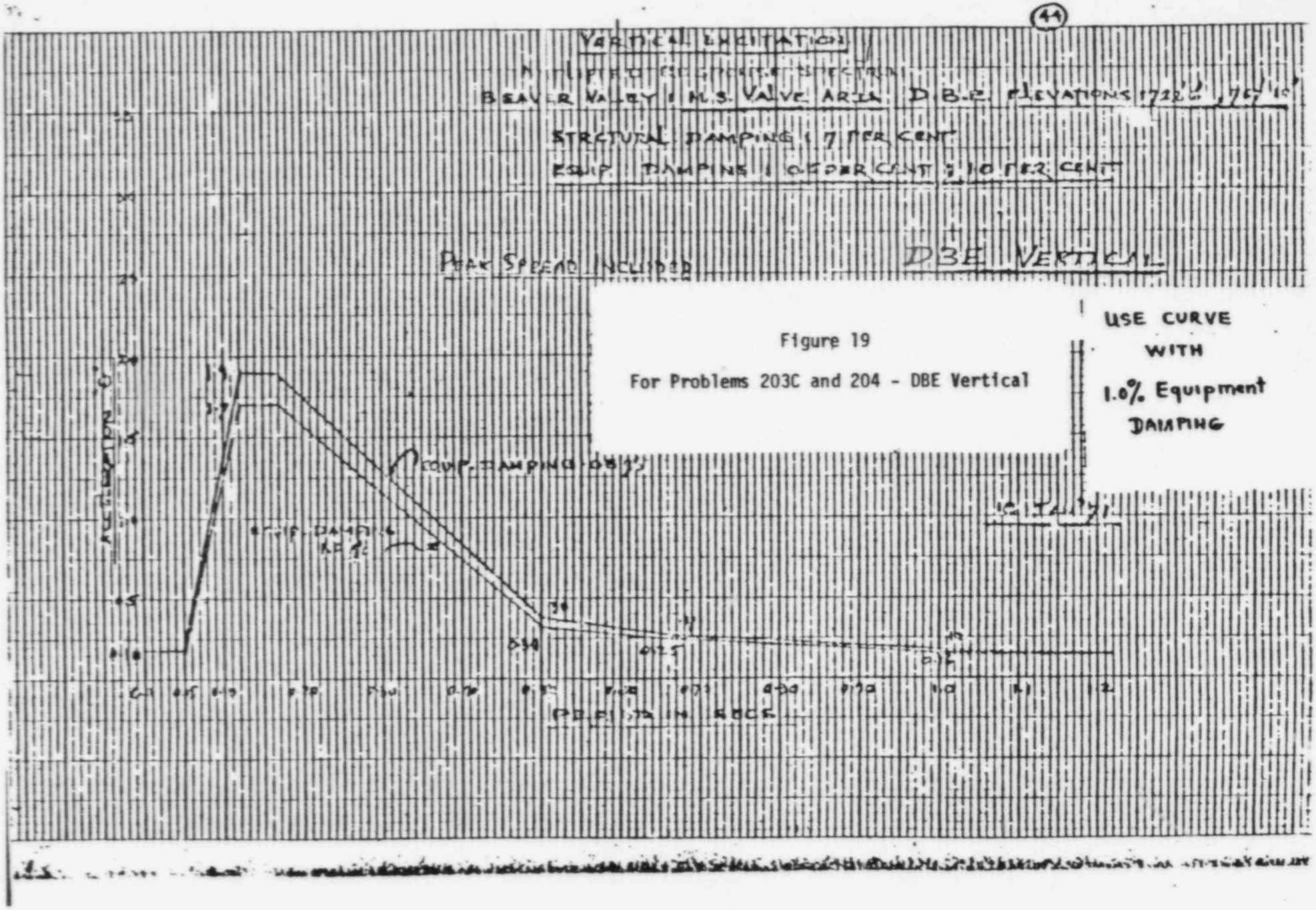


Figure 18

For Problems 203C and 204 - DBE Horizontal


VERTICAL EXCITATION
BEAVER VALLEY I N.S. VALVE AREA D.B.E. ELEVATIONS 1712'-0", 767'-10"
STRUCTURAL DAMPING 1.7 PER CENT
EQUIP. DAMPING 1.0 PER CENT, 10 PER CENT
PEAK SPEAD INCLUDED
DBE VERTICAL
USE CURVE WITH 1.0% Equipment DAMPING
Figure 19
For Problems 203C and 204 - DBE Vertical
EQUIP. DAMPING 0.5%
ACCELERATION IN "G"
FREQUENCY IN CPS